P20671

128

INDEX

NAME INDEX

ott (W.), Machine Drawing and Design: a Textbook of Intermediate Standard for Engineering Students, 962
(Yoshio), The Wolf of Corea, 71
ous (J. E.), and R. Argaud, Formation of Adrenaline in the Suprarenal Gland, 682
ti (G.), Height of the Chromosphere in 1930, 1014
ham (J. J.), The late Mr. Herbert Tomlinson, F.R.S., 153
ard (C.), and A. Boutaric, Some Physical Properties of the Blood Serum in Lipoid Nephrosis, 315; and M. Doladilhe, The Physical Properties of the Blood Serum and of the Proteins separated from this Serum, etc., 555; and R. Arcand, The Physical Properties of the Serum Proteins and of the Hydropic Serosities in Lipoid Nephrosis, 646
erman (J. W.), [W. D. Bancroft, Catharine Gallagher, and], Optical Sensitisation, 846
ams (W. S.), elected President of the American Astronomical Society, 634
amson (J.), [death], 404
eew (N. W.), [N. S. Kurnakow and], Physico-chemical Study of the Gold-Copper Solid Solutions, 554
amon (Dr. A.), [death], 486
nslie (Capt. M. A.), Sir William Herschel's Mirrors, 1007
roldi (M.), Fossil Corallinaceæ from the Canaries (2), 735
den (Dr. H. L.), The Year's Progress in Astronomy, 801; Van Gent's Short Period Variable, 641
man (A. R.), The Meteorite Craters at Henbury, Central Australia, 977
nder (Dr. F. W.), Braille M[illegible] for teaching Electricity and Magnetism to the [illegible] 698
nder (H. G.), Bird Song and W[illegible] 549
xander (Prof. S.), Prof. H. Wildon Carr, 99; Purpose of a University, 385
xander (W. B.), Control of Prickly-Pear by the Cochineal Insect, 226
nko (N. F.), Diatoms growing on Stones on the Black Sea Littoral near Sebastopol, 422
(W. E.), Experiments in Wire-drawing (2), 594; W. Cartwright, Experiments in Wire-drawing (1), 4
(Prof. W. C.), Animal Aggregations: a Study in General Sociology, 940
(E. Patricia), and P. Smith, Selection of Skilled Apprentices for the Engineering Trades, 463
(F. J.), and R. B. Moore, Krypton and Xenon, 380
and Hanburys, Ltd., Insulin Therapy, 461
one (Dr. T. E.), [Dr. B. F. J. Schonland, and], Branching of Lightning, 794
n (A. H. G.), Supplement 6 to Trimen's "A Hand-Book to the Flora of Ceylon," 891
rof. T.), Reflection of Water Molecules at the id Surface, 72
(M.), Mercury Derivation of Divalent Bromo-[illegible]rols, 647
(H. R.), The Direct Determination of Nitrogen in ses, 845
R.), [A. Boutaric and], Experimental Researches the Adhesion of Lubricating Layers to Metals, 882
lingam (C.), [Prof. J. H. Orton and], Sex-change he Oyster, 273
Amoudruz (G.), [A. Jayet and], The Discovery of Magdalenian Deposits near Frangy (Haute Savoie), 1087
Amstutz (A.), The Petrographic Character of Banks Island in Melanesia, 734
Anderson (H. V.), and K. C. Chesley, X-Ray Analysis of Slate, 1043
Anderson, [Newton and], Respiration of Wheat at Low Temperature, 970
Andrade (Prof. E. N. da C.), The Viscosity of Liquids, 835
Andrew (Prof. J. H.), appointed Professor of Metallurgy in Sheffield University, 975
Andrews (H. E.), Catalogue of Indian Insects. Pt. 18, 867
Andrews (J.) and others; edited by Prof. R. Hegner and J. Andrews, Problems and Methods of Research in Protozoology, 395
Andrews and Bacon, Production of High Vacua, 121
Andruetto (G.), The Intrinsic Equations of Elastic Equilibrium, 734
Annequin (R.), [L. Bert and], A New Method of Synthesis of Einnamic Aldehyde and its Homologues substituted in the Nucleus, 125
Antoniani (C.), Behaviour in an Electric Field of Colloidal Humic-mineral Complexes, 735
Appleton (Prof. E. V.), Polarisation of Downcoming Wireless Waves in the Southern Hemisphere, 1037; and G. Builder, Wireless Echoes of Short Delay, 918
Arber (Dr. Agnes), Structural Features of the Cruciferous Flower, 1043
Arcand (A.), [C. Achard, A. Boutaric, and], The Physical Properties of the Serum Proteins and of the Hydropic Serosities in Lipoid Nephrosis, 646
Archangelskii (A.), and D. Perkin, Origin of the Ferrous Deposits in the Lipetsk Area, 163
Arditti (G.), The Oxidation of Paraffin Oil, 882
Argaud (R.), [J. E. Abelous and], Formation of Adrenaline in the Suprarenal Gland, 682
van Arkel (A. E.), und J. H. de Boer, Deutsche, von den Verfassern autorisierte Ausgabe von L. Klemm und W. Klemm, Chemische Bindung als elektrostatische Erscheinung, 816
Arkell (Dr. W. J.), [Dr. K. S. Sandford and], Palæolithic Man and the Nile-Faiyum Divide: a Study of the Region during Pliocene and Pleistocene Times, 287; [J. A. Douglas and], The Stratigraphical Distribution of the Cornbrash (2), 125
Arkwright (J. A.), and others, A System of Bacteriology in Relation to Medicine. Vol. 6, 888
Armellini (G.), The Horizontal Diameter of the Sun in 1929 and 1930, 1014; The Theory of the Variability of the Family of Mira Ceti, 646
Armstrong (Dr. E. F.), Paper Making, 949; Problems of the Mineral Industry, 508
Armstrong (Prof. H. E.), Cosmic Evolution and Earthly Needs, 761; The Dyestuff Industry, 542
Armstrong (J. I.), awarded a Beit Fellowship for Scientific Research, 161
Arnot (Dr. F. L.), appointed Lecturer in Natural Philosophy in the United College, St. Andrews, 81; Diffraction of Electrons, 799
Arnulf (A.), La mesure des rayons de courbure des surfaces sphériques employées en optique, 323

Arrivaut (G.), Action of Arsenic Chloride upon Nickel, 82
Ashbridge (N.), Acoustical Problems of Broadcasting Studios, 844
Ashcroft (E. W.), Faraday, 323
Ashworth (Dr. J. R.), The Specific Heat of Ferromagnetics and Ewing's Model of the Magnetic Atom, 1003
Askania-Werke A.-G., Photographic Vibrograph, 460
Askew (F. A.), Miss H. M. Bruce, Dr. R. K. Callow, J. St. L. Philpot, and T. A. Webster, Crystalline Vitamin D, 758
Aston (Dr. F. W.), Atomic Weights deduced from Mass-spectra, 460; Constitution of Lithium, 149; Constitution of Thallium and Uranium, 725; New Isotopes of Strontium and Barium, 221; The Unit of Atomic Weight, 731
Atkins (Dr. W. R. G.), Accuracy obtainable with Gas-filled Photoelectric Cells, 550; Radiation and Life, 199; The Penetration of Light through Successive Layers of Tissue Paper, 545; The Treatment of 'Gapes' in Chickens, 585; and Florence A. Stanbury, Illumination and Tree Growth, 191
Atkinson (Ll. B.), The Mechanical Aspects of Electricity (Thomas Hawksley Lecture), 865
Atkinson (Dr. R. d'E.), Atomic Synthesis and Stellar Energy, 194
Van Aubel (Prof. E.), Diamagnetism of Liquid Mixtures, 455; Rotatory Magnetic Polarisation, 1004
Auden (Dr. H. A.), and Dr. W. P. Joshua, Saccharification of Wood, 1045
Audubert (R.), The Rôle of Water in Photovoltaic Cells, 466; and J. Roulleau, The Rôle of the Phenomena of Photoconductance in the Photovoltaic Effect, 555
Auger (P.), and C. Lapicque, Variation in the Spectrum of the Sensibility of Cuprous Oxide Cells, 646
Aughtie (Dr. F.), A Remote Electrically Recording Accelerometer with particular reference to Wheel-impact Measurements, 918; A Remote Electrically Recording Load-gauge for Wheel-impact Measurements, 918
Austin (H. O.), Insulation of Overhead Transmission Cables, 416
Aveling (Dr. F. A. P.), Conferment upon, of the title of Professor, 975
Ayling (Jean), The Behaviour of Young Children, 777
Ayyar (T. V. Ramakrishna), Control of Prickly-Pear by the Cochineal Insect, 837

Baade (Dr. W.), A New Cluster of Faint Nebulæ, 641
Baba (Kikutaro), A supposed Primitive Gill-less Nudibranch, 728
Babička (J.), Polarographic Analysis with the dropping Mercury Cathode of Extracts from Plant Tissues, 1013
Bacon, [Andrews and], Production of High Vacua, 121
Badami (J. S.), [Prof. A. Fowler and], Spectrum of the Hydrogen-nitrous Oxide Flame, 881; [Dr. K. R. Rao and], Resonance Spectrum of Hydrogen, 585; and Dr. K. R. Rao, The Structure of the Spectrum Se III, 496
Badger (Prof. W. L.), and Prof. W. L. McCabe, Elements of Chemical Engineering, 622
Badley (J. H.), The Will to Live: an Outline of Evolutionary Psychology, 954
Badoche (M.), [C. Dufraisse and], Researches on the Dissociable Organic Oxides, 422, 503
Bailey (C. R.), and A. B. D. Cassie, Infra-Red Absorption Spectrum of Carbonyl Sulphide, 637
Bailey (Prof. E. B.), Representation of Crystal Structure, 869
Bailey (Mrs. F. M.), awarded the Brewster-Medal of the American Ornithologists' Union, 998
Bailey (Dr. G. H.), and H. W. Bausor, Chemistry for Matriculation. Third edition, 173
Bailey (Dr. K. C.), The 'Lapides palmati' mentioned in the "Historia Naturalis" of the Elder Pliny, 672
Bailey (Prof. S. I.), [death], 13
Bailly (O.), and R. Netter, The Isolation of Carotene from the Suprarenal Glands, 1086
Bainbridge (K. T.), Isotopes of Lithium, Sodium, and Potassium, 876
Baird and Tatlock (London), Ltd., Analytical Reagents, Standards, and Tests, 65
Baker (J. R.), Spermicidal Power of Chemical Con ceptives, 119
Baker (Prof. R. H.), Astronomy: an Introduction, 56
Baker (R. T.), On a Fossil Timber from the Sydney bour Colliery, 806
Baker (W.), A Two-Dimensional Space Lattice? 1078
Bakker (Dr. C. J.), [E. Segré and], Zeeman Effect Forbidden Line, 1076
Balavoine (P.), A Formula for the Determination of Alcoholic Strength of Brandy, 279; The Analy Characters of Caramel regarded as a Colouring M for Food, 83
Bald (J. G.), [G. Samuel and], *Thrips tabaci* as a V of Plant Virus Disease, 494
Baldet (F.), The Raffety Bands and the Spectra of Co 234
Baldwin (Prof. J. Mark), Gift to the Edward Bag Poulton Fund of Oxford University, 975
Balfour-Browne (J. W. A. F.), elected a Frank Sm Student in Zoology at Gonville and Caius Coll Cambridge, 768
Ballantyne (W. H.), The Cost of Patent Litigation, 7
Balls (Dr. W. L.), and others, Operation of the Control Law upon the Pedigree of Cotton Se Developments of the Existing System for Seed Su of Cotton in Egypt, 766
Balme (G.), [R. de la Boulaye and], Velocity of Propaga of Musical Sounds, 646
Bancroft (W. D.), and J. E. Rutzler, jr., Revers Coagulation in Living Tissue, (2) 280, 1014; G. H. Richter, (3) 423, (4) 846; J. W. Ackerman, Catharine Gallagher, Optical Sensitisation, 846; S. F. Whearty, jr., Activation by Charcoal, 280
Banting (Dr. F. G.), awarded the Flavelle Medal of Royal Society of Canada, 275
Barbieri (G. A.), Molybdo-octocyanides, 647; Rhodi Compounds, 683
Barcroft (Prof. J.), [Dr. R. Lemberg, Dr. D. Keilin, and Uteroverdin, 967
Bardet (J.), [C. Levaditi, A. Tchakirian, A. Vaisman, and The Distribution of Gallium in the Organism, 466
Barksdale (J. D.), [Dr. J. A. Cushman and], Tertiar Foraminifera, 1080
Barnard (Dr. F.), [death], 666
Barnard (J. E.), and W. J. Elford, The Causative Organis in Infectious Ectromelia, 917
Barnell (H. R.), appointed Frank Smart University Student in Botany in Cambridge University, 844
Barnes (Dr. A. S.), appointed Dean of the Faculty Medicine of Birmingham University, 80
Barnes (Bishop E. [illegible]), The Evolution of the Universe, 7
Barnett (Dr. [illegible]), appointed Curator of Reptiles of t Zoological Society's Gardens, 1036
Barnett (Dr. M. A. F.), Radio Observations during a So Eclipse, 381
Barnett (Prof.), A New Electron-Inertia Effect, 549
Barnitt (J. B.), and R. H. Heilman, Heat Insulation o Furnaces, 971
Baron (C.), C. Boulanger, and R. Le Grain, Petrol-alcohol-benzene Mixtures, 163
Barr (Prof. A.), [death], 266; [obituary article], 294
Barr (Dr. G.), A Monograph of Viscometry, 947
Barrett (B. H.), [Prof. J. W. Gregory and], Gener Stratigraphy, 945
Barrett (C.), The Habits of *Megascolides australis*, 669
Barrett (Sir James W.), Nationalism and Science in Chin 1035; Preservation of the Australian Flora and Fau 1041
Barritt (N. W.), Cotton Growing in Egypt, 1001
Barry (T. H.), Oil from Malayan *Aleurites Montana* the Properties of Hong Kong Oil, 1086
Bartlett, jr. (J. H.), Isotopic Displacement in Hyp Structure, 408
Bartoszewiczowna (Mlle. E.), [W. Swietolawski and plication of the Adiabatic Microcalorimeter Determination of the Heat of Adsorption and of isation, 126
Barve (P. M.), [Dr. B. N. Desai and], Coagulat Colloids by Electrolytes, 907
Bastow (S. H.), and F. P. Bowden, On the Co Smooth Surfaces, 881

Basu (P. C.), [Dr. B. S. Guha and], Human Skulls and Bones from the Naga Hills, 762
Bate (A. E.), The Bottle-Pipe Resonator, 270
Bates (J. R.), [G. E. Kimball and], The Band Spectrum of AsH, 969
Bateson (G.), elected a Fellow of St. John's College, Cambridge, 768
Bather (Dr. F. A.), Echinoderm Larvæ, 417
Baur (Dr.), Plant Breeding in Germany, 975
Bausor (H. W.), [Dr. G. H. Bailey and], Chemistry for Matriculation. Third edition, 173
Beadle (G. W.), Supernumerary Cell Divisions in Maize, 191
Beadle (L. C.), awarded a Grant from the Balfour Fund of Cambridge University, 880
Bearden (Dr. J. A.), Absolute X-Ray Wave-lengths, 156
Beattie (Prof. J. M.), Foot-and-Mouth Disease Research, 765; Studies in Immunity, 888
Beauvais (G.), [C. Gutton and], Oscillators with very Short Waves, 1013
Becke (Prof. F.), [death], 13
Beckett (H. E.), [A. F. Dufton and], Measurement of Ultra-Violet Radiation, 223; Unusual Lightning, 189
Becquerel (J.), and L. Matout, The Decomposition of the Absorption Bands of Xenotime by a Transverse Magnetic Field, 466
Bedford (Lieut.-Col. Sir Charles), [death], 143; [obituary article], 178
Beebe (Dr. W.), The Bermuda Oceanographic Expedition, 406
Beghin (H.), and Prof. G. Julia, Exercices de mécanique. Tome 1, fasc. 2, 514
Bĕlař (Dr. K.), [obituary article], 59
Beliankin (D.), Anemusite (with reference to Pacifites of Barth), 422
Belin (E.), The Secrecy of Telegraphic and Radiotelegraphic Transmissions, 421
Bell, Bart. (Sir Hugh), [death], 13; [obituary articles], 96, 98
Bendien (Dr.), Method of Diagnosis of Cancer, 438
Bendrihem (A.), [J. Roche and], The Combination of Globin with Hæmatins of various Origins, 646
Benedicks (Dr. C.), and H. Löfquist, Non-Metallic Inclusions in Iron and Steel, 856
Benedict (Ruth), Folk-Tales of the Cochita, New Mexico, 970
Benham (Dr. F. C.), appointed University Reader in Commerce in London University, 804; Fluctuations in Employment in Great Britain, 753
Bennett (S. A.), awarded the Medal of the Belfast Naturalists' Field Club, 757
Bennett (Victoria E. M.), and Dr. Susan Isaacs, Health and Education in the Nursery, 690
Bennett (Dr. W. C.), Hawaiian Temples, 497
Benson (Sir J. Hawtrey), [death], 696
Bentley (B. H.), appointed Professor of Botany in Sheffield University, 1048
Berg (L.), The Black Sea Sprat, 770
Bergey (D. H.), and others, Bergey's Manual of Determinative Bacteriology: a Key for the Identification of Organisms of the Class Schizomycetes. Third edition, 6
Bergius (Dr. F.), joint sharer of the Nobel Prize for Chemistry for 1931, 864
Bergmann (Dr. E.), and W. Schutz, Structure of the Azides, 1077
Bergmann (Dr. L.), A Photoelectric Relay, 677
Berkeley (L. M.), Addition-Subtraction Logarithms to Five Decimal Places, 91
Bernheim (Mlle. Germaine), Preparation of the Cyanamides of the Earths and Alkaline Earths, 315
Berry (Dr. R. J. A.), and Dr. R. G. Gordon, The Mental Defective: a Problem in Social Inefficiency, 954
Bert (L.), and R. Annequin, A New Method of Synthesis of Einnamic Aldehyde and its Homologues substituted in the Nucleus, 125
Bertrand (G.), and P. de Berredo Carneiro, The Active Principle of Guarana, 555; and P. Serbescu, The Toxic Power of Aluminium compared with that of Iron, Nickel, and other Metals, 466
Bertyn (F.), The Poisonous Effect of the Fogs of the Meuse Valley due to Industrial Emanations, 422
Best (Elsdon), [obituary article], 929
Besterman (T.), Some Modern Mediums, 92
Betti (M.), and P. Pratesi, Optical Resolution of Racemic Aldehydes (2), 1014
Bevans (C. A.), [C. E. Parmenter, S. N. Trevino, and], Articulation of Isolated Sounds, 380
Bews (Prof. J. W.), The Ecological Viewpoint, 245
Beyer (Prof. S. W.), [death], 59
Bhagavantam (S.), Effect of Pressure on Raman Spectra, 188; Intensity of Raman Scattering in Gases, 272; Polarisation of Raman Scattering by Hydrogen Gas, 70; [Sir C. V. Raman and], Evidence for the Spin of the Photon from Light-Scattering, 114; Experimental Demonstration of Spin of Light, 576; Spin of Light Quanta, 727
Bhargava (Y.), [Prof. M. N. Saha and], The Spin of the Photon, 870
Bickford (William), Centenary of the Discovery of the Bickford Miner's Safety Fuse, 576
Biden (C. L.), Sea-Angling Fishes of the Cape (South Africa), 209
van Biesbroeck (Prof. G.), Comet Notes, 416
Biffen (Sir R. H.), Rust Diseases of Cereal Crops, 728
Bigot (A.), and J. Dubois, The Presence of the Ordovician in the Moroccan Anti-Atlas, 555
Bilham (E. G.), Meteorology and Agricultural Research, 667
Billy (M.), and F. Trombe, The Preparation of Pure Cerium, 734
Binet (L.), and J. Magrou, Sulphur and Growth, 466; and N. V. Strumza, The Hæmatopoietic Power of Carotene, 387
Bingham (R. T. W.), and others, Reflection of X-Rays, 641
Birckner [Seidell and], Anti-Neuritic Vitamin, 229
Birula (A. A.), The Metacarpalia and Metatarsalia of *Ursus spelæus* Rosenm., 163; The Rodents from the Quaternary Deposits in the Crimea, 127
Bishop (L. R.), Nitrogen Contents of Barley and its Wort, 308
Bjerknes (Prof. V. F. K.), awarded the Symons Gold Medal of the Royal Meteorological Society, 931; Dynamical Aspects of Electromagnetism, 369
Blacktin (S. C.), Properties of Aerosols, 968; and H. Robinson, Electrification of Coal Dust, 498
Blair (E. W.), [death], 13
Blanc (G. A.), Certain Properties of the Silica remaining after attacking Leucite with Acids, 647
Blanc (G.), and J. Caminopétros, Experimental Researches on the Sensibility of Domestic Animals . . . to the Virus of Exanthematic Fever, 503
Blanchard (Prof. A. A.), and Prof. J. W. Phelan, Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. Fourth edition, 92
Blanesburgh (Lord), inaugural address at opening of new session of the Sir John Cass Technical Institute, 611
Blazey (C.), Brittleness in Copper, 594
Bleek (Miss D. F.), The Hadzapi or Watindega of Tanganyika, 379
Bless (A. A.), Composition of the Interior of the Earth, 280
Bligh (E. W.), [S. G. B. Stubbs and], Sixty Centuries of Health and Physick: the Progress of Ideas from Primitive Magic to Modern Medicine, 939
Bligh (N. M.), Nightingale's Magnetism and Electricity, 959; Shearcroft's Post-Primary Science. Book 1, 960; Toms's School Certificate Magnetism and Electricity, 431
Blina (Dr. L. V.), Detection of Syphilis, 459
Bloch (E.), [L. Bloch, F. Esclangon, and P. Lacroute], Observation of the Zeeman Effect with High Frequency, 386
Bloch (L.), E. Bloch, F. Esclangon, and P. Lacroute, Observation of the Zeeman Effect with High Frequency, 386
Bloch (O.), The Faith of a Technical Man, 901
Boas (Prof. F.), Race and Progress, 557
Bocciarelli (D.), A Hard Component of the β-Radiation of Potassium, 374
de Boer (J. H.), [A. E. van Arkel und], Deutsche, von den Verfassern autorisierte Ausgabe von L. Klemm und W. Klemm, Chemische Bindung als elektrostatische Erscheinung, 816

Bohn (G.), and Mme. Anna Drzewina, Influence of Metallic Silver on the Calcification of the Larvæ of the Sea-urchin, 806

Bohn (P. R.), The Mechanism of the Synthesis of Fats at the Expense of Glucides, 770

Bohr (Prof. Niels), Maxwell and Modern Theoretical Physics, 691

Du Bois (A. H.), Variations of the Blood Serum Albumins under the influence of Reticulo-Endothelial Blocking, 279

Du Bois [McBain and], Electrokinetics and the Interpretation of Surface Conductivity, 677

Bolam (Dr. T. R.), Condition of Sparingly Soluble Substances in Gelatine, 222

Bölla (Dr. G.), Structure of the Raman Band of Water, 546

Bonacina (L. C. W.), [J. E. Clark, I. D. Margary, R. Marshall, Capt. C. J. P. Cave, and], Phenological Observations in the British Isles from Nov. 1929 to Nov. 1930, 917

Bonar (Dr. J.), Theories of Population from Raleigh to Arthur Young, 940

von Bonde (Dr. C.), The Correlation between Marine Biology and the Problems of the Fishing Industry, 801

Bone (Prof. W. A.), Photographic Analysis of Explosion Flames, 589; The Slow Combustion of Methane and Ethane, 188; R. P. Frazer, and W. H. Wheeler, Flame Propagation in an Electric Field, 274

Bonino (G. B.), and L. Brull, Raman Spectrum and Chemical Constitution of Certain Chloroethylenes, 595; Raman Spectrum of Dichlorobromomethane, 1051; and P. Cella, Raman Spectra of Hydrogenated Derivatives of Naphthalene, 1051

Bonnet (Prof.), A Sea-lion Census, 640

Bonvicini (D.), Certain Fundamental Theorems of Electrodynamics and of the Statics of Elastic Solids (2), 806

Booker, [Rollefson and], Photochemical Decomposition of Hydrogen Iodide, 72

Boothman (Flight-Lieut. J. N.), Aeroplane Speed Record, 490

Borloz (A.), Liquation Phenomena in a Coinage Bronze, 734

Borsook (H.), and H. M. Winegarden, Work of the Kidney in the Production of Urine; The Energy Cost of the Excretion of Urine, 83

Bosch (Dr. C.), joint sharer of the Nobel prize for chemistry for 1931, 863

Bose (Prof. D. M.), and S. Datta, Absorption Spectra of the Ce^{+++} Ion in Solution, 270; Raman Lines due to Co-ordination Bond, 725

Bosscha (Johannes), Centenary of the birth of, 822

Bougault (J.), and G. Schuster, Composition of Karité Butter, 682; and J. Guillou, Some Reactions of certain Barbituric Derivatives, 770

Boulanger (C.), [C. Baron, R. Le Grain, and], Petrol-alcohol-benzene Mixtures, 163

de la Boulaye (R.), and G. Balme, Velocity of Propagation of Musical Sounds, 646

Boulenger (E. G.), Dr. Joan B. Procter, 664

Boulton (E. H. B.), reappointed university lecturer in forestry in Cambridge University, 844

Bourguel (M.), [R. Lespieau, R. L. Wakeman, and], The Raman Effect in Chemistry, 503

Bourne (Prof. G. C.), appointed Chairman of the Advisory Committee of the Development Commissioners on Fishery Research, 184

Boutaric (A.), [C. Achard and], Some Physical Properties of the Blood Serum in Lipoid Nephrosis, 315; [C. Achard, A. Arcand, and], The Physical Properties of the Serum Proteins and of the Hydropic Serosities in Lipoid Nephrosis, 646; [C. Achard, M. Doladilhe, and], The Physical Properties of the Blood Serum and of the Proteins separated from this Serum, etc., 555; and R. Amiot, Experimental Researches on the Adhesion of Lubricating Layers to Metals, 882

Bowden (E.), [M. Hochstadter, W. Vogel, and], An Improved Method of constructing High-voltage Cables, 933

Bowden (F. P.), [S. H. Bastow and], On the Contact of Smooth Surfaces, 881

Bowen (Dr. I. S.), [Prof. R. A. Millikan and], Similarity between Cosmic Rays and Gamma Rays, 582

Bowen (R. E.), Movement of the so-called Hairs in the Ampullar Organs of Fish Ears, 280; The Cupula of the Ear, 846

Bower (Dr. E. C.), Orbit and Mass of Pluto, 1047

Bowie (Dr. J. A.), Rationalization, 92

Bowman (W. D.), The Story of Surnames, 743

Boycott (Prof. A. E.), Nature of Viruses, 727

Boylan (R. K.), The Mobilities of Atmospheric Large Ions, 1013

Boys (Prof. C. V.), Carbon Contacts, 968; Electric Pendulum Clocks, 651

Bozman (A. M.), A School Algebra: as far as the Advanced Course in the School Certificate Stage, 1061

Bozza (Dr. G.), Mechanism of Drying, 380

Bradbrooke (F. D.), The Light Aeroplane Manual, 961

Bradford (Dr. S. C.), Classification for Bibliography of Science, 268; Condition of Sparingly Soluble Substances in Gelatine, 223

Bradshaw (W. N.), [S. G. Clarke and], The Calcium Fluoride Method for the Determination of Fluoride, 1086

Bragg (Prof. W. L.), awarded the Hughes Medal of the Royal Society, 821; presented with the Hughes Medal of the Royal Society, 974; The Architecture of the Solid State (Kelvin Lecture), 210, 248; The New Crystallography, 511

Brasch (A.), and F. Lange, Utilisation of Atmospheric Electric Fields, 380

Brauner (Prof. B.), The Faraday Festival, 352; and E. Švagr, A Physico-chemical Study of the Sulphates of the Rare Earths, 1013

Brauns (D. A.), Optical Rotation and Atomic Dimension, 876

Bray (T.), Television and Atmospherics, 439

Bretscher (Dr. K.), Bird Migration in Switzerland, 676

Bridel (M.), and Mlle. A. Kramer, The Constitution of Asebotoside (Asebotine): its Identity with Phlorizoside (Phlorizine), 978

Bridges (Dr. C. B.), The Gene and the Theory of Living Structures, 991

Briggs (Prof. H.), Classification of Carbonaceous Minerals, 72; Relation between the Yield of Crude Oil and the Composition of Retortable Carbonaceous Minerals, 42

Bright (Sir Charles), Let's Help! a Collection of Good Causes, 989

Brighton (A. G.), appointed Curator of the Sedgwick Museum of Geology, Cambridge University, 804

Briner (E.), A. Demolis, and H. Paillard, The Ozonation of Aldehydes and the Theory of Active Molecules, 235; and B. Susz, The Maximum Concentration of Endothermic Compounds at High Temperatures, 83

Briquet (A.), Le littoral du nord de la France et son évolution morphologique; suivi d'un appendice: L'évolution du rivage du nord de la France et l'activité de l'homme, 396

Briscoe (Prof. H. V. A.), and others, The Atomic Weight of Thallium, 763

Briscoe, Robinson, and Stoddart, Rhenium Compounds, 192, 729

Bristol (Prof. C. L.), [death], 666

British Drug Houses, Ltd., Insulin Therapy, 461; Products of the, 406; Specialities of, 866

Britton (L.), Hunger and Love, 475

Bromehead (C. N.), The London Skull, 118

Bronsdon (H. W.), and E. H. S. van Someren, Application of the Spectrograph to the Analysis of Non-ferrous Metals and Alloys, 554, 802

Bronson (B. S.), Nutrition and Food Chemistry, 856

Brooks (F. T.), Forestry Research in Great Britain, 118

Brooks (Matilda Moldenhauer), The Penetration of 1-naphthol-2-sulphonate Indophenol, etc., 83

Broom (Dr. R.), The Origin of the Human Skeleton: an Introduction to Human Osteology, 4

Brose (Dr. H. L.), appointed Professor of Physics at Nottingham University College, 81

Brouwer (D.), [Prof. E. Brown and], Analysis of Clock Records, 38

Brown (Dr. A. N. Rudmose), appointed Professor of Geography in Sheffield University, 1048

Brown (Prof. E.), and D. Brouwer, Analysis of Clock Records, 38

Brown (F. J.), The Cable and Wireless Communications of the World. Second edition, 1057

Brown [Newton and], Respiration of Wheat at Low Temperature, 970
Brown (O. F.), [R. A. Watson Watt and], Radio Research in the British Empire, 755
Brown (Robert), Papers commemorative of, 899
Brown (W. R.), [R. Newton and], Frost Injury to Plants, 911
Browne (W. R.), Notes on Bathyliths and Some of their Implications, 806
Bruce (Major-Gen. Sir David), [death], 930
Bruce (Miss H. M.), [F. A. Askew, Dr. R. K. Callow, J. St. L. Philpot, T. A. Webster, and], Crystalline Vitamin D, 758
Bruhat (G.), and J. Thouvenin, The Double Refraction produced by the Compression of Amorphous Silica and Crystallised Quartz and its dispersion in the Ultra-Violet, 1050
de Bruin (T. L.), [Prof. P. Zeeman, J. H. Gisolf, and], Magnetic Resolution and Nuclear Moment of Rhenium, 637
Brull (L.), [G. B. Bonino and], Raman Spectrum and Chemical Constitution of Certain Chloroethylenes, 595; Raman Spectrum of Dichlorobromomethane, 1051
Brun (A.), The Apparent Dispersion of the Optical Axes in Peridote and the Measurement of $2V$, 1086; The Separation of the *ng* and *np* Ultra-Violet Spectra refracted by a Doubly Refracting Prism, 1086
Brunel (A.), [R. Fosse, P. E. Thomas, and], Application of the Quantitative Spectrophotometric Analysis of Allantoin, 421; The Quantitative Analysis of Very Small Quantities of Allantoin at High Dilutions, 315
Brunet (Prof. P.), Faraday and French Physicists, 346
Bryce (Dr. G.), [death], 404
Bryk (F.), Die Beschneidung bei Mann und Weib, 91
Buch (Dr. K.), Dr. H. Wattenberg, and H. W. Harvey, Apparent Dissociation Constants of Carbon Dioxide in Sea-water of Different Salt Contents, 411
Buchner (Dr. H.), Diamagnetism of Liquid Mixtures, 301
Buchner (Dr. P.), Tier und Pflanze in Symbiose, 558
Budge (Sir E. A. Wallis), Amulets and Superstitions, 204
Builder (G.), [Prof. E. V. Appleton and], Wireless Echoes of Short Delay, 918
Bull (H. B.), and R. A. Gortner, Studies on Electrokinetic Potentials (9), 423
Bullard (E. C.), and H. S. W. Massey, Diffraction of Electrons, 799
Buller (Prof. A. H. R.), Recent Advances in our Knowledge of the Higher Fungi, 81; Researches on Fungi. Vol. 4, 944
Burchardt (H.), Regulation of the Secretory Activity of the Seminal Vesicle, 468
Burchell (J. P. T.), Derived Early Mousterian (Levalloisian) Implements in the Melt-water Gravels of the Coombe Rock Glaciation, 909; Pottery with Flint Implements of Upper Palæolithic Facies from Swanscombe, Kent, 548; Relation of Neanthropic Man to the Ice Age, 879
Burdon (R. S.), Measurements of the Height of a Large Drop of Mercury, 456
Buret (R.), [C. Dufraisse and], The Dissociable Organic Oxides: a Dimethoxyrubrene, 163
Burfield (S. T.), [Prof. J. H. Orton and], Biological Effects of Cosmic and γ-Radiation, 376
Burgess (A. F.), Control of the Gipsy and Brown-tail Moth-pests in the United States, 146
Burgwitz (G.), [G. Nadson and], Yeasts from the North Polar Ocean, 682
Burkitt (M. C.), Age of Certain Gravels in the New Forest Area, 222
Burpee (Dr. L. J.), awarded the Tyrrel medal of the Royal Society of Canada, 275
Burt (Prof. C.), appointed professor of psychology at University College, London, 161
Burton (A. C.), [Prof. J. C. McLennan, A. Pitt, J. O. Wilhelm, and], Superconductivity at High Frequencies, 1004
Burton (E. F.), [A. C. Hendrik and], A Treatment for Malignant Tumours, 544
Burton (M.), The Age of Flint, 32
Bury (H.), Age of Certain Gravels in the New Forest Area, 377
Buston (H. W.), A Micro-method for the Determination of Uronic Anhydride Groups in Pectic Substances, 1086
Butcher (Dr. R. W.), Faraday as a Botanist, 820
Butenandt (A.), [Dr. G. F. Marrian and], Œstrus-producing Hormones, 305
Butkevitch (V. V.), [D. Prianischnikov and], The Physiological Characteristics of Potassium Salts, 163
Butler (D.), Curious Behaviour in a North American Corn-snake in Reference to Moles, 579
Buxton (Dr. L. H. Dudley), and D. Talbot Rice, Human Remains from Kish, 798
Buxton (Dr. P. A.), Control of Humidity of Air Currents, 837; Humidity Control and Entomological Problems, 1079
Byck (H. T.), [F. O. Rice and], Collision between Organic Molecules and Surfaces, 228

Cagnasso (A.), [L. Cambi and], Nitrosodithiocarbamates, 595
Cahen (R.), [J. Saidman, J. Meyer, and], The Local Effects in the Rat due to Electric Fields of Very High Frequency, 387
Calderwood (W. L.), Flying-fish, 216
Caldwell (Miss F. E. S.), awarded the Harkness Scholarship in Cambridge University, 80
Callan (T.), and N. Strafford, Examination of Dyed Leathers in Cases of Alleged Dermatitis, 733
Callow (Dr. R. K.), [F. A. Askew, Miss H. M. Bruce, J. St. L. Philpot, T. A. Webster, and], Crystalline Vitamin D, 758
Calvet (E.), Velocities and Heats of Saponification of the Amides, 235
Cambi (L.), and A. Cagnasso, Cobalt Nitrosodithiocarbamates, 683; Nitrosodithiocarbamates, 595
Cameron (Dr. A. E.), Agricultural Entomology, 943
Camichel (Prof. C.), Leçons sur les conduites, 209
Caminopétros (J.), [G. Blanc and], Experimental Researches on the Sensibility of Domestic Animals . . . to the Virus of Exanthematic Fever, 503
Camis (Prof. M.), translated and annotated by Dr. R. S. Creed, The Physiology of the Vestibular Apparatus, 815
Cammiade (L. A.), Were-Tigers in India, 728
Campbell (Dr. Norman R.), Formal Logic, 620
Cannan (Prof. E.), Population and Production, 534, 658
Cannicci (G.), Bacterial Flora of Certain Fish, 735
Cannon (Prof. W. B.), conferment upon, of an Honorary Doctorate by Paris University, 936
Capey (R.), The Printing of Textiles, 855
Cardinall (A. W.), Tales told in Togoland, to which is added the Mythical and Traditional History of Dagomba, by E. F. Tamakloe, 1026
Carneiro (P. de Berredo), [G. Bertrand and], The Active Principle of Guarana, 555
Carpenter (Sir Harold), Stainless Metals, 382
Carr (Dr. H. Wildon), The Monadology of Leibniz: with an Introduction, Commentary, and Supplementary Essays, 136
Carr (Prof. H. Wildon), [obituary articles], 98, 99
Carré (P.), and P. Mauclère, The Chloride of Acid Ethyl Sulphite and the Neutral Mixed Alkyl Sulphites, 386
Carrière (E.), and Janssens, Determination of Fluorine as Calcium Fluoride, 806
Carroll (W. E.), [E. Roberts and], Mexican Hairless Swine, 866
Carr-Saunders (Prof. A. M.), to continue in the Muirhead Lectureship in Birmingham University, 80
Carruthers (F. G.), Earwigs and their Forceps, 440
Carter (G. E. L.), Occurrence of Vanadiferous Nodules on the Coast of South Devon, 42
Cartwright (W.), [W. E. Alkins and], Experiments in Wire-drawing (1), 554
Casella (C. F.), and Co., Ltd., A New Pattern of the Fortin Barometer, 732
Cassie (A. B. D.), [C. R. Bailey and], Infra-Red Absorption Spectrum of Carbonyl Sulphide, 637
Cassie (A. M.), [E. B. Wedmore, W. B. Whitney, and], Electric Circuit Breaker Research, 675
Casteret (N.), The Communication of the Trou du Toro with the Goueils de Jouéou, the Source of the Garonne, 682

Catcheside (D. G.), Chromosome Linkage in a Triploid *Œnothera*, 460; [Prof. R. R. Gates and], Origin of Chromosome Linkage in *Œnothera*, 637
Cathcart (Dr. G. C.), The Treatment of Chronic Deafness by the Electro-phonoide Method of Zund-Burguet. Second edition, 563
Cattan (R.), [J. Troisier and], Exanthematic Fever in Man, without Visible Symptoms, caused by *Rhipicephalus sanguineus*, 422
Cauchois (Mlle. Yvette), [H. Hulubei and], The Monochromatic Stimulation of Raman Spectra in the Ultra-Violet, 315
Cave (Capt. C. J. P.), Unusual Lightning, 378
Cave (Capt. C. J. P.), [J. E. Clark, I. D. Margary, R. Marshall, L. C. W. Bonacina, and], Phenological Observations in the British Isles from Dec. 1929 to Nov. 1930, 917
Cave-Browne-Cave (Wing-Comdr. T. R.), appointed Professor of Engineering at University College, Southampton, 681
Caven (Prof. R. M.), and Dr. G. D. Lander, Systematic Inorganic Chemistry: from the Standpoint of the Periodic Law. New edition, 209
Cavendish (Henry), 1731–1810, 608
Cawood (W.), and H. S. Patterson, A Curious Phenomenon shown by Highly Charged Aerosols, 150; [H. S. Patterson, Prof. R. Whytlaw-Gray, and], The Atomic Weight of Fluorine, 375
Cayrol (J.), and L. Genevois, The Specific Inhibition of the Alcoholic Fermentation of Yeast Cells without Arrest of the Respiration, etc., 199
Cayrol (P.), Action of Various Halogen Derivatives on Alcoholic Fermentation, 770
Cella (P.), [G. B. Bonino and], Raman Spectra of Hydrogenated Derivatives of Naphthalene, 1051
Chadwick (Dr. J.), [Sir Ernest Rutherford [Lord Rutherford], Dr. C. D. Ellis, and], Radiations from Radioactive Substances, 3
Chamié (Mlle. C.), and Mlle. A. Korvezee, The Centrifugation of Solutions of Polonium in the Presence of Various Electrolytes, 82
Champion (H. G.), and B. D. Pant, Seeds and Seedlings of Sâl, 1080
Chance Bros. and Co., Ltd., Coloured Grass as a Deterrent to House Flies, 277
Chandler (Prof. A. C.), Introduction to Human Parasitology. Fourth edition, 323
Chapman (F.), Two New Australian Fossil King-crabs, 683; and Irene Crespin, New Species of *Lepidocyclina*: *L. hamiltonensis* and *L. howchini*, 683
Chapman (Prof. S.), Phenomena of the Upper Atmosphere (Bakerian Lecture), 415; Some Phenomena of the Upper Atmosphere (Bakerian Lecture), 464
Charaux (C.), and J. Rabaté, The Biochemical Study of the Genus *Salix*, 199
Charlesworth (Prof. J. K.), Quaternary Ice Margins (North Sea), 498
Charlot (J.), [E. H. Morris, Ann Axtell Morris, and], The Temple of the Warriors at Chichen Itzá, Yucatan, 694
Chaudron (G.): [E. Herzog and], The Protection by Cathode Polarisation of Iron dipped into Aerated Saline Solutions, 882; [J. Hérenguel and], The Preparation of Pure Magnesium by Sublimation, 1013; [P. Jolibois and], A New Method for getting Calcium Triphosphate in a Soluble Form, 315
Chaze (J.), Excretion of Nicotine from the Aerial Parts of the Tobacco Plant, 82
Cheisin (E.), Some New Marine Infusoria, Symbiotic in Molluscs of Lake Baikal, 163
Chen (K. K.), and C. F. Schmidt, Ephedrine and Related Substances, 629
Chesley (K. C.), [H. V. Anderson and], X-Ray Analysis of Slate, 1043
Childe (Prof. V. Gordon), South Russian Steppe Graves, 190; The Prehistoric Colonists of Yorkshire and their Economics, 776
Chinchalkar (S. W.), [Sir C. V. Raman and], A New Type of Magnetic Birefringence, 758
Chipp (Dr. T. F.), [death], 13; [obituary article], 141
Chippindale (H. G.), Latency of Seedlings in Some Grasses, 1075
Chittenden (Prof. R. H.), The Development of Physiological Chemistry in the United States, 90
Chitwood (B. G.), [J. R. Christie and], A Nematode Parasite of a Lucanid Beetle, 910
Chlopin (V.), and A. Ratner, Distribution of a Dissolved Substance between the Crystalline and the Fluid Phase, 387
Chodat (F.), Action of Light upon Cellular Permeability, 126; and Suzanne Kann, The Diurnal Course of Transpiration of Two Alpine Plants, 126
Choucroun (Mlle.), The Hypothesis of Mitogenetic Radiation acting on the Multiplication of Bacteria, 316
Chrétien (A.), The Dielectric Constant and Chemical Constitution, 163
Christensen (C. F.), The Whaling Factory Ship *Vikingen*, with Some Notes on Whaling, 56
Christie (J. R.), and B. G. Chitwood, A Nematode Parasite of a Lucanid Beetle, 910
Clark (Lt.-Col. E. Kitson), Humanity under the Hammer, 790
Clark (J. E.), I. D. Margary, R. Marshall, Capt. C. J. P. Cave, and L. C. W. Bonacina, Phenological Observations in the British Isles from Dec. 1929 to Nov. 1930, 917
Clark (Prof. W. E. Le Gros), Physical Anthropology of the American Indian, 740
Clarke (Prof. F. W.), [death], 59; [obituary article], 214
Clarke (S. G.), and W. N. Bradshaw, The Calcium Fluoride Method for the Determination of Fluoride, 1086
Clarke (S. H.), The Tertiary Wall of Wood Fibres, 1078
Clements (F.), The Correlation between Tanning and Unexposed Skin Colour as recorded by the Colour Top, 423
Clendening (Dr. L.), The Human Body. Second edition, 173
Clinch (Phyllis), Cytological Studies of Potato Plants affected with Certain Virus Diseases, 198
Coblentz (W. W.), R. Stair, and J. M. Hogue, The Spectral Erythemic Reaction of the Human Skin to Ultraviolet Radiation, 555
Cocchinaras (N. E.), Composition of Linseed Oil, 1086
Codrington (K. de B.), Indian Terra-cottas, 414
Cogné [Picon and], Study of Some Sulphides of the Rare Earths, 882
Coker (Prof. E. G.), Stresses in Wheels, 174
Colles [Gibson and], Organic Compounds of Gold, 840
Collet (Mlle. Paule), and G. Foex, Influence of the Field on the Magnetic States of Platinum, 82
Compton (Prof. A. H.), Radioactivity and the Atomic Nucleus, 3
Constable (A. D.), Use of Electric Propulsion in High-speed Liners, 16
Conway (Prof. A. W.), The Influence of the Work of Sir William Rowan Hamilton on Modern Mathematical Thought, 198
Cook (M.), and E. C. Larke, Physical Testing of Copper and Copper-rich Alloys in the Form of Thin Strip, 554
Cooke, Jr. (C. M.), and H. E. Crampton, New Species of *Partula*, 36
Cooke (H. C.), W. F. James, and J. B. Mawdsley, Pre-Cambrian Rocks of Quebec, 1006
Cooke, Troughton, and Simms, Ltd., "The Orientator", 102
Coolidge (T. B.), Oxidation Reduction Potential of Complex Iron Compounds in Yeast, 223
Coomaraswamy (Dr. A.), Yaksas, 71
Copeman (P. v. d. R.), Oranges and Arsenates, 120; and F. J. Dillman, Decomposition of Guano, 682
Copisarow (Dr. M.), Dehydration of Salts, 838; Matter: Life: Mind, 1042
Coppens (C. A.), [J. Schonland and], Point Discharge Measurements below Thunderstorms, 200
Corbellini (A.), Stereoisomerism of Derivatives, etc., 1014
Cornish (Dr. Vaughan), The Poetic Impression of Natural Scenery, 656
Costantin (J.), P. Lebard, and J. Magrou, Influence of a Period in the Mountains on the Productivity of the Potato, 1086

Cotton (A.), Comparison of the Magnetic Rotations of Crystallised Quartz and Fused Quartz, 81
Couch (J. N.), Symbiosis of Fungus and Scale Insect, 119
Coulston (Daphne L.), A New Colorimetric Method for measuring the Hydrogen Ion Concentration of Natural Waters, 316; The Metabolism of Cold-blooded Animals, 316; The Splenectomy of Tadpoles, 316; Variations of the Hydrogen Ion Concentration of Sea Water, 316
la Cour (D.), Tide-Gauge Measurements of Height Differences, 875
Cournot (J.), [L. Guillet, A. Roux, and], The Influence of Occluded Gases on the Mechanical Properties of Metallurgical Products, 978
Coville (Dr. F. V.), awarded the George Robert White Gold Medal of Honor, 1034
Cowan (Lt.-Col. S. H.), appointed Lecturer in Forest Engineering in Edinburgh University, 880
Cowley (Sir Arthur E.), [death], 666
Cox (L. R.), Eocene Mollusca of North-west India, 460
Craft (F. A.), The Physiography of the Shoalhaven River Valley (1), 279; Physiography of the Shoalhaven River Valley (2, 3), 387
Craig (J. I.), The Elements of Analytical Geometry. Vol. 1: Straight Line and Circle, 52
Crampton (H. E.), [C. M. Cooke, Jr., and], New Species of *Partula*, 36
Craster (Dr. H. H. E.), elected Bodley's Librarian, Oxford University, 768
Crawford (M. F.), [Prof. J. C. McLennan, J. B. Leppard, and], Nuclear Moments of the Isotopes of Lead: Relative Values of the $g(I)$ Factors of Pb(207) and Tl, 301
Crawshay (R.), The Spore Ornamentation of the Russulas, 891
Creighton (Harriet B.), and Barbara McClintock, A Correlation of Cytological and Genetical Crossing-over in *Zea mays*, 1014
Cremer (H. W.), appointed Honorary Secretary of the Institution of Chemical Engineers, 756
Crespin (Irene), [F. Chapman and], New Species of *Lepidocyclina*, *L. hamiltonensis* and *L. Nowchini*, 683
Creusot [A. Mailhe and], The Transformation of Benzene into Methane, 422; The Transformation of Toluene and of Xylene into Methane, 466
Crew (Prof. F. A. E.), [J. N. Pickard and], The Scientific Aspects of Rabbit Breeding, 512
Crompton (Col. R. E. B.), The First Central Electric Power Station in England, 140
Crompton (W. M.), Hippopotamus Figures from Ancient Egypt, 273
Crookshank (Dr. F. G.), Epidemiological Essays, 323
Cross (Dr. F. R.), [death], 179
Crowfoot (Mrs. Grace M.), Hand-spinning in Egypt and the Sudan, 71
Crowther (J. G.), An Outline of the Universe, 627
Cullen (Dr. W.), Gold Resources of the World, 4
Culver (Prof. C. A.), Electricity and Magnetism: an Advanced Text-book for Colleges, 629
Cunliffe (Dr. P. W.), An Apparatus for recording the Ultra-Violet Light of the Sky, 35
Cunningham (Dr. Brysson): Development of the Hudson Bay Region and the North-west Territories of Canada, 53; Influence of Modern Hydro-Electric Power Development on the British Coal Trade, 397
Cunningham (G. H.), The Gasteromycetes of Australasia (11): The Phallales (Pt. 2), 280; (12), 595; (13), 918
Cunningham (J. T.), The Double Lateral Line of *Lepidosiren*, 377
Curie (M.), and A. Lepape, The Thermal Conductivity of the Rare Gases, 1050; and M. Prost, The Radiation accompanying the Hydration of Quinine Sulphate, 386
Curie (Mme. Irène), and M. Lecoin, A New Gaseous Compound of Polonium, 199
Curnow (Dr. I. J.), The World Mapped: being a Short History of Attempts to map the World from Antiquity to the Twentieth Century, 289
Cushing (Prof. H.), conferment upon, of an Honorary Doctorate by the University of Berne, 681
Cushing (H.), Action of Atropine in counteracting the Effects of Pituitrin and of Pilocarpine injected into the Cerebral Ventricles, 280; Reaction to Posterior Pituitary Extract (Pituitrin) when introduced into the Cerebral Ventricles, 280; Similarity in the Response to Posterior Lobe Extract (Pituitrin) and to Pilocarpine when injected into the Cerebral Ventricles, 280; The Counteractive Effect of Tribromethanol (Avertin) on the Stimulating Response to Pituitrin injected in the Ventricle, 422; The Method of Action of Pituitrin introduced into the Ventricle, 422
Cushman (Dr. J. A.), Atlantic Foraminifera, 798; and J. D. Barksdale, Tertiary Foraminifera, 1080
Cuthbertson (J. W.), [H. O'Neill and], The Work-hardening Capacity and Elongation Properties of Copper, 595

Dachert (A.), Positive Eugenics in Practice, 147
Dakin (Prof. W. J.), A New Bopyrid Parasite from the Coast of N.S.W., 595; The Composition of the Blood of Aquatic Animals and its bearings upon the possible conditions of Origin of the Vertebrates, 66; and Mahalah G. C. Fordham, A New and Peculiar Marine Nemertean from the Australian Coast, 796
Dalby (Prof. W. E.), Power and the Internal Combustion Engine, 886
Dale (Dr. H. H.), Biology and Civilisation (Norman Lockyer Lecture), 897; Science and Curative Medicine (Stephen Paget Memorial Lecture), 499; The Biological Nature of the Viruses, 599
Daley (C.), Food of Australian Aborigines, 762
Daly (B.), [Prof. J. Reilly, P. J. Drumm, and], Diazotisation of Aminophenylpyrazoles, 162
Dalziel (Dr. J. M.), [J. Hutchinson and], Flora of West Tropical Africa. Vol. 2, Part 1, 952
Damant (Capt. G. C. C.), Modern Diving Devices, 324
Damiens (A.), A New Porcelain without Silica, based on Pure Fluorspar, 82
Dampier (Sir William), appointed Secretary of the Agricultural Research Council, 299; Dairy Research, 1071
Daniel (Dr. R. J.), Musculature of Crustacea, 970
Daniels (E. J.), The Attack on Mild Steel in Hot-Galvanising, 594
Dannenberg (Prof. A.), Geologie der Steinkohlenlager. Band 2, Teil 2, 816
Darby (Dr. H. C.), appointed University Lecturer in Geography in Cambridge University, 1011
Darrow (K. K.), La synthèse des ondes et des corpuscles. Introduction et des notes par M. Boll, 629
Dartayet (M.), [Prof. J. Hartmann and], The Recent Opposition of Eros, 550
Darwin (Dr. Erasmus), Two Hundredth Anniversary of the Birth of, 931
Darzens (G.), A Method of Separating the Cresols and the Properties of Pure *m*-Cresol, 315; and A. Lévy, The Direct Bromination of Metacresol, 555
Das (Dr. A. K.), B. B. Ray, and D. N. Dasgupta, Measurement of Pressure and Temperature in the Upper Atmosphere, 878
Dasgupta (D. N.), [Dr. A. K. Das, B. B. Ray and], Measurement of Pressure and Temperature in the Upper Atmosphere, 878
Datching (T.), The Purification of the Protactinium fixed on Tantalum Oxide, etc., 466
Datta (B. B.), [Dr. B. B. Ray and], Part-Absorption in X-Rays, 224
Datta (S.), [Prof. D. M. Bose and], Absorption Spectra of the Ce^{+++} Ion in Solution, 270; [Prof. D. M. Bose and], Raman Lines due to Co-ordination Bond, 725
David (P.), A Valve Generator with very Stable Frequency, 82
Davies (D.), [obituary article], 403
Davies (Dr. S. J.), and E. Giffen, awarded the Crompton Medal of the Institution of Automobile Engineers, 635
Davies (W. L.), Determination of Chlorides in Dairy Products and Biological Material, 733
Davison (Dr. C.), The Idu (Japan) Earthquake of Nov. 26, 1930, 552; The Japanese Earthquake of 1923, 989

Davison (E. H.), Handbook of Cornish Geology. Second edition, 779
Dawe (Dr. F. Sherwill), The Comma Butterfly in England, 760
Dawson (B. H.), Sigma Scorpii, 1081
Dawson of Penn (Lord), appointed a member of the Medical Research Council, 184
Deacon (G. E. R.), Velocity of Deep Currents in the South Atlantic, 267
Deane (C.), Trichopterygida of Australia and Adjacent Islands, 387
Debucquet (L.), and L. Velluz, Organic Compounds of Tungsten and Molybdenum containing Sulphur, 422
Decker (M.), The Synthesis of Bichler and Napieralski, 467
Decoux (B.), A Piezoelectric Quartz Frequency Meter with Synchronous Modulation, 386; and P. Le Corbeiller, A Self-maintained Electrical System Utilising a Neon Tube, 978
Dehalu (M.), Observation of the Total Eclipse of the Moon on April 2, 1931, at Cointe, 846
Deimel (Prof. R. F.), Mechanics of the Gyroscope, 289
Dejardin (G.), Extension of the Spectrum Sensibility of Photoelectric Cells under the Action of Oxygen, 83; Utilisation of Ultra-Violet Light in Photoelectric Cells with Glass Bulbs, 83
Delanoë (P.), The Jackal and Hedgehog Reservoirs of the Moroccan Spirochæte, *Sp. hispanicum* var. *marocanum*, 770
Delaunay (Prof. H.), Nitrogenous Excretion in Invertebrates, 306
Dellbridge (J. H.), [death], 960
Delporte (E.), Atlas céleste, 690
Demassieux (Mme. N.), and V. Henri, The Ultra-Violet Absorption Spectra of Pure Hydrochloric Acid and Bromine, 882
Demerec, Mutable Genes in Delphinium, 676
Demetrovič (B.), Some Experiments concerning the Reflection of X-Rays, 882
Demolis (A.), [E. Briner, H. Paillard, and], The Ozonation of Aldehydes and the Theory of Active Molecules, 235
Denning (late W. F.), [obituary article], 12; a Memorial Tablet to the, 1068
Deraniyagala (P. E. P.), Evolution in the Chelonia, 273
Desai (Dr. B. N.), Condition of Sparingly Soluble Substances in Gelatine, 223; and P. M. Barve, Coagulation of Colloids by Electrolytes, 907
Desai (Manohar S.), The Heat of Dissociation of Fluorine, 34
Desch (Prof. C. H.), The Social Function of Science, 824
Deshusses: (J.), [L. Deshusses and], Distribution of the Pyrethrins in the Pyrethrum Flower, 126; (J. and L.), Some Insects specially Injurious to Cultivation in French Switzerland, 467
Deslandres (Dr. H.), Simple relations between the Molecular Spectrum and the Structure of the Molecule, 199, 315
Dews (H. C.), The Metallurgy of Bronze, 627
Dibblee (G. B.), Instinct and Intuition: a Study in Mental Duality, 51
Dickens (B. G.), [W. B. Mann and], The Thermal Conductivities of Saturated Hydrocarbons in the Gaseous State, 881
Dickinson (E. W.), and H. W. Grimmitt, Rural Electrification, 902
Dickinson (H. W.), The Work of Jolliffe and Banks, 698
Dieke (G. H.), [Prof. R. W. Wood and], Analysis of Complicated Band Spectra with the Aid of Magnetic Rotation Spectra, 545
Diels (Dr. L.), elected a Corresponding Member of the Field Museum of Natural History, 756
Dillman (F. J.), [P. R. v. d. R. Copeman and], Decomposition of Guano, 682
Dillon (T.), and Annie McGuinness, On Alginic Acid: its Mode of Occurrence and its Constitution, 162
Dingwall (Dr. E. J.), Bryk's Die Beschneidung bei Mann und Weib, 91; The Girdle of Chastity: a Medico-Historical Study, 628
Dirac (Dr. P. A. M.), A Connexion between Electricity and Magnetism, 586
Dittler (E.), and O. Kuhn, The Genesis of Bauxite in the Upper Sann Valley, 467
Dixon (Prof. A. C.), elected President of the London Mathematical Society, 868
Dixon (Prof. W. E.), [death], 295; [obituary article], 401
Dobb (M.), Current Economic Theory in relation to the Five-Year Plan, 790
Doladilhe (M.), [C. Achard, A. Boutaric, and], The Physical Properties of the Blood Serum and of the Proteins separated from this Serum, etc., 555
Dollo (Dr. L.), [obituary article], 57
Donaldson (Capt. J. M.), elected President of the Institution of Electrical Engineers, 147; The Unification of Electric Power Companies, 755
Donisthorpe (H. St. J.), Additions to the British Coleopterous Fauna, 155
Donnan (Prof. F. G.), Matter and Radiation, 290; Prausnitz and Reitstötter's Elektrophorese, etc., 988
Dony (F.), [A. Picard, E. Stahel, and], The Absorption of the Penetrating Gamma Rays by Lead Screens 12-30 cm. thick, 846
Douglas (C. K. M.), The Present Position of Weather Forecasting, 768
Douglas (J. A.), and W. J. Arkell, The Stratigraphical Distribution of the Cornbrash (2), 125
Douglas (Prof. J. S. C.), [death], 788; [obituary article], 862
Douglass (Dr. A. E.), Tree-Rings and the Sunspot Cycle, 121
Douvillé (H.), Some Examples of Evolution, 918
Dover (C.), Effects of Inadequate Feeding on Insect Metamorphosis, 303
Downey (Dr. W. E.), [obituary article], 403
Dowson (W. J.), appointed University Lecturer in Mycology in Cambridge University, 844
Drakeley (Dr. T. J.), appointed Principal of the Northern Polytechnic, 124
Dralle (H. E.), The Use of Motive Power in the Rumanian Oilfields, 633
Drugman (J.), On Different Habits of Fluorite Crystals, 42
Drumm (P. J.): The Constitution of Fischer and Bulow's Pyrazole, 162; [Prof. J. Reilly, B. Daly, and], Diazotisation of Aminophenylpyrazoles, 162; [Prof. J. Reilly, M. Hayes, and], Lichenin, 162; [Prof. J. Reilly, N. Noonan, and], The Evaluation of the Menthone Content of Peppermint Oil, 845
Druyvesteyn (Dr. M. J.), Neon-Helium Bands, 1076
Dryden, jr. (A. L.), Accuracy in Percentage Representation of Heavy Mineral Frequencies, 422
Dryden (John), three hundredth anniversary of the birth of, 215
Drzewina (Mme. Anna), [G. Bohn and], Influence of Metallic Silver on the Calcification of the Larvæ of the Sea-Urchin, 806
Dubar (L.), The Sensibility of Cuprous Oxide Photoelectric Cells, of the Type with Copper Grid, 918
Dubois (J.), [A. Bigot and], The Presence of the Ordovician in the Moroccan Anti-Atlas, 555
Dubusay (R.), and R. Pallu, The Photochemical Oxidation of Sulphur, 646
Dudden (Dr. H.), the Savilian Chair of Astronomy at Oxford, 681
Dufay (J.), The Spectrum of the Eclipsed Moon, 978
Dufraisse (C.), and M. Badoche, Researches on the Dissociable Organic Oxides, 422; The Dissociable Organic Oxides, 503; and R. Buret, The Dissociable Organic Oxides: a Dimethoxyrubrene, 163
Dufton (A. F.), and H. E. Beckett, Measurement of Ultra-Violet Radiation, 223; [H. E. Beckett and], Unusual Lightning, 189
Du Mez (Prof. A. G.), [Prof. G. L. Jenkins and], Quantitative Pharmaceutical Chemistry: containing Theory and Practice of Quantitative Analysis applied to Pharmacy, 958
Dunbar (W.), Eighty Years' Rainfall at North Craig Reservoir, Kilmarnock, 917
Dunn (J. S.), The Oxidation of some Copper Alloys, 594
Dunnington (F. G.), Formation of a Spark, 1081
Dupont (J.), and J. J. Guerlain, The Dry Distillation of Peru Balsam, 646
Durell (C. V.), and A. Robson, Advanced Trigonometry, 92

Durrans (Dr. T. H.), Cellulose Lacquers, 192; Solvents. Second edition, 958
Durward (J.), Rotation of 'Dust Devils', 412
Dushman (Dr. S.), High Vacua, 72
Dymond (E. G.), appointed Lecturer in Natural Philosophy in Edinburgh University, 880; Polarisation of a Beam of Electrons by Scattering, 149
Dziewonski (K.), and S. Pizoń, A New Method of Synthesis of Dinaphthopyrone, 279

Eagle (A.), Matter: Life: Mind, 906
Eakle (Prof. A. S.), [death], 215
Earl (J. C.), and Miss T. M. Reynolds, The Celluloses of Two Water Plants, 316
Earle (F. M.), and others, Methods of Choosing a Career: a Description of an Experiment in Vocational Guidance conducted on Twelve Hundred London Elementary School Children, 393
Earnshaw (Thomas), a Memorial Tablet to, 215
Eason (A. B.), Flow and Measurement of Air and Gases. Second edition, 654
East (E. M.), Immunity to Sugar Cane Mosaic acquired by the Host, 555
Eastham (L. E. S.), appointed Professor of Zoology in Sheffield University, 1048
Echeson (Dr. E. G.), [death], 143
Eddington (Sir Arthur): The Cosmical Constant and the Wave Equation, 763; The Evolution of the Universe, 709; The Expanding Universe, 821; The Mass of the Proton, 1049
Edge (W. L.), The Theory of Ruled Surfaces, 856
Edington (Dr. J. W.), appointed Professor of Bacteriology in Sheffield University, 1048
Edison (Dr. T. A.), [death], 696; [obituary article], 751
Edkins (Dr. Nora), conferment upon, of the Title of Reader by London University, 805
Edmundson (C. H.), New Hawaiian Medusæ, etc., 36
Edwards (A. B.), Geology and Petrology of the Black Spur Area (Healesville), 467
v. Eekelen (M.), [A. Emmerie, Prof. L. K. Wolff, and], Vitamin A and the Antimony Chloride Reaction, 495
Einstein (Prof. A.), appointed Rouse Ball Lecturer at Cambridge University for 1931–32, 916
Elderton (Miss E. M.), conferment upon, of the Title of Reader in Eugenics, 975
Eldridge (A. A.), Organisation of Scientific Abstracting Services, 1004
Elford (W. J.), [J. E. Barnard and], The Causative Organism in Infectious Ectromelia, 917
Elgee (F.), Early Man in North-East Yorkshire, 776
Eliasberg (P. S.), [S. P. Kostychev, V. Gvaladze, and], The Formation of Pyruvic Acid in Lactic Fermentation, 127
Elkin (A. P.), Rock-Paintings in North-West Australia, 419
Elliott (Charlotte), Manual of Bacterial Plant Pathogens, 953
Elliott (K. A. C.), [Sir F. Gowland Hopkins and], Relation of Glutathione to Cell Respiration with special reference to Hepatic Tissue, 805
Ellis (B. A.), [Sir Robert Robertson and], Faraday's "Chemical Manipulation", 371
Ellis (Dr. C. D.): [Sir Ernest Rutherford [Lord Rutherford], Dr. J. Chadwick, and], Radiations from Radioactive Substances, 3; [Lord Rutherford and], Origin of γ-Rays, 415, 805
Elmen (G. W.), New High Permeability Alloys, 764
Elmhirst (R.), Studies in the Scottish Marine Fauna, 42
Elton (C.), Animal Ecology and Evolution, 243
Emery, Bacterial Origin of the Tumours of the Elm, 422
Emmerie (A.), M. v. Eekelen, and Prof. L. K. Wolff, Vitamin A and the Antimony Chloride Reaction, 495
Engledow (Prof. F. L.), "Of composts shall the Muse disdain to sing?", 854; The Policy of the National Institute of Agricultural Botany, 184
Englert (E.), [Prof. W. Gerlach and], A New Relation between Electrical Resistance and Energy of Magnetisation, 151
Enström (A. Y.), Research in Industry and Rationalisation, 122
Epstein (D.): [J. W. C. Gunn, E. Epstein, G. Rimer, and], The Adrenal Secretion of *Xenopus lævis*, 126; [J. W. C. Gunn and], The Reaction of *Xenopus* to Digitalis, 126
Epstein (E.), [D. Epstein, J. W. C. Gunn, G. Rimer, and], The Adrenal Secretion of *Xenopus lævis*, 126
Erlang (A. K.), Udgivet ved R. E. H. Rasmussen, Femcifrede Logaritmer og Antilogaritmer, 91
Esclangon (E.), Observation of the Eclipse of the Moon of Sept. 26, 1931, made in Haute-Provence, 806
Esclangon (F.): A Method of Measuring an Alternating High-frequency Magnetic Field, 882; The Theory of the Discharge without Electrodes, 82; [L. and E. Bloch, P. Lacroute, and], Observation of the Zeeman Effect with High Frequency, 386
Essig (Prof. E. O.), A History of Entomology, 655
Evans (I. H. N.), Balun Bidai, 762
Evans (J. W.), The Biology and Morphology of the Eurymelinæ (Cicadelloidea, Homoptera), 387
Evans (U. R.): The Passivity of Iron, 1062; Thin Films in relation to Corrosion Problems, 489
Ewald (P. P.), und C. Hermann, Strukturbericht, 1913–1928, 511
Ewen (C. L'Estrange), A History of Surnames of the British Isles: a Concise Account of their Origin, Evolution, Etymology, and Legal Status, 891
Ewing (Sir Alfred): Power, 567; elected President of the British Association, 1932, 575; The Life and Work of Sir Charles Parsons, 932

Fabry (Prof. C.), An Interferential Level without an Air Bubble, 466; elected a Foreign Member of the Royal Society, 64
Fairfield (Dr. D.), Exploring for Plants, 52
Fairley (A. S.), Stellar Photometry, 461
Fajans (Prof. K.): Radioelements and Isotopes: Chemical Forces and Optical Properties of Substances, 948; and K. Wust. Translated by B. Topley. A Textbook of Practical Physical Chemistry, 852
Falconer (Sir Robert), elected President of the Royal Society of Canada, 276
Fallows (Fearon), centenary of the death of, 143
Fantham (Prof. H. B.), awarded the South Africa Medal of the South African Association, 29; presented with the South Africa Medal and grant, 801; New Game Reserves in South Africa, 992
Faraday, Michael, a letter of, relating to a rumoured knighthood, 697
Farrington (B.), Vesalius on Vivisection, 125
Faustino (L. A.), [F. Talavera and], Industrial Shells of the Philippines, 676
Fawcett (Prof. C. B.), The Distribution of Urban Population in Great Britain, 1070
Fay (C. R.), Youth and Power: the Divisions of an Economist, 955
Fayet (G.), The Proximities of Cometary Orbits and the Orbit of Pluto, 163
de Fazi (R.), and A. Hemmeler, Reactions between Organic and Mineral Compounds (1), 43
Feigl (Dr. F.), Qualitative Analyse mit Hilfe von Tupfelreaktionen: theoretische Grundlagen und praktische Ausfuhrung, 987
Fenn (L. A.), National Needs, 909
Fenner (Dr. C.), The Rift Valleys of South Australia, 155
Ferguson (Dr. Allan), Review of "James Clerk Maxwell: A Commemorative Volume," 607
Fersman (A.), A New Law on the Composition of Granitic Pegmatites, 683
Field (Elsie H.), Reactions of Dermal Melanophores in *Necturus* to heat and to cold, 163
Field (G. S.), Velocity of Sound in Tubes: Ultrasonic Method, 117
Field (Prof. K.), Interconnexion of Electric Light and Power Supply Companies, 297
Fikry (Dr. M. A.), Cross-Pollination in Cotton, 1080
Filippov (G.), [G. A. Nadson and]: The Formation of the New Stable Races of Micro-organisms under the influence of X-rays (2), 422; (3), 467
Filitti (Mlle. Sabine), The Determination of the Charge of the Micelle, 386

Findlay (Prof. A.), Practical Physical Chemistry. Fifth edition, 959
Findlay (W. M.), Disease-resisting Turnips, 414
Fink and Weinfurtner, Methylene Blue Stain for Yeast Cells, 306
Fisher (Dr. R. A.), Evolution of Dominance, 1079
Fisher (W. K.), South American Sea Stars, 154
Fitch (A. A.), Metallurgical Spectrum Analysis, 802
Fitzpatrick (Rev. Dr. T. C.), [death], 788
FitzSimons (F. W.), Discovery of Fossil Bushmen in the Zuurberg Mountains, 611
Flack (Group-Capt. Martin), [obituary article], 402
Flammarion (Mme. G. Camille), Photographs of the Planet Mercury, 82
Flerov (K. K.), The Elks (*Alces* Gray) of the Old World, 503; The Generic Character in the family Tragulidæ (Mammalia, Artidactyla), 503
Flett (Sir John S.), elected President of the Mineralogical Society, 834
Flexner (Dr. A.), Universities: American, English, German, 811
Florentin (D.), [A. Kling and], The Mode of Action of Dehydrating Catalysts in the Hydrogenating Cracking of Phenols, 1050
Florey (Dr. J.), appointed Professor of Pathology in Sheffield University, 1048
Foerster (Prof. F.), [obituary article], 752
Foëx (G.): [Mlle. Paula Collet and], Influence of the Field on the Magnetic States of Platinum, 82; and Mlle. B. Kessler, The various Magnetic States of the Nickel Ion in Solutions of its Chloride, 315
Foord (S. G.), [Dr. E. J. B. Willey and], An Oxidisable 'Active Nitrogen', 493
Forbes (A. C.), Forestry Practice and Research, 31
Fordham (A. A.), Civil Engineering Design, 962
Fordham (Mahalah G. C.), [Prof. W. J. Dakin and], A New and Peculiar Marine Nemertean from the Australian Coast, 796
Forel (Prof. A.), [death], 215
Forestier (H.), and M. Galand, Beryllium Ferrite and the Ferric Oxide arising from its Decomposition, 978
Forster (Dr. M. O.), Service at the Indian Institute of Science, Bangalore, extended, 1049
Fosse (R.), A. Brunel, and P. E. Thomas, Application of the Quantitative Spectrophotometric Analysis of Allantoin, 421; The Quantitative Analysis of Very Small Quantities of Allantoin at High Dilutions, 315
Foster (Sir Gregory, Bart.), [death], 576; [obituary article], 665
Fotheringham (Dr. J. K.), A New History of Astronomy, 986; Motion of the Perihelion of Mercury, 841
Fournier (G.), The Translation of Light Intensities, 234
Fowler (Prof. A.), and J. S. Badami, Spectrum of the Hydrogen-nitrous Oxide Flame, 881; and W. M. Vaidya, Spectrum of Carbon Disulphide Flames, 192
Fowler (R. H.): Quantum-Mechanical Models of a Nucleus, 453; The Photoelectric Effect, 415
Fox (A. L.), The Taste of Thioureas, 124
Fox (Dr. C. S.), The Gondwana System, 763
Fox (Prof. E. L.), [death], 486
Fradin (É.), Dropping of the Prosecution of, for the Glozel alleged Antiquities, 60
Fraipont (Prof. C.), Cerebral Evolution of the Primates, with special reference to the Hominidæ, 61
Francis (E. L.), and Prof. F. C. Thompson, The Drawing of Non-ferrous Wires, 554
Francis (W. L.), Studies in Membrane Behaviour (1), 1049
Frank-Kamenetskii (A.), and V. Konceirch, The Chemical Composition of the Water of the Hot Springs in Northern Transbaikalia, 422
Franklin (Prof. W. S.), and Prof. G. E. Grantham, General Physics, 134
Fraser-Harris (Dr. D. F.), Medical Pioneers in Science, 864
Frazer (R. P.), [Prof. W. A. Bone, W. H. Wheeler, and], Flame Propagation in an Electric Field, 274
Freed (S.), Absorption Spectra of Crystals at Low Temperatures as References in the Measurement of Stellar Velocities, 533
Freeland (D. M.), The Determination of Vanillin in Chocolate and Cocoa Butter, 845
Freeman (H.), An Elementary Treatise on Actuarial Mathematics, 286
Freri (M.), [A. Quilico and], Azopyrrole Blacks (3), 595
Freundlich (Prof. E.): Eclipse Observations and the Einstein Shift, 1045; The Deflexion of Light in the Sun's Gravitational Field, 993
Frisch (S.), [Prof. R. de L. Kronig and], Nuclear Moments, 228
Frivold (Dr. O. E.), and S. Koch, The Magneto-Electric Saturation Effect, 675
Fromageot (C.), and A. Porcherel, Action of Pancreation upon Different Types of Wool, 1013
Fuchs (Dr. W.), Die Chemie der Kohle, 1024
Fujii (Prof. K.), elected an Honorary Fellow of the Royal Microscopical Society, 834
Fuller (Mary E.), The Life-history of *Calliphora ochracea* Schiner (Diptera, Calliphoridæ), 280
Funk (N. E.), The Economic Advantages of the Interconnexion of Electric Power Stations, 669
Furlinger (F.), [P. Kruger and], Histology and Chemistry of Tetanus and Tonus Substratum, 468

Gabillion (R.), Soies artificielles et matières plastiques, 855
Gagnasso (A.), [L. Cambi and], Cobalt Nitrosodithiocarbamates, 683
Galand (M.), [H. Forestier and], Beryllium Ferrite and the Ferric Oxide arising from its Decomposition, 978
Gallagher (Catharine), [W. D. Bancroft, J. W. Ackerman, and], Optical Sensitisation, 846
Gallenkamp and Co., Ltd., Catalogue of Chemical and Industrial Laboratory Apparatus, 757
Galopin (E.), Use of the Polarising Microscope in the Determination of Organic Substances, 734
Garbett (Commdr. L. G.), Observations of Upper Winds over the Oceans, 62
Gardiner (A. C.), [R. Southern and], Reports from the Limnological Laboratory (2), 1013
Gardiner (Prof. J. Stanley), Coral Reefs and Atolls: being a Course of Lectures delivered at the Lowell Institute at Boston, February 1930, 206; elected a Trustee of the British Museum, 299; The Harvard Museum Expedition to Australia, 457
Gardiner (M. S.), [D. H. Tennant, D. E. Smith, and], Nature of Golgi Substance, 728
Gardner (N. L.), [W. A. Setchell and], Marine Algæ from the Pacific, 191
Garner (Prof. W. E.), Activated Adsorption, 583
Garratt (Prof. G. A.), The Mechanical Properties of Wood, 961
Garreau (Mlle. Y.), [J. Parrod and], The Oxidation Products of *d*-Mannose by Ammoniacal Copper Oxide in the Presence of Air, 1050
Garrod (Miss D. A. E.), Work of the British School of Archæology in Palestine, 297
Garstang (Prof. J.), Joshua: Judges, 938
Garstang (T. E.), renewal to, of the Sir George Jessel Studentship of Mathematics in London University, 161
Garstang (W. L.), and H. L. Hinshelwood, Combination of Hydrogen and Oxygen, 1044
Gask (Prof. G. E.), address to the Students of the School of Pharmacy of the Pharmaceutical Society, 667
Gassendi, the Transit of Mercury, and, 787
Gatenby (Prof. J. B.): Outgrowths from Pieces of *Helix aspersa*, the Common Snail, 1002; and Joyce C. Hill, Effect of certain Substances and of Heat on Cells of *Abraxas*, 31
Gates (Prof. R. R.), and D. G. Catcheside, Origin of Chromosome Linkage in *Œnothera*, 637
Gatty [Post and], Flight round the Earth, 60
Geddes (Sir Eric), Mass Production, 182
Geddes (Prof. P.), [Sir J. Arthur Thomson and], Life: Outlines of General Biology. 2 Vols., 1056
Geijer (Dr. P.), Gallivare malmfalt geologisk beskrivning, 384
Geilinger (Dr. W.), Der Kilimandjaro: sein Land und seine Menschen, 956
Genevois (L.), [J. Cayrol and], The Specific Inhibition of the Alcoholic Fermentation of Yeast Cells without Arrest of the Respiration, etc., 199

George (Prince), address at the opening of the new Ramsay Memorial Laboratory of Chemical Engineering at University College, 932
George (T. N.), The British Carboniferous Reticulate Spiriferidæ, 1012
Gerasimovic (B.), Probability Theorems connected with the Discovery of Variable Stars by a Photographic Method, 682
Gerlach (Prof. W.), and E. Englert, A New Relation between Electrical Resistance and Energy of Magnetisation, 151
Gessner (Dr. H.), Die Schlämmanalyse, 1061
Gevers (Dr. T. W.), Pre-Cambrian Tillite in South-west Africa, 191
Gheury de Bray (M. E. J.), Elementary Hyperbolics: for Technical and other Students; specially adapted to the requirements of Beginners. 2 Vols., 1026
Ghosh (Prof. Ekendranath) and Birendrakumar Mitra, Anterior Abdominal Vein in the Toad, 273
Ghosh (J. C.), The Indian Education Problem, 681
Gianfranceschi (Prof.), The Origin of Penetrating Rays, 581
Gibbs (G. J.), Records of Actinic Value of Daylight, 35
Gibson (late Prof. G. A.), Advanced Calculus: a Sequel to an Elementary Treatise on the Calculus, 851
Gibson and Colles, Organic Compounds of Gold, 840
Gideon (P. W.), An Introduction to Zoology, 952
Gidley (Dr. J. W.), [death], 788
Giffen (E.), [Dr. S. J. Davies and], awarded the Crompton Medal of the Institution of Automobile Engineers, 635
Gilard (P.), The Ultra-Violet Transmission of Glasses, 846
Gill (H. A.), The Cost of Patent Litigation, 790
Gill (T.), Tropical Forests of the Caribbean, 1059
Gillbe (Dr. H. F.), Jubilee Celebrations of the Society of Chemical Industry, 157
Gilmour (J. S. L.), appointed Assistant Director of the Royal Botanic Gardens, Kew, 756
Gisolf (J. H.), [Prof. P. Zeeman, T. L. de Bruin, and], Magnetic Resolution and Nuclear Moment of Rhenium, 637
Giuntini (J.), The Spectrographic Study of the Compounds of Tartaric Acid and Copper, 646
Glaister (Prof. J.), Hairs and Wools, 227
Glanville (S. R. K.), Unofficial Moments of a Great Archæologist, 131
Glasser (Dr. O.), Wilhelm Conrad Röntgen und die Geschichte der Röntgenstrahlen. Mit einem Beitrag: Persönliches uber W. C. Röntgen, mit Margret Boveri, 629
Glazebrook (Sir Richard), appointed Chairman of the Advisory Council of the Science Museum, 184; awarded a Royal Medal of the Royal Society, 821; presented with a Royal Medal of the Royal Society, 973; Dr. S. W. Stratton, 928; Standards of Measurement: their History and Development (Guthrie Lecture), 14, 17
Glazunov (A.), The Nature of a Crystallisation Centre, 128
Glennie (Major E. A.), Gravity Anomalies, 1004
Goard (Dr. A. K.), Chemical Composition: an Account of the Methods by which Atomic Weights and Molecular Formulæ have been determined, 958
Goesse (Prof. J. B.), [death], 666
Golaz (M.), A New Principle of Hydraulics, 646
Goldschmidt (Prof. V. M.), Conferment upon, of an Honorary Degree by the University of Freiburg im Breisgau, 756, 833
Goldstern (Dr. N.), and Dr. F. Putnoky, Illumination in Factories, 1080
Good (P.), Lessons from the Flood-lighting Display, 822
Goodland (R.), A Bibliography of Sex Rites and Customs: an Annotated Record of Books, Articles, and Illustrations in all Languages, 892
Goodrich (Prof. E. S.), The Work of the late Sir Ray Lankester, 64
Goodwin (A. J. H.), Association and Chronology in Prehistory, 801
Gordon (Dr. R. G.), [Dr. R. J. A. Berry and], The Mental Defective: a Problem in Social Inefficiency, 954
Gorini (C.), Acido-proteolytes and Thermophiles in the Pasteurisation of Milk, 43
Gorman (M. J.), and H. A. Lafferty, On a Method of distinguishing the Seedlings of Swedish Turnip (*Brassica napus* L. var. *napobrassica* (L.) Reichb.) from those of broad-leaved Rape (*Brassica napus* L. var. *biennis* (Schubl et Mart) Reichb.), 162
Gorter (Dr. C. J.), The Theoretical Magneton Numbers in Weiss Units, 68
Gorter (Prof. E.), and W. A. Seeder, A Method of studying Surface Films, 413
Gortner (R. A.), [H. B. Bull and], Studies on Electrokinetic Potentials (9), 123
Gosselin (A.), et M. Gosselin, Constitution et thermochimie des molécules, 92; (M.), [A. Gosselin et], Constitution et thermochimie des molécules, 92
Grabau (Prof. A. W.), and others, Central Asiatic Expeditions: the Permian of Mongolia, 956
Grabham (Dr. M. C.), on Lord Kelvin's paper on "The Clustering of Gravitational Matter in any Part of the Universe", 793; Electrical Conditions in Stratified Clouds, 969
Graff (K.), Visual Measurements on Planetary Colours, 467
Graham (George), F.R.S., 1673–1751, 435
Graham (Lieut. R. R.), Air-pressures upon a Bird's Wing, 119
Grant (Dr. J.), The Measurement of Hydrogen Ion Concentration, 852
Grant (Prof. Kerr), Rhythmic Breaking of Ship-waves, 838
Grantham (Prof. G. E.), [Prof. W. S. Franklin and], General Physics, 134
Gray (Dr. P.), appointed lecturer in zoology (vertebrate embryology) in Edinburgh University, 880
Gray (P.), appointed a Tutor for Adult Education in Birmingham University, 80
Gray (Dr. R. W.), Migrations of the Greenland Whale and Narwhal, 798
Grebel (A.), Automatic Self-tightening Bolts, 846
Green (Dr. J. B.), and J. Wulff, Hyperfine Structure of Thallium II., 409
Greene (Dr. R.), Oxygen and Everest, 893
Greenwood (H.), and Prof. F. C. Thompson, Wires drawn through Rotating Dies, 152
Greenwood (Dr. T.), Mackaye's The Dynamic Universe, 288; The Development of Formal Logic, 1021; The International Congress of the History of Science and Technology, 77
Grégoire (Prof. V.), elected an Honorary Fellow of the Royal Microscopical Society, 834
Gregory (Prof. J. W.): A Century of Geology, 857; African Settlement and the Origin of Rift Valleys, 87; Deep Trench on the North Sea Floor, 37, 792; and B. H. Barrett, General Stratigraphy, 945
Gregory, Bt. (Sir Richard), History of Glass-making, 697
Grenet (G.), [E. Mathias and], The Electric Field at the Summit of the Puy de Dôme, 806
Grenfell (Sir Wilfred), The Uncharted State of Part of the Coast of Labrador, 635
Gresson (Dr. R. A. R.), appointed Lecturer in Zoology (Cytology) in Edinburgh University, 880
Griaule (M.), Le livre de recettes d'un dabtara abyssin, 204
Grieve (B. J.), A Virus Disease of Roses in Australia, 839
Griffith (A. S.), Experiments with B.C.G. ('Bacille-Calmette-Guérin') Vaccine, 145
Griffiths (W. T.), [D. G. Jones, L. B. Pfeil, and], Nickel-Copper Alloys of High Elastic Limit, 502
Grimes (M.), and A. J. Hennerty, Bacteria belonging to the Sub-genus *Aerobacter*, 162
Grimmitt (H. W.), [E. W. Dickinson and], Rural Electrification, 902
Grimshaw and Payman, Ignition of Fire-damp by Coal-mining Explosives, 867
Grimwood (E. J.), [Dr. C. J. Smithells, S. V. Williams, and], Melting Nickel-chromium Alloys in Hydrogen, 595
Grindley (G. C.), appointed University Demonstrator in Experimental Psychology in Cambridge University, 844
Grinnell (Dr. J.), re-elected President of the American Ornithologists' Union, 998; The Migration of Birds, 329
Groom (Prof. P.), [death], 544; [obituary article], 695
Grubb (Sir Howard), [death], 544; [obituary article], 609

Grundfest (H.), The Relative Effectiveness of Spectral Radiation for the Vision of the Sun-fish, *Lepomis*, 555
Guerlain (J. J.), [J. Dupont and], The Dry Distillation of Peru Balsam, 646
Guha (Dr. B. S.), and P. C. Basu, Human Skulls and Bones from the Naga Hills, 762
Guilbert (J.), [Mlle. D. van Stolk, H. Pénau, and], Carotene and Vitamin A, 467; [Mlle. D. Van Stolk, H. Pénau, H. Simonnet, and], Pure Carotene and Vitamin A, 199
Guillet (L.), A. Roux, and J. Cournot, The Influence of Occluded Gases on the Mechanical Properties of Metallurgical Products, 978
Guillou (J.), [J. Bougault and], Some Reactions of certain Barbituric Derivatives, 770
Gulevitch (V.), Methyl-guanido-oxalic Acid (Creaton) as a Constituent Part of Muscles, 127
Gunn (D. L.), Temperature and Humidity Relations of the Cockroach, 186
Gunn (J. W. C.), and D. Epstein, The Reaction of *Xenopus* to Digitalis, 126; [D. Epstein, E. Epstein, G. Rimer, and], The Adrenal Secretion of *Xenopus lævis*, 126
Guntherschulze (Prof. A.), and F. Keller, Cathode Phenomena in the Glow Discharge, 840
Gurney (Dr. R. W.), Quantum Theory of Electrolysis, 1044
Gutton (C.), and G. Beauvais, Oscillators with very Short Waves, 1013
Guye (Prof. C. E.), Faraday's Connexion with Switzerland and Swiss Industrial and Economic Development, 349; The Lower Limit of Physico-chemical Phenomena, 279
Guyot (R.), The Reflection of very Short Electro-magnetic Waves, 503
Gvaladze (V.), [S. P. Kostychev, P. S. Eliasberg, and], The Formation of Pyruvic Acid in Lactic Fermentation, 127

Haas (Dr. P.), and Prof. T. G. Hill, Occurrence of Dulcitol in a Red Seaweed, 378
Hackspill (L.), A. Stieber, and R. Hocart, Crystallised Boron, 1013; and R. Lauffenburger, Action of Heat on the Alkaline Diacid Phosphates, 682
Haenny (C.), The Magnetic Double Refraction of Paramagnetic Salts in Aqueous Solutions, 1086
Haïssinsky (M.), A New Reaction of Polonium, 315; The Electrochemical and Chemical Behaviour of Polonium in Tartaric Acid Solution, 199
Haldane (Prof. J. B. S.), Oxidation by Living Cells, 175
Hale (H. M.), The Pigmy Right Whale (*Neobalæna*), 910
Hall (Sir Daniel), The Faith of a Man of Science, 1069
Hall (E. H.), Electric Conductivity and Optical Absorption in Metals, 555
Hall (Dr. H. R.), A Season's Work at Ur: al-'Ubaid, Abu Shahrain (Eridu), and Elsewhere; being an Unofficial Account of the British Museum Archæological Mission to Babylonia, 1919, 131
Hall (Prof. W. T.), Textbook of Quantitative Analysis, 323
Halliday (E. L.), Correlations between the Field Changes due to Lightning and the Appearance of the Flashes, 200
Hambly (W. D.), Serpent Worship, 1043
Hamilton (Sir William Rowan), The Mathematical Papers of. Vol. 1: Geometrical Optics, edited by Prof. A. W. Conway and Prof. J. L. Synge, 167
Hampton (W. M.), and W. N. Wheat, Recent Developments in Optical Glass Manufacture, 926
Hamshere (Dr. J. L.), Photoelectrons and Negative Ions, 871
Handy (Dr. E. S. C.), Class Distinction in the Society Islands, 459
Hanson (D.), and I. G. Slater, Unsoundness in Aluminium Sand-castings, 502
Harada (Isokiti), A New Parasitic Copepod, 37
Hardt (H. C.), [A. Kailin and], The Velocity of Catalysed Hydrogenation, 467
Harker (Dr. A.), resignation of, of the Readership in Petrology in Cambridge University, 420
Harmer (Sir Sidney F.), elected a Foreign Member of the Royal Swedish Academy of Science, 723; elected an Honorary Member of the Société Zoologique de France, 29; Southern Whaling, 292
Harris (Prof. D. Fraser), on a lecture by Faraday, 612
Harris (Dr. H. A.), conferment upon, of the Title of Professor, 975
Harris (N. L.), and H. G. Jenkins, Discharge Tubes and their Technical Application, 330
Harris (W. J.), and R. A. Keble, Victorian Graptolite Zones, with Correlations and Descriptions of New Species, 467
Harrison (T. H.), Speed of Flight of Birds, 586
Hartley (Sir Harold), and others, Conductivity of Tetraethylammonium and Ammonium Salts, 461; The Behaviour of Electrolytes in Solution, 680
Hartmann (J.), The Jet-Wave Rectifier, 156
Hartmann (Prof. J.), and M. Dartayet, The Recent Opposition of Eros, 550
Hartog (Sir Philip), Joseph Priestley and his Place in the History of Science, 464; Priestley and Lavoisier, 797
Hartree (Prof. D. R.), Electron Diffraction, 47
Harvey (A.), [F. Twyman and], The Validity of the Schwarzschild relation as applied to the Use of the Logarithmic Sector, 770
Harvey (H. W.), [Dr. H. Wettenberg, Dr. K. Buch, and], Apparent Dissociation Constants of Carbon Dioxide in Sea-water of different Salt Contents, 411
Harwood (H. F.), [Prof. A. Holmes and], Petrology of the Volcanic Fields east and south-east of Ruwenzori, Uganda, 977
Hatschek (E.), Viscometry, 947
Haughton (J. L.), and R. J. M. Payne, Transformations in the Gold-copper Alloys, etc., 554
Hayes (M.), [Prof. J. Reilly, P. J. Drumm, and], Lichenin, 162
Hazard (R.), [M. Polonovski and], Some Physiological Effects of Chlorotropane, 734
Heasman (W. J.), appointed Senior Curator of the Cambridge University Museum of Zoology, 161
Heath (Sir Thomas L.), A Manual of Greek Mathematics, 739
Hedges (Dr. E. S.), Periodic Physico-Chemical Phenomena, 398
Heilman (R. H.), [J. B. Barnitt and], Heat Insulation of Furnaces, 971
Hemmeler (A.), [R. de Fazi and], Reactions between Organic and Mineral Compounds (1), 43
Henderson (Ross, Posnjak, and], A New Uranium Mineral, 155
Hendricks (S. B.), [F. C. Kracek, Dr. E. Posnjak, and], Group Rotation in Solid Ammonium and Calcium Nitrates, 410
Hendrik (A. C.), and E. F. Burton, A Treatment for Malignant Tumours, 544
Hendry (G. W.), Adobe Brick Analysis for Plant Contents, 1006
Hennerty (A. J.), [M. Grimes and], Bacteria belonging to the Sub-genus *Acrobacter*, 162
Henri (V.), [Mme. N. Demassieux and], The Ultra-Violet Absorption Spectra of Pure Hydrochloric Acid and Bromine, 882
Henry (A. J.), [death], 788
Henry (P. S. H.), The Specific Heats of Air, Oxygen, and Nitrogen from 20° C. to 370° C., 1049
d'Herelle (Prof. F.), translated by Prof. G. H. Smith, The Bacteriophage and its Clinical Applications, 431
Hérenguel (J.), and G. Chaudron, The Preparation of Pure Magnesium by Sublimation, 1013
Hermann (C.), [P. P. Ewald und], Strukturbericht, 1913–1928, 511
Herndon and Pangborn, Non-stop Flight from Japan to the U.S.A., 634
Herzog (E.), and G. Chaudron, The Protection by Cathode Polarisation of Iron dipped into Aerated Saline Solutions, 882
Heurtley (W. A.), Work of the British School of Archæology in Athens, 934
Hevesy (Prof. G.), and Dr. R. Hobbie, Lead Content of Rocks, 1038
Hewins (Prof. W. A. S.), [death], 930
Hewitt (C. R.), [death], 404
Hewitt (L. F.), Oxidation-Reduction Potentials in Bacteriology, 73
Hewlett (Prof. R. T.), Sir William Simpson, 695
Hey (M. H.), Studies on the Zeolites. Part 2, 42

Hidaka (K.), Mixing of Warm and Cold Saturated Air, 911
Hill (Prof. A. V.), Myothermic Experiments on the Frog's Gastrocnemius, 805
Hill (Joyce C.), [Prof. J. B. Gatenby and], Effect of certain Substances and of Heat on Cells of *Abraxas*, 31
Hill (Sir Leonard), Group-Capt. Martin Flack, 402, 496; Some Problems of Population, 488
Hill (Sir Thomas E.), [death], 930
Hill (Prof. T. G.), The Advancement of Botany, 780; [Dr. P. Haas and], Occurrence of Dulcitol in a Red Seaweed, 378
Hinchley (Prof. J. W.), [death], 295; [obituary article], 402
Hinshelwood (H. L.), [W. L. Garstang and], Combination of Hydrogen and Oxygen, 1044
Hinton (M. A. C.), Rats and Mice as Enemies of Mankind, Third edition, 1036
Hirayama (K.), Impact of Stars with Nebulæ, 156
Hirst (Mercia C.), [J. B. Speakman and], Constitution of the Keratin Molecule, 1073
Hitchen (C. S.), [F. Twyman and], Estimation of Dissolved Metals, 587
Hobbie (Dr. R.), [Prof. G. Hevesy and], Lead Content of Rocks, 1038
Hobson (Dr. A.), The International Institute of Agriculture, 737
Hocart (R.), [L. Hackspill, A. Stieber and], Crystallised Boron, 1013
Hochstadter (M.), W. Vogel, and E. Bowden, An Improved Method of Constructing High-voltage Cables, 933
Hockin (L. E.), [Prof. M. W. Travers, T. J. P. Pearce and], Influence of Hydrogen on Chemical Changes in Silica Vessels, 66
Hodges (J. H.), and E. F. Linhorst, The Thermal Decomposition of Nitrogen Pentoxide, 83
Hodson (Col. T. C.), Training of Colonial Probationers in Anthropology, 458
Hoffding (Prof. H.), [death], 179
Hoffmann (G.), Fluctuations in Cosmic Radiation, 120
Hogben (Prof. L.), Acromegaly in the Far North, 375; Historical Aspects of Biology, 132; Principles of Animal Biology, 242
Hogg (A. R.), Aitken Condensation Nuclei, 908
Hogue (J. M.), [W. W. Coblentz, R. Stair and], The Spectral Erythemic Reaction of the Human Skin to Ultra-Violet Radiation, 555
Hollander (Dr. B.), Brain, Mind and the External Signs of Intelligence, 815
Holmes (Prof. A.), Lead Content of Rocks, 1039; Radioactivity and Earth Movements, 419, 496; The Origin of Acid Igneous Rocks, 120; and H. F. Harwood, Petrology of the Volcanic Fields East and South-east of Ruwenzori, Uganda, 977
Holmes (Dr. Barbara), Cancer and Scientific Research, 136
Holmes (Dr. E. G.), appointed University Lecturer in Pharmacology in Cambridge University, 420
Holmyard (Dr. E. J.), History of Alchemy, 774; Makers of Chemistry, 321
Holt (Anne), A Life of Joseph Priestley, 625
Holtedahl (O.), Some General Structural Features of the Arctic and Adjacent Regions, 125
Holtum (R. E.), Leaf Fall in the Tropics, 798
Holzknecht (Prof. G.), [death], 788; [obituary], 863
Homes (M. V. L.), Cellular Permeability, 1005
Hooton (Dr. E. A.), and others, The Indians of Pecos Pueblo: a Study of their Skeletal Remains, 740
Hope-Jones (F.), Electric Clocks, 651
Hopkins (Sir Frederick Gowland), Progressive Biology, 923; recommended for re-election as President of the Royal Society, 864; and K. A. C. Elliott, Relation of Glutathione to Cell Respiration with special reference to Hepatic Tissue, 805; and others, The Chemistry of the Vitamins, 39, 842
Hopkins (Dr. R. H.), appointed Adrian Brown Professor of Brewing in Birmingham University, 80
Hopkinson (Dr. E.), Pugnacity of White Specimens of the Australian Zebra-finch, 866
Hopwood (A. T.), [Dr. L. S. B. Leakey, Prof. H. Reck and], Age of the Oldoway Bone Beds, Tanganyika Territory, 724; New Yields from the Oldoway Bone Beds, Tanganyika Territory, 1075
Hopwood (Prof. F. Lloyd), Ultrasonics: some Properties of Inaudible Sound, 748
Hori (Prof. Yosimiti), Orientated Deposits of Copper on Bismuth, 412
Hotine (Capt. M.), Surveying from Air Photographs, 946
Houghton (H. G.), Light Transmission through Fog, 1043
Houston (W. V.), and C. M. Lewis, Rotational Raman Spectrum of CO_2, 280
Houstoun (Dr. R. A.), Intermediate Physics, 134
Hovgaard (W.), Distribution of Stresses in Welded and Riveted connexions, 555
Hovorka (V.), The Oxidation of Hydrazine and Semicarbazide by Potassium Iodate, 1013
Howard (A.), and Yeshwant D. Wad, The Waste Products of Agriculture: their Utilization as Humus, 854
Howard (Dr. L. O.), awarded the Capper Award, 64
Howarth (O. J. R.), The British Association for the Advancement of Science: a Retrospect, 1831–1931. Centenary (second) edition, 687
Howes (Mrs. G. B.), [obituary], 295
Howlett (L. E.), Raman Spectra of Benzene and Toluene, 796
Hrdlička (Dr. A.), Skulls of the Pueblo and related Indian Races, 1079
Hubble and Humason, The Velocities of Distant Nebulæ, 1007
Huber (B.), The Permeability of Protoplasm to Water, 497
Huffman (R.), Nuer Customs and Folk-Lore, 989
Hughes (A. W. McKenny), Inheritance of Melanism in Moths, 496
Huguenard (E.), and A. Magnan, An Ultra-rapid Cinematograph giving from 2000 to 3000 Images per Second, 163
Hulme (H. R.), elected an Isaac Newton Student in Cambridge University, 804
Hulubei (H.), and Mlle. Yvette Cauchois, The Monochromatic Stimulation of Raman Spectra in the Ultra-Violet, 315
Humason [Hubble and], The Velocities of Distant Nebulæ, 1007
Humason (M. L.), The Apparent Recession of the Spiral Nebulæ, 461
Hume-Rothery (Dr. W.), The Macro-etching of Aluminium-silicon Alloys, 503
Humphrey (D.), Intermediate Mechanics. Vol. 2: Statics and Hydrostatics, 244
Humphreys (Dr. W. J.), The Melting of Glaciers, 911
Hunt (H. A.), retirement from position of Meteorologist to the Commonwealth of Australia, 634
Hunter (P. V.), The Subsidiary Systems connected with the Grid System, 633
Huntress (Prof. E. H.), A Brief Introduction to the use of Beilstein's Handbuch der organischen Chemie, 136
Huskins (Prof. C. L.), [Dr. J. Philp and], A Satellite Missing from Ever-Sporting Stocks, 970
Hutchinson (Prof. A.), elected President of the Cambridge Philosophical Society, 834
Hutchinson (J.), and Dr. J. M. Dalziel, Flora of West Tropical Africa. Vol. 2, Part 1, 952
Huxley (Prof. J. S.), Africa View, 87

Ilchester (Lord), elected a Trustee of the British Museum, 299
Imai (Yoshitaka), Genetics of Japanese Morning Glory, 497
Imamura (Dr. Shigemoto), Japanese Nematodes, 586
Imanishi (S.), Ultra-Violet Absorption and Raman Effect for Hydrazine, 64
Imms (Dr. A. D.), Control of West Indian Insect Pests, 878
Ince (Dr. E. L.), appointed Lecturer in Mathematics in Edinburgh University, 880
Innes (Dr. R. T. A.), A New System of Film Projection, 1048
Ionescu (T. V.), Ionised Gases and the Working of Valves with Positive Grid, 882
Irwin (J.), awarded the Duke of Northumberland prize of the Institution of Naval Architects, 768
Isaacs (Dr. Susan), Intellectual Growth in Young Children, with an Appendix on Children's "Why" Questions, by Nathan Isaacs, 777; [Victoria E. M. Bennett and], Health and Education in the Nursery, 690

Isbell [Kharasch and], Organic Gold Compounds, 415
Ito (T.), and T. Shiga, on Scorodite from Kiura Mine, Bungo, Kiushiu, Japan, 977
Iyer (Rao Bahadur L. K. Ananthakrishna), [the late H. V. Nanjundayya and], The Mysore Tribes and Castes. Vol. 3, 50

Jackson (D. A.), Hyperfine Structure in the Rubidium Spectrum, 34
Jacob (C. T.), Control of Prickly-Pear by the Cochineal Insect, 117
Jacobs [King and], The Oxidation of Iodide by Persulphate, 121
Jacobsen (Dr. J. C.), A Counting Device for Use with the Geiger Counter, 674; A Method of Recording Coincidences between Geiger Counters, 185
Jaeger (F. M.), Spatial Arrangements of Atomic Systems and Optical Activity; Methods, Results, and Problems of Precise Measurements at High Temperatures; The Constitution and Structure of Ultramarines, 852
Jaffray (J.), Some Properties of Thermocouples in a Vacuum, 1086
Jaggar (Prof. T. A.), The Work of the Hawaiian Volcano Observatory, 1036
Jahn (C.), [W. R. Schoeller and], The Quantitative Separation of Titanium from Tantalum and Niobium, 845
James (Col. S. P.), W. D. Nicol, and P. G. Shute, The Prevention of Malarial Infection in Human Beings, 404
James (T. E.), Rumford and the Royal Institution: A Retrospect, 476
James (W. F.), [H. C. Cooke, J. B. Mawdsley, and], Pre-Cambrian Rocks of Quebec, 1006
Janssen (J.), Œuvres scientifiques. Recueillies et publiées par H. Dehérain. Tomes 1 et 2, 239
Janssens [E. Carrière and], Determination of Fluorine as Calcium Fluoride, 806
Japan (Emperor of), elected an Honorary Member of the Linnean Society of London, 793
Jayet (A.), and G. Amoudruz, The Discovery of Magdalenian Deposits near Frangy (Haute Savoie), 1087
Jeans (Sir James), Beyond the Milky Way, 592, 821, 825; The Annihilation of Matter, 100, 103; The Evolution of the Universe, 701; The Origin of the Solar System, 432; The Stars in their Courses, 615
Jeffreys (Dr. H.): Physics of the Earth, 984; Turbulence in a River, 1078
Jellinek (Prof. K.), Lehrbuch der physikalischen Chemie. Funf Bände: Band 3: Die Lehre von der Statik chemischer Reaktionen in verdünnten Mischungen (Lösungen). Erste und zweite Auflage. Lief. 9, 852; Lief. 10 (Band 4). Erste und zweite Auflage, 958
Jenkins (Prof. G. L.), and Prof. A. G. Dumez, Quantitative Pharmaceutical Chemistry: containing Theory and Practice of Quantitative Analysis applied to Pharmacy, 958
Jenkins (H. G.), [N. L. Harris and], Discharge Tubes and their Technical Applications, 330
Jensen (H. L.), The Actinomycetales (1), 279; The Systematic Position of *Mycobacterium cœliacum* Gray and Thornton, 280
Jevons (Prof. H. Stanley), The British Heavy Steel Industry. 678
Johnson (Lieut. G. R.), Peru from the Air. With Text and Notes by R. R. Platt, 172
Johnson (Dr. H. M.), Bodily Positions in Restful Sleep, 190
Johnston (H. L.), Prediction of Isotopes, 498
Jolibois (P.), and G. Chaudron, A New Method for getting Calcium Triphosphate in a Soluble Form, 315
Jones (D. G.), L. B. Pfeil, and W. T. Griffiths, Nickel-copper Alloys of High Elastic Limit, 502
Jones (Prof. F. Wood), The External Meatal Notch as a Primitive Character, 458
Jones (L. I.), Result of Interchange of Samples of Soils at Stations of different Altitudes, 668
Jones, Lewis, and Seaman, Flame Temperatures, 1081
Jones (Dr. Spencer), The Distance of Nova Pictoris, 121
Jones (Tudor), The Primitive Conducting Mechanisms of the Vertebrate Heart, 881
Jones (W. R. D.), The Copper-Magnesium Alloys (4), 595
Joos (Prof. G.), Repetition of the Michelson-Morley Experiment, 729
Jordan (Prof. D. Starr), [death], 544; [obituary article], 788
Jorgensen (Prof. J.), A Treatise of Formal Logic: its Evolution and Main Branches. with its relations to Mathematics and Philosophy. 3 Vols., 1021
Joseph (Dr. A. F.), resignation from the Imperial Bureau of Soil Science, 220
Joshua (Dr. W. P.), [Dr. H. A. Auden and], Saccharification of Wood, 1045
Jouast (R.), and N. Stoyko, The Propagation of Short Radio-electric Waves, 82
Jouguet (E.), The Secular Stability of the Rotors of Turbines, 1049
Joukowsky (E.), A Levigator with a Motionless Liquid Medium, 734; The Phreatic Sheet of Soral (Canton of Geneva), 235
Julia (Prof. G.), [H. Beghin and], Exercises de mécanique. Tome 1, fasc. 2, 514

Kablukov (I.), and F. Perelmann, The Heat of Combustion of certain Organic Halogenic Compounds, 127
Kailin (A.), and H. C. Hardt, The Velocity of Catalysed Hydrogenation, 467
Kann (Suzanne), [F. Chodat and], The Diurnal Course of Transpiration of two Alpine Plants, 126
Kaplan (Prof. J.), Excitation of the Green Auroral Line, 304; The Nature of the Aurora, 191
Karasinski (M.), Determination of Fluorine as CaF_2 according to the Method of Berzelius, 126
Kauffman (Prof. C. H.), [death], 143
Kay (G. F.), Duration of the Pleistocene Period, 586
Kaye (Dr. G. W. C.), New Physics Building at the National Physical Laboratory, 311; Noise and its Measurement, 251, 253
Kayser (Prof. H.), und Prof. H. Konen, Handbuch der Spektroscopie. Band 7, Lief. 2, 1061
Keane (Dr. C. A.), [death], 576; [obituary article], 752
Keble (R. A.), [W. J. Harris and], Victorian Graptolite Zones, with Correlations and Descriptions of New Species, 467
Keeler (Dr. C. E.), The Laboratory Mouse: its Origin, Heredity, and Culture, 431
Keen (Dr. B. A.), return to the Rothamsted Experimental Station, 998; The Physical Properties of the Soil, 391
Keilin (D.), elected Quick Professor of Biology in Cambridge University, 161; appointed Fellow of Magdalene College, Cambridge, 916; [Dr. R. Lemberg, Prof. J. Barcroft, and], Uteroverdin, 967
Keith (Sir Arthur), Ethnos: or the Problem of Race considered from a New Point of View, 624; The Construction of Man's Family Tree, 590; The Place of Prejudice in Modern Civilisation (Prejudice and Politics), 473
Keller (F.), [Prof. A. Guntherschulze and], Cathode Phenomena in the Glow Discharge, 840
Kemp (A. R.), Paragutta, 218
Kendall (J.), [Dr. D. Kostoff and], Tetraploid and Triploid Petunias, 227
Kendrick (T. D.), A late La Tène Spear-head from the Thames, 586
Kennard (E. H.), Quantum Mechanical Motion of Free Electrons in Electromagnetic Fields, 83
Kennelly (Prof. A. E.), The Convention of Equidimensional Electric and Magnetic Units, 164; The Modern Electric Age in relation to Faraday's Discovery of Electromagnetic Induction, 356
Kenner (Prof. J.), An Aspect of Co-ordination, 1000
Kermack (W. O.), and W. H. McCrea, An Operational Method for the Solution of Linear Partial Differential Equations, 882
Kerner-Marilaun (Dr. F.), Palaoklimatologie, 1025
Kerr (P. F.), [C. S. Ross and], Kaolin Minerals, 875
Kerrich (G. J.), appointed Junior Curator of the Cambridge University Museum of Zoology, 161
Kershaw (S.), Worsted Open Drawing, 1060
Kessler (Mlle. B.), [G. Foëx and], The various Magnetic States of the Nickel Ion in Solutions of its Chloride, 315

Kestelman (H.), awarded the Sir George Jessel Studentship in Mathematics in London University, 161
Ketelaar (J. A. A.), Structure of the Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium, 303, 440
Keyston (J. E.), [Dr. H. Schuler and], Hyperfine Structure of Thallium II., 409; Changes of Intensity in the Hyperfine Structure of Lines, 911
Kharasch and Isbell, Organic Gold Compounds, 415
Kichuchi (Kenzo), Polymorphic Characters in Rotifers influenced by Feeding, 227
Kiess (Dr. and Mrs.), The Arc Spectrum of Zirconium, 228
Kimball (G. E.), and J. R. Bates, The Band Spectrum of AsH., 969
King (C. D.), [W. M. Marston, Elizabeth H. Marston, and], Integrative Psychology: a Study of Unit Response, 1025
King (Prof. E. S.), [death], 863
King and Jacobs, The Oxidation of Iodide by Persulphate, 121
Kingman (Dr. F. E. T.), The Critical Increment of the Adsorption of Hydrogen on Amorphous Carbon at 400°-520° C., 272
Kipp (P. J.), and Zonen, A New Type of Ammeter, 183
Kirkby and Wheeler, Explosions in Closed Cylinders, 729
Kirkpatrick (Sir Cyril), The Tidal Thames, 789
Kitakami (Sirô), *Blepharoceridæ* of Japan, 640
Kitasato (Baron), [obituary article], 142
van der Klaauw (Dr.), The Auditory Region in certain Extinct Mammals, 910
Kling (A.), and D. Florentin, The Mode of Action of Dehydrating Catalysts in the Hydrogenating Cracking of Phenols, 1050
Knight (J. F. H.), bequest to London University, 80
Koch (S.), [Dr. O. E. Frivold and], The Magneto-electric Saturation Effect, 675
Kofoid (Prof. C. A.), Japanese Dinoflagellates, 154
Kohlrausch (Prof. K. W. F.), Der Smekal-Raman-Effekt, 1026; The Raman Effect, 155
Kollath (R.), [C. Ramsauer, D. Lilienthal, and], Collision Properties of Protons, 911
Koller (Dr. O.), Mammals of an Island Group (Pityusa), 414
Komai (T.), and Y. M. Tung, Anal Gland of *Squilla*, 762
Koncevich (V.), [A. Frank-Kamenetskii and], The Chemical Composition of the Water of the Hot Springs in Northern Transbaikalia, 422
Konen (Prof. H.), [Prof. H. Kayser und], Handbuch der Spektroscopie. Band 7, Lief. 2, 1061
Kopaczewski (W.), Traité de biocolloidologie. Tome 1: Pratique des colloides. Deux. édition. Fasc. 3: Mesures capillaires et électriques, 852
Korsakova (M. P.): Mechanism of the Reduction of Nitrates (3), 387; and E. Nikitina, Influence of the Associated Bacteria on the Nitrogen Régime of *Granulobacter pectinovorum*, 387
Korvezee (Mlle. A.), [Mlle. C. Chamié and], The Centrifugation of Solutions of Polonium in the Presence of various Electrolytes, 82
Kostoff (Dr. D.), and J. Kendall, Tetraploid and Triploid Petunias, 227
Kostychev (S. P.), V. Gvaladze, and P. S. Eliasberg, The Formation of Pyruvic Acid in Lactic Fermentation, 127
Kothari (D. S.), [R. C. Majumdar and], The Relativistic Opacity Coefficient, 908
Kracek (F. C.), S. B. Hendricks, and Dr. E. Posnjak, Group Rotation in Solid Ammonium and Calcium Nitrates, 410
Kramer (Mlle. A.), [M. Bridel and], The Constitution of Asebotoside (Asebotine): its Identity with Phlorizoside (Phlorizine), 978
Kreiken (Dr. E. A.), Stellar Rotation, 308
Krieger (C. J.), Elements of the Trojan Planet Æneas, 764
Krishnamurti (P.), Raman Spectra of Liquid Mixtures, 639
Kronig (Prof. R. de L.), and S. Frisch, Nuclear Moments, 228
Kruger (P.), and F. Furlinger, Histology and Chemistry of Tetanus and Tonus Substratum, 468
Kruyt (Prof. H. R.), translated by Prof. H. S. van Klooster. Colloids: a Textbook. Second edition, 852
Kryloff (Prof. N. M.), Les méthodes de solution approchée des problèmes de la physique mathématique, 963; Angenäherte und symbolische Lösung der Differentialgleichungen der mathematischen Physik und Technik, 963
Krylov (A.), The Loss of Airships *R38*, *R101*, and others, 683
Kuhn (O.), [E. Dittler and], The Genesis of Bauxite in the Upper Sann Valley, 867
Kukarkin (B. W.), The Variability of Betelgeux, 764
Kunitomi (S. I.), The Idu (Japan) Earthquake of Nov. 26, 1930, 552
Kurbatov (S.), The Pyrophyllite from the Tchistaya-Gora Deposits in the Southern Ural, 770
Kurnakow (N. S.), and N. W. Ageew, Physico-chemical Study of the Gold-Copper Solid Solutions, 554

L. (W. W.), Matter: Life: Mind, 906
Labarthe (A.), [L. and A. Seguin), An Apparatus for the Study of the Phenomena of Injection and of Combustion in Motors by the Ultra-cinematograph, 421
Lacaille (A. D.), The Cult of the Bull in Scotland, 874
Lackenby (H.), awarded the Elgar Scholarship of the Institution of Naval Architects, 420
Lacroix (A.), The Recent (June 27, 1931) Fall of an Asiderite Meteorite in the extreme south of Tunis, 646; The Tectites of Indo-China, 386; The Tectites of the Philippines, 554
Lacroute (P.), [L. and E. Bloch, F. Esclangon, and], Observation of the Zeeman Effect with High Frequency, 386
Ladame (G.), The Central Rhodopes and the Balkans, 83
Laemmlein (G.), The Regular Formation of Twins in Porphyro-quartz of Samshvildo, 387
Lafferty (H. A.), [M. J. Gorman and], On a Method of distinguishing the Seedlings of Swedish Turnip (*Brassica napus* L. var. *napobrassica* (L.) Reichb.) from those of Broad-leaved Rape (*Brassica napus* L. var. *biennis* (Schubl et Mart) Reichb.), 162
Laforgue (P.), Prehistory of West Africa, 839
Laidlay (J. C.), Breeding from Colour Varieties, 379
Laignel-Lavastine (Prof. M.), The Concentric Method in the Diagnosis of Psychoneurotics, 690
Laing (late Andrew), institution of an Annual Lecture in memory of, 670
Lal (Rai Bahadur Hira), Indian Place-names, 839
Lamb (Dr. C. G.), reappointed Reader in Electrical Engineering in Cambridge University, 916
Lamb (Dr. F. W.), An Introduction to Human Experimental Physiology, 475
Lambrey (M.), A Method of Studying the Decomposition of Gun-cottons at the Ordinary Temperature, 1050
de Lana (Franceso Terzi), tercentenary of the birth of, 993
Lanchester's Laboratories, Ltd., The Loud Speakers of, 669
Lander (Dr. C. H.), Oil and Petrol from Coal, 900
Lander (Dr. G. D.), [Prof. R. M. Caven and], Systematic Inorganic Chemistry: from the Standpoint of the Periodic Law. New edition, 209
Landolt (Hans Heinrich), Centenary of the Birth of, 899
Lang (Dr. H. R.), appointed Secretary of the Institute of Physics and editor of the *Journal of Scientific Instruments*, 1036
Lang (Prof. W. H.), awarded a Royal Medal of the Royal Society, 821; presented with a Royal Medal of the Royal Society, 973
Langdon (Prof. S. H.), elected a Corresponding Member of the Field Museum of Natural History, 756
Lange (F.), [A. Brasch and], Utilisation of Atmospheric Electric Fields, 380
Langseth (Dr. A.), Fine Structure of Raman-Lines in Liquids, 225
Lantz (R.), and G. Mingasson, The Naphthalene Bisulphite Compounds, 315
Lapicque (C.), [P. Auger and], Variation in the Spectrum of the Sensibility of Cuprous Oxide Cells, 646
Lapworth (Prof. A.), awarded the Davy Medal of the Royal Society, 821; presented with the Davy Medal of the Royal Society, 973
Larke (E. C.), [M. Cook and], Physical Testing of Copper and Copper-rich Alloys in the form of Thin Strip, 554

Lauffenburger (R.), [L. Hackspill and], Action of Heat on the Alkaline Diacid Phosphates, 682

Lautsch [Prof. Paneth and], Isolation of the Radical Ethyl, 1007

Lawrence (E. O.), and D. H. Sloan, Production of High-speed Canal Rays without the use of High Voltages, 83

Lea (A. M.), On Baridiinæ (Curculionidæ), mostly from New Guinea, 279

Leake (Dr. H. Martin), Plea for the establishment of Biology as a Profession, 666

Leakey (Dr. L. S. B.): The Marriage of Kikuyu Girls, Kenya, 696; The Stone Age Cultures of Kenya Colony. With Appendices by J. D. Solomon, C. E. P. Brooks, A. T. Hopwood, H. C. Beck, and M. Connolly, 1019; A. T. Hopwood, and Prof. H. Reck: Age of the Oldoway Bone Beds, Tanganyika Territory, 724; New Yields from the Oldoway Bone Beds, Tanganyika Territory, 1075

Leavenworth (Prof. F. P.), Measures of Double Stars, with the Measures by Prof. W. O. Beal, 743

Lebard (P.), [J. Costantin, J. Magrou, and], Influence of a Period in the Mountains on the Productivity of the Potato, 1086

Lebedeff (Dr. A. A.), A Focusing Method for producing Electron Diffraction Patterns, 491

Lebreton (Mlle. E.), and F. Mocoroa, The Number and Nature of the Proteolytic Ferments of the Pancreatic Juice, 199

Le Breton (E.), F. Mocoroa, and E. Stulz, The Proteolytic Ferments of the Intestinal Juice and of the Pancreatic Juice, 422

Le Brocq (L. F.), [H. Sutton and], Protection of Magnesium Alloys against Corrosion, 502

Le Camus (C.), and F. de Saint-Just, Magnetic and Electrical Observations in the Sahara, 882

Lecoin (M.), [Mme. Irene and], A New Gaseous Compound of Polonium, 199

Le Corbeiller (P.), [B. Decaux and], A Self-maintained Electrical System utilising a Neon Tube, 978

Lee (L. L.), Soil Classification, 677

Leech (H.), appointed Experimental Engineer at University College, Southampton, 681

Leeman (A. C.), The Antimony Electrode as a Means for *p*H Measurements, 682

Lees (S.), appointed Professor of Mechanical Engineering in the University of Birmingham, 278

Le Fèvre and Webb, Molecular Weight Determinations, 38

Le Grain (R.), [C. Baron, C. Boulanger, and], Petrol-alcohol-benzene Mixtures, 163

Leitz (E.), A New Illumination Device for Microscopy, 1010

Lemaître (Abbé G.), The Evolution of the Universe, 704

Lemarchands (M.), and H. L. Roman, Action of Anhydrides upon Metals, 163

Lemberg (Dr. R.), Prof. J. Barcroft, and Dr. D. Keilin, Uteroverdin, 967

Lenher, Oxidation of Ethylene, 912

Lennard-Jones (Prof. J. E.), The Nature of Cohesion, 462, 763

Lepape (A.), [M. Curie and], The Thermal Conductivity of the Rare Gases, 1050

Leppard (L. B.), [Prof. J. C. McLennan, M. F. Crawford, and], Nuclear Moments of the Isotopes of Lead: Relative Values of the *g*(*I*) Factors of Pb(207) and Tl, 301

Lespagnol (A.), [M. Polonovski and], Two New Sugars from Human Milk, Gyrolactose and Allolactose, 125

Lespieau (R.): M. Bourguel, and R. L. Wakeman, The Raman Effect in Chemistry, 503; and R. L. Wakeman, The Preparation of the Trimethylene Hydrocarbons, 235

Leulier (A.), and Mme. A. Roche, The Mechanism of the Antiglycosuric Action of Santonine, 422

Levaditi (C.), J. Bardet, A. Tchakirian, and A. Vaisman, The Distribution of Gallium in the Organism, 466

Levine (Prof. M.), and H. W. Schoenlein, A Compilation of Culture Media for the Cultivation of Micro-organisms, 24[illegible]

Lévy (A.), [G. Darzens and], The Direct Bromination of Metacresol, 555

Lévy (G.), β-ethylnaphthaline and its Hydrogenation Products, 163

Levy (R.), An Introduction to the Sociology of Islam, Vol. 1, 951

Lewis (C. M.), [W. V. Houston and], Rotational Raman Spectrum of CO_2, 280

Lewis (Prof. G. N.), Generalised Thermodynamics, 498

Lewis (Prof. H. F.), Fundamentals of Organic Chemistry, 957

Lewis [Jones, Seaman, and], Flame Temperatures, 1081

Lewis (W. B.), [Lord Rutherford, F. A. B. Ward, and], Long-Range α-Particles, 37

Leyshon (W. A.), The Jumping Negative Glow, 795

Liapounov, A. M., 1857–1918, A. J. Pressland, 138

Lighthall (Dr. W. D.), Matter: Life: Mind, 907

Lilienstern (Marie), A Liverwort as Pioneer on Burnt Forest Land, 37

Lilienthal (D.), [C. Ramsauer, R. Kollath, and], Collision Properties of Protons, 911

Linder (E. G.), The Dissociation of Water, 799

Lindsay (Prof. R. B.), [Prof. G. W. Stewart and], Acoustics: a Text on Theory and Applications, 779

Ling (Prof. A. R.), Plant Biochemistry, 621

Linhorst (E. F.), [J. H. Hodges and], The Thermal Decomposition of Nitrogen Pentoxide, 83

von Lippmann (Prof. E. O.): Entstehung und Ausbreitung der Alchemie. Band 2: Ein Lese- und Nachschlage-Buch, 774; Lucian and Condensed Air by Compression, 666

Litchko (E.), Regeneration of the Extremities in the Axolotl under the Influence of X-rays, 127

Lloyd (Dr. Ll.), Disappearance of Insect-borne Diseases from Britain, 798

Lloyd (Prof. F. E.), and Prof. G. W. Scarth, An Elementary Course in General Physiology. Part 2: Laboratory Exercises, 563

Lockhart (R. D.), appointed Professor of Anatomy in Birmingham University, 80

Lockyer (Dr. W. J. S.): Changes of the Corona in the Sun-spot Cycle, 229; Forms of the Solar Corona and their Origin, 784

Lodge (Sir Oliver): A Retrospect of Wireless Communication, 591; Advancing Science: being Personal Reminiscences of the British Association in the Nineteenth Century, 982; Communications, 932; The Evolution of the Universe, 722

Loewinson-Lessing (F.), V. Mitkevitch, and A. Turcev, Experiments in the Artificial Magnetisation of Limonites, 127

Lofquist (H.), [Dr. C. Benedicks and], Non-metallic Inclusions in Iron and Steel, 856

Lombardini (M.), Geometric Considerations for Periodal Analysis, 1050

Long (Prof. J.), [death], 666

Longo (P.), [A. Puppo and], The Storm of July 24, 1930, in the Treviso-Udine District, 466

Longwell (Prof. C. R.), Outlines of Physical Geology, 513

Loomis (A. L.), Improvement in Time-recording, 38

Lord (Lieut.-Col. J. R.), [death], 404

Lorentz (Prof. H. A.), Lectures on Theoretical Physics delivered at the University of Leiden. Translated by Dr. L. Silberstein and A. P. H. Trivelli. Vol. 3: Maxwell's Theory, edited by Dr. H. Bremekamp; The Principle of Relativity for Uniform Translations, edited by Dr. A. D. Fokker, 959

Lo Surdo (A.), Thermionic Valves with Fall of Potential across the Grid, 734

Lot (F.), Bretons et Anglais aux V^e et VI^e siècles, 61

Louis (Prof. H.), Sir Hugh Bell, Bt., 96

Loukianoff (G.), An Archaic Egyptian Figurine, 640

Loveday (A.), Britain and World Trade: Quo Vadimus and other Economic Essays, 955

Lowater (Miss F.), The Band Spectrum of Zirconium Oxide, 917

Lowe (C. van Riet), Giant Crescents: a New Stone Age Industry from South Africa, 36

Lowndes (A. G.), *Eurytemora thompsoni*, A. Willey: a New European Record, 967

Ludlam (Dr. E. B.), Band Spectrum of the Green Flame of Phosphorus, 271

Lugard (Lord), Africa in Transition, 730

Luguer (Col. T. T. P.), Mason and Dixon's Line, 995
Lukes (R.), Action of Grignard's Reagent on *N*-Methyl Pyrrolidon, 127
Lumbroso (U.), [C. Nicolle and], The *Bacterium granulosa* of Noguchi in its Relations with the Etiology of Trachoma, 81
Lumière (A.), and A. Seyewetz, Preparation of Fine Grain Negative Images by Development, 1086
Lundegårdh (Prof. H.), translated and edited by E. Ashby, Environment and Plant Development. Being "Klima und Boden in ihrer Wirkung auf das Pflanzenleben," 135
Lyman (Prof. T.), awarded the Frederick Ives Medal of the Optical Society of America, 834
Lynch (A.), Brain and Mind, 954

Maby (J. C.), Identification of Wood and Wood Charcoal Fragments, 733
McBain (Prof. J. W.): Periodic Precipitation in the Absence of Colloids, 1042; and Du Bois, Electrokinetics and the Interpretation of Surface Conductivity, 677
Macbeth (Prof. A. K.), Organic Chemistry for Medical, Intermediate Science, and Pharmaceutical Students. Second edition, 657
MacBride (Prof. E. W.), Death and Development, 382
McCabe (Prof. W. L.), [Prof. W. L. Badger and], Elements of Chemical Engineering, 622
McCale (C. H.), The Utilisation and Conservation of Indian Coal, 219
McCann (D. C.), [H. S. Olcott and], Cause of the Transformation of Carotene into Vitamin A., 998
McClean (Capt. W. N.), River Flow Records, 867
McClintock (Barbara), [Harriet B. Creighton and], A Correlation of Cytological and Genetical Crossing-over in *Zea mays*, 1014
McClintock (Dr. M.), Street Traffic Engineering, 1033
McCrea (G. W.), An X-Ray Examination of α-Mannitol and *d*-Mannose, 882
McCrea (W. H.), [W. O. Kermack and], An Operational Method for the Solution of Linear Partial Differential Equations, 882
McDonald (Dr. E.), Cancer Research and the Scientific Method, 407
MacDonald (J.), Forest Gardens, 915
Macdonald (Prof. R.), The Form of Fæcal Pellets and Specific Identification, 68
McElvain [Snell and], Aceto-acetic Ester Condensation, 229
Macfadyen (Dr. W. A.), Tertiary Foraminifera, 1080
Macfie (Dr. R. C.), [obituary article], 179
MacGregor (Dr. M. E.), Ultra-Violet Rays and Mosquito Larvæ, 68
McGuinness (Annie), [T. Dillon and], On Alginic Acid: its Mode of Occurrence and its Constitution, 162
McInerny (A. J.), Deserts and the Birth of Civilizations, 475
McKay (A. T.), Diffusion for the Infinite Plane Sheet, 733
Mackaye (Prof. J.), The Dynamic Universe, 288
Mackenzie (Prof. J. S.), Cosmic Problems: an Essay on Speculative Philosophy, 628
McKerrow (J. C.), Novius Organum: Essays in a New Metaphysic, 562
Macky (Dr. W. A.), Liquid Drops in Electric Fields, 799
McLachlan (Dr. N. W.), Inertia of Loud-Speaker Vibrating Diaphragm, 641; Modern Apparatus for the Reproduction of Speech and Music, 517; On the Effective Mass of Flexible Discs and Conical Diaphragms used for Sound Reproduction, 733
McLennan (Prof. J. C.): Superconductivity a Polarisation Phenomena, 373; A. C. Burton, A. Pitt, and J. O. Wilhelm, Superconductivity at High Frequencies, 1004; M. F. Crawford, and L. B. Leppard, Nuclear Moments of the Isotopes of Lead: Relative Values of the $g(I)$ Factors of Pb(207) and Tl, 301
Macnair (Major J. L. P.), Branching of Lightning, 969
McNeil (Dr. C.), appointed Clark Professor of Child Life and Health in Edinburgh University, 197
Macrae (Major A. E.), Overstrain of Metals: and its application to the Auto-Frettage Process of Cylinder and Gun Construction, 49
Macrae (Dr. T. F.), appointed a Research Student in Biochemistry at the Lister Institute, 197
Madeira (P. C.), Exploration of Yucatan by Aeroplane, 866
Madigan (C. T.), The Macdonnell Ranges, 1006
Magnan (A.), [E. Huguenard and], An Ultra-rapid Cinematograph giving from 2000 to 3000 Images per Second, 163
Magnusson (N. H.), Långbans malmträkt geologisk beskrivning, 384
Magrou (J.): [L. Binet and], Sulphur and Growth, 466; [J. Constantin, P. Lebard, and], Influence of a Period in the Mountains on the Production of the Potato, 1086
Mahajan (Prof. L. D.), Effect of Light on the Surface Tension of Boys's Soap Solutions, 496
Mailhe (A.), and Creusot, The Transformation of Benzene into Methane, 422; The Transformation of Toluene and of Xylene into Methane, 466
Majorana (Q.), Certain New Facts ascertainable by means of Ordinary Photoelectric Cells, 734; New Photoelectric Investigations, 646
Majumdar (R. C.), and D. S. Kothari, The Relativistic Opacity Coefficient, 908
Malan (D.), The Absorption Spectrum of Oxygen at High Temperatures, 386
Malaprade and Schnoutka, The Separation and Estimation of Boric Acid and Alumina, 315
Malherbe (Prof. I. de V.), The Aims and Objects of Soil Science, 801
Malloch (J. R.), Australian Diptera, 595, 918
Malone (J. F. J.), A New Prime Mover, 80
Mann (G. E.), [Dr. H. A. Tempany and], Principles of Tropical Agriculture, 954
Mann (L. MacLellan), Find of alleged Pre-Chellean Implements at Stanstead, Surrey, 144
Mann (W. B.), and B. G. Dickens, The Thermal Conductivities of Saturated Hydrocarbons in the Gaseous State, 881
Marboux (G.), An Electrical Oscillator of Low Frequency Stabilised by a Tuning Fork, 42
Mardles (Dr. E.), The Peroxidation of Hydrocarbons during Combustion in Air, 116; The Slow Combustion of Methane and Ethane, 304
Margary (I. D.), [J. E. Clark, R. Marshall, Capt. C. J. P. Cave, and L. C. W. Bonacina, Phenological Observations in the British Isles from Dec. 1929 to Nov. 1930, 917
de Margerie (Dr. E.), elected a Foreign Member of the Royal Society, 64
Marie (C.), and N. Marinesco, The Volume Contraction produced by the Hydration of Proteins, 978; and N. Thon, The Phenomena of Expansion presented by certain Electrolytic Deposits of Metals, 421
Marie (Dr. C.), Annual Tables of Constants and Numerical Data for Chemistry, Physics, Biology, and Technology, 662
Marinesco (N.), The Electromotive Force of Filtration produced by the Ascent of the Sap in Plants, 422; [C. Marie and], The Volume Contraction produced by the Hydration of Proteins, 978
Marlatt (Dr. C. L.), Report to the U.S. Department of Agriculture, 612
Maroger (J.), The Reconstitution of the Painting Technique of Jean Van Eyck, 978
Marples (G.), Ringed Plover and its Eggs, 154
Marrack (J. R.), and F. Campbell Smith, The Study of Specific Combination in Immunity Reactions, 1077
Marrian (Dr. G. F.), and A. Butenandt, Œstrus-producing Hormones, 305
Marsh (Othniel Charles), Centenary of the Birth of, 696
Marshall (Sir Guy), Weevils of Samoa, 676
Marshall (R.), [J. E. Clark, I. D. Margary, Capt. C. J. P. Cave, L. C. W. Bonacina, and], Phenological Observations in the British Isles from Dec. 1929 to Nov. 1930, 917
Marston (Elizabeth H.), [W. M. Marston, C. D. King, and], Integrative Psychology: a Study of Unit Response, 1025
Marston (W. M.), C. D. King, and Elizabeth H. Marston, Integrative Psychology: a Study of Unit Response, 1025
Martin (Dr. A. R.), Polarity and Vapour Pressure, 456
Martin (Dr. G.), The Modern Soap and Detergent Industry. Second edition. 2 Vols., 625

Martin (Prof. L. C.), Some Recent Developments in Microscopy, 833
Marvin (Prof. F. S.), A New Summary of Knowledge, 937; Paul Tannery and the History of Science, 613; Soviet Science, 170
Maskell (Dr. E. J.), appointed University Lecturer in Plant Physiology in Cambridge University, 844
Massey (H. S. W.), [E. C. Bullard and], Diffraction of Electrons, 799
Masson (Prof. I.), Melting Points of Nitrobenzene and of Benzene, 726; Problems in the National Teaching of Science (Pedler Lecture), 753
Massy (Miss Anne L.), [obituary article], 59
Mathias (E.): The Usefulness of Long Periods of Observation of the Rainfall in a given Place, 918; and G. Grénet, The Electric Field at the Summit of the Puy de Dôme, 806
Matignon (C.), Commercial Nitrates of Lime, 646
Matout (L.), [J. Becquerel and], The Decomposition of the Absorption Bands of Xenotime by a Transverse Magnetic Field, 466
Matthews (R. B.), Electricity for Everybody: Handbook for 1931, 960; New Agricultural Devices in Germany, 297
Matuyama (E.), [J. Okubo and], The Forbidden Lines in the High Frequency Discharge of Mercury, Cadmium, and Zinc, 224
Mauclère (P.), [P. Carré and], The Chloride of Acid Ethyl Sulphite and the Neutral Mixed Alkyl Sulphites, 386
Maulik (S.), [A. J. Engel Terzi and], Dr. L. W. Sambon, 486
Mawdsley (J. B.), [H. C. Cooke, W. F. James, and], Pre-Cambrian Rocks of Quebec, 1006
Mayer (Prof. F.), Advances in the Dye-stuff Industry, 792
Mazur (Dr. J.): Change of Density of Carbon Disulphide with Temperature, 673; Change of the Dielectric Constant of Carbon Disulphide with Temperature, 761; [Prof. M. Wolfke and], Change of Dielectric Polarisation of Carbon Disulphide with Temperature, 871; [Prof. M. Wolfke and], Change of Dielectric Polarisation of Nitrobenzene with Temperature, 584
Mead (Dr. Margaret), Social Organisation in Manoa, 414
Medical Supply Association, Ltd., Catalogue of X-Ray Apparatus and Appliances, 112
Medvedev (J.), The Kinetics of the Alcoholic Fermentation, 163
Meek (C. K.), A Sudanese Kingdom: an Ethnographical Study of the Jukun-speaking Peoples of Nigeria, 285; Tribal Studies in Northern Nigeria. Vol. 1, 285
Meggitt (Prof. F. J.), Insectivorous Snakes, 413
Mellanby (Prof. E.), appointed a Member of the Medical Research Council, 184
Meller (H. B.), Air Pollution at Pittsburgh, 307
Mellor (Dr. J. W.), A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. 11, 957
Melotte (P. J.), Star Density in different Galactic Latitudes, 192
Melvin (E. H.), [O. R. Wulf, and], Ultra-Violet Spectrum of Ozone, 763
Menzbier (M. A.), The Combination of Factors to which the Origin and the Development of Terrestrial Vertebrates is due, 127
Menzies (Dr. R. C.), A Two-Dimensional Space Lattice? 907
Mercier (F.), Influence of Dextrorotatory Pseudo-cocaine on the Hypertensive Action of Adrenaline, 1050
Merriam (Dr. C. Hart), awarded the Roosevelt medal, 147
Metz (C. W.), and M. Louise Schmuck, Differences between Chromosome Groups of Soma and Germ-line in *Sciara*, 423
Meyer (Dr. A. R.), elected President of the International Illumination Congress, 1934, 643
Meyer (J.), [J. Saidman, R. Cahen and], The Local Effects in the Rat due to Electric Fields of very High Frequency, 387
Meyer (Mrs. Kirstine), Faraday and Ørsted, 337
Mezzadroli (G.), and E. Vareton, Action of Ultra-short Electromagnetic Waves (2-3 Metres), on Amylase, 43
Miall (Dr. S.), A History of the British Chemical Industry, 46
Michal (K.). Oscillation in Oxygen Consumption during the Day and during the whole Life of Invertebrates, 1013; Relation between the Population Density and the Optimum for Life, and of this to the Sex Ratio, in some Invertebrates, 1013
Michel-Lévy (A.), and H. Muraour, The Temperature of Deflagration of Colloidal (explosive) Powders, 421
Middleton (A. D.), The Vole Cycle in Britain, 36
Miers (Sir Henry), Address to the Museums Association, 330
Miller (A. A.), Climatology, 514
Miller (A. H.), Incubation of the Mexican Jacana, 306; Song of an American Oriole, 970; The Impaling Instinct of Shrikes, 1005
Miller (Prof. E. C.), Plant Physiology: with reference to the Green Plant, 952
Millikan (Prof. R. A.), The Evolution of the Universe, 709; and Dr. I. S. Bowen, Similarity between Cosmic Rays and Gamma Rays, 582
Milne (Prof. E. A.), Collapsed Stars and Novæ, 587; The Evolution of the Universe, 715; The Internal Temperature of White Dwarf Stars, 999
Milne-Thomson (Prof. L. M.), Two Books of Logarithms, 91
Mingasson (G.), [R. Lantz and], The Naphthalene Bisulphite Compounds, 315
Mitchell (Sir Peter Chalmers), Life and Matter, 723; "The World List of Scientific Periodicals", 70; Zoos and National Parks, 578
Mitkevitch (V.), [F. Loewinson-Lessing, A. Turcev and], Experiments in the Artificial Magnetisation of Limonites, 127
Mitkewich (W. T.), Faraday and Electrical Science in Russia and the U.S.S.R., 359
Mitra (Birendrakumar), [Prof. Ekendranath Ghosh and], Anterior Abdominal Vein in the Toad, 273
Mnich (E.), The Phosphorus Compounds of Plants (6), 279
Mocoroa (F.), [E. Le Breton, E. Stulz, and], The Proteolytic Ferments of the Intestinal Juice and of the Pancreatic Juice, 422; [Mlle. E. Lebreton and], The Number and Nature of the Proteolytic Ferments of the Pancreatic Juice, 199
Moffett (A. A.), Chromosomes and Constitution, 875
Moggridge (J. Y.), [J. Phillip, J. D. Scott, and], Photochemical Measurements of Light Intensity in two common Vegetation Types in Tropical Africa, 162
Moir (J. Reid), Palæolithic Flint Implements, 767; The Oldoway Human Skeleton, 797
Moissan (Henri), A Monument to, 679
Mori (Yasumasa), Transformation of Scales in Gold Fish, 119
Moles (Prof. E.), The Atomic Weight of Fluorine, 966
Mollison (J. A.), record flight from Australia to England, 266
Montessus de Ballore (Dr. R. de), Probabilités et statistiques, 286
Montgomery (Dr. G. L.), appointed Lecturer in Clinical Pathology in St. Andrews University, 81
Mooney (R. B.), and H. G. Reid, The Absorption Spectra of Cyanogen and the Cyanogen Halides, 882; Ultra-Violet Absorption Spectra of Cyanogen and the Cyanogen Halides, 271
Moore (R. B.), [F. J. Allen and], Krypton and Xenon, 380
Moreux (Abbé), Meteoric Hypothesis for the Origin of the Solar System, 729
Morgan (Prof. G. T.): Jubilee Celebrations of the Society of Chemical Industry, 226; and Dr. S. Sugden, Paramagnetism of Bivalent Silver, 31; and R. Taylor, Syntheses of Ethyl Alcohol, 38; and Pettet, Identification of Hydroxylic Compounds, 37
Morris (Ann Axtell), [E. H. Morris, J. Charlot, and], The Temple of the Warriors at Chichen Itzá, Yucatan, 694
Morris (E. H.), [J. Charlot, and Ann Axtell Morris], The Temple of the Warriors at Chichen Itzá, Yucatan, 694
Morris (Sir William R.), gift to the British Empire Cancer Campaign, 440
Morris-Owen (R. M.), Esperanto in Scientific Literature, 969
Morshead (Lieut.-Col. H. T.), [obituary article], 58
Mortensen (Prof. T.), The Development and Larval Forms of Echinoderms, I-II., 417
Mott (N. F.), Polarisation of a Beam of Electrons by Scattering, 454
Mottern [Nelson and], Organic Acids in Plants, 415
de Moubray (G. A. de C.), Matriarchy in the Malay Peninsula and Neighbouring Countries, 624
Mougnaud (P.), The Estimation of Fluorine, 386

Moullin (E. B.), The Theory and Practice of Radio Frequency Measurements: a Handbook for the Laboratory and a Textbook for Advanced Students. Second edition, 1057
Mowdawalla (F. N.), appointed Professor of Electrical Technology in the Indian Institute of Science, Bangalore, 197
Moynihan of Leeds (Lord), address at the laying of the corner stone of the Wellcome Research Institution, 974; re-elected president of the Royal College of Surgeons of England, 101
Muir (M. M. Pattison), [death], 437
Muirhead (Prof. J. H.), Prof. A. S. Pringle-Pattison, 575
Mukherjee (Prof. J. N.), and S. P. Roychoudhury, Hydrolytic Adsorption of Activated Charcoal, 412
Mullen (A. W.), The Strange Acquirement of a Central Australian Parrot, the Corella, 579
Muller (Prof. E.), translated by Dr. H. J. T. Ellingham, A Laboratory Manual of Electrochemistry, 743
Munch (J. C.), and J. Silver, The Pharmacology of Thallium and its use in Rodent Control, 383
Muraour (H.), [A. Michel-Lévy], The Temperature of Deflagration of Colloidal (explosive) Powders, 421
Murphy (Dr. A. J.), Constitution of the Alloys of Silver and Mercury, 554, 1082
Murphy (P.), Armadas of the Sky: the Problem of Armaments, 963
Murray (D. G.), [E. S. Simpson and], A New Siderotite from Bencubbin, Western Australia, 977
Musya (K.), Luminous Phenomena accompanying Earthquakes, 155
Muybridge (Eadweard), the work of, 143
Myers (Dr. C. S.), On the Nature of Mind, 537, 744
Myers (Dr. J. G.), The Biological Control of West Indian Insect Pests, 878
Myers (O. H.), Cult of the Sacred Bull in Ancient Egypt, 119
Myres (Prof. J. L.), Topography and Tradition, 938

Nadson (G.): and G. Burgwitz, Yeasts from the North Polar Ocean, 682; and G. Filippov, The Formation of New Stable Races of Micro-organisms under the Influence of X-Rays, (2) 422, (3) 467; and E. A. Stern, Action of the Ultra-Violet and X-Rays on the Yeast Cell, 467; The Combined Action of Metals and of X-Rays on Yeasts, 503
Nagaoka (Prof. H.), Propagation of Electromagnetic Waves, 120
Nagata (Masani), awarded the Donohoe Comet medal of the Astronomical Society of the Pacific, 868
Nakamura (Prof. Gisaburo), Isotope Effect in the Band Spectrum of Lithium Hydride, 759
Nakashima (Hirokichi), Tree Growth and Weather, 840
Namba (S.), Abnormality of Radio Signals passing through High Latitudes, 1044
Nanjundayya (the late H. V.), and Rao Bahadur L. K. Ananthakrishna Iyer, The Mysore Tribes and Castes. Vol. 3, 50
Nansen (Dr. F.), translated by G. C. Wheeler, Through the Caucasus to the Volga, 319
Narayan (Dr. A. L.), First Structure in the Arc Spectra of Indium and Thallium, 675
Narlikar (V. V.), elected an Isaac Newton Student in Cambridge University, 804
Nasonov (N.), On *Acrorhynchus baicalensis* Rubtzoff (Turbellaria, Rhabdocœla) from Lake Baikal, 127
Nathan (Dr. M.), L'esprit et ses maladies, 6
Needham (Dr. J.), Excretion of Uric Acid, 152
Negretti and Zambra: Catalogue of Meteorological Instruments, 670; Distance Thermometers, 972
Nelson and Mottern, Organic Acids in Plants, 415
Nenadkevic (K.), An Electro-colorimetric Method for the Determination of Small Quantities of Manganese, 770
Netter (R.), [O. Bailly and], The Isolation of Carotene from the suprarenal glands, 1086
Neumann (M.), and A. Serbinoff, Limits of Gaseous Explosions, 1040
Newnham (E. V.), Measurement of Pressure and Temperature in the Upper Atmosphere, 878
Newson (J. E.), and A. Wragg, The Failure of High-strength Brass, 503
Newton (Sir Isaac), room dedicated to the memory of, at Coimbra University, 930
Newton and Anderson, Respiration of Wheat at Low Temperature, 970
Newton (R.), and W. R. Brown, Frost Injury to Plants, 911; Respiration of Wheat at Low Temperature, 970
Ney (Mlle. M.), Enlargement of Diffused Lines without Change of Frequency in the Raman Effect, 126
Nicholls (J. R.), Jenkins and DuMez's Quantitative Pharmaceutical Chemistry, 958
Nicholls (K.), awarded a Woolmen Company medal, 757
Nicloux (M.), Combustion of Alcohol by the Pœcilotherm, 682
Nicod (J.), translated by P. P. Wiener, Foundations of Geometry and Induction, 430
Nicol (H.), Distribution of Agar-liquefying Bacteria, 1041
Nicol (W. D.), [Col. S. P. James, P. G. Shute, and], The Prevention of Malarial Infection in Human Beings, 404
Nicolle (C.), and U. Lumbroso, The *Bacterium granulosa* of Noguchi in its relations with the Etiology of Trachoma, 81
Nierenstein (Dr. M.), Constitution of Cyanidin Chloride, 587; Gallnuts as a Chemical Reagent, 1006
Nightingale (E.), Magnetism and Electricity, 959
Nikitina (E.), [M. Korsakova and], Influence of the Associated Bacteria on the Nitrogen Régime of *Granulobacter pectinovorum*, 387
Noble (L. F.), Nitrate Deposits of California, 155
Noel (E.), [obituary article], 100
Noguera (E.), Pottery of Ancient Mexico, 459
Nolan (Prof. J. J.), and Dr. P. J. Nolan, Atmospheric Ionisation, 971
Nolan (Dr. P. J.), [Prof. J. J. Nolan and], Atmospheric Ionisation, 971
Noonan (N.), [Prof. J. Reilly, P. J. Drumm, and], The Evaluation of the Menthone Content of Peppermint Oil, 845
Norman (Ivy Evelyn), and P. J. Smith, Leather Crafts Manual, 1060
Normand (Dr. C. W. B.), Graphical Indication of Humidity in the Upper Air, 583
du Noüy (Dr. P. Lecomte), Effect of Light on the Surface Tension of Boys's Soap Solution, 674
Novotny (F.), and F. Toul, The Estimation of Traces of Elementary Oxygen, 1013
Nunn (Sir T. Percy), Prof. H. Wildon Carr, 98
Nygaard (G.), Freshwater Algæ and Phytoplankton from the Transvaal, 316

Oakley (Dr. R. A.), [death], 486
Odell (N. E.), Oxygen and Everest, 1037
O'Donoghue (Dr. C. H.), Abnormalities of the Vascular System of the Anura, 42
Offord (J. M.), Recollections of the Quekett Microscopical Club, 29
Okhlopkova (E.), Certain Problems on the Limits of the Theory of Logarithmic Potential, 43
Okubo (J.), and E. Matuyama, The Forbidden Lines in the High Frequency Discharge of Mercury, Cadmium, and Zinc, 224
Olcott (H. S.), and D. C. McCann, Cause of the Transformation of Carotene into Vitamin A, 998
Oliver (D. A.), Subjective Interpretation of Loudspeaker Frequency Response Curves in Terms of Loudness, 268
O'Neill (H.), The Diameter Measurement of Certain Brinell Indentations in Cold-rolled Metal, 595; and J. W. Cuthbertson, The Work-hardening Capacity and Elongation Properties of Copper, 595
Onslow (Hon. Mrs. M. W.), Chemical Effect of a Mendelian Factor for Flower Colour, 373; The Principles of Plant Biochemistry. Part 1, 621
Orlov (J.), The Remains of a Primitive Representative of Pinnipedia from the Neogene Deposits in Western Siberia, 503
Orrok (Dr. G. A.), The Pearl Street Electric Power Station, New York, 140
Orton (Prof. J. H.): and C. Amirthalingam, Sex-change in the Oyster, 273; and S. T. Burfield, Biological Effects of Cosmic and γ-Radiation, 376

Osborn (Prof. H. F.), conferment upon, of an honorary doctorate by Paris University, 936; edited by Florence Milligan, Fifty-two Years of Research, Observation, and Publication, 1877–1920: a Life Adventure in Breadth and Depth, 625; The Principles of Evolution revealed by Palæontology, 894

Osborn (T. G. B.), J. G. Wood, and T. B. Paltridge, The Autecology of *Stipa nitida*: a Study of a Fodder Grass in Arid Australia, 918

Osborne (Prof. W. A.), Conservation of Rainfall as Carbohydrates, 378

Oswald (Dr. F.), Index of Potters' Stamps on Terra Sigillata "Samian Ware". With a Supplement, 951

Paillard (H.), [E. Briner, A. Demolis, and], The Ozonation of Aldehydes and the Theory of Active Molecules, 235

Painton (E. T.), The Steel-cored Aluminium Cable, 1070

Pallu (R.), [R. Dubrisay and], The Photochemical Oxidation of Sulphur, 646

Paltridge (T. B.), [T. G. B. Osborn, J. G. Wood, and], The Autecology of *Stipa nitida*: a Study of a Fodder Grass in Arid Australia, 918

Paneth (Prof. F.), translated by Dr. R. W. Lawson, The German Bunsen Society in Vienna, 94; and Lautsch, Isolation of the Radical Ethyl, 1007

Pant (B. D.), [H. G. Champion and], Seeds and Seedlings of Sâl, 1080

Papish (Dr. J.), Identification of the Element of Atomic No. 87 in Samarskite, 696; and Wainer, The Discovery of Element No. 87, 789

Paréjas (E.), Results of the Harvard University Geological Expedition in the Canadian Rockies, 1929 (3), 235

Parker (Dr. H. L.), Polyembryony in a Braconid Parasite, 190

Parmenter (C. E.), S. N. Trevino, and C. A. Bevans, Articulation of Isolated Sounds, 380

Parrod (J.), and Mlle. Y. Garreau, The Oxidation Products of *d*-Mannose by Ammoniacal Copper Oxide in the Presence of Air, 1050

Parsons (Sir John H.), Young's Theory of Colour Vision, 123

Partington (Prof. J. R.), Alchemical Apparatus, 118; Chinese Alchemy, 1074

Paterson (C. C.), The British Standard Specification for Street Lighting, 488

Patterson (H. S.): Prof. R. Whytlaw-Gray, and W. Cawood, The Atomic Weight of Fluorine, 375; [W. Cawood and], A Curious Phenomenon shown by Highly-charged Aerosols, 150

Payman [Grimshaw and], Ignition of Fire-damp by Coal-mining Explosives, 867

Payne (Cecilia H.), The Stars of High Luminosity, 615

Payne (R. J. M.), [J. L. Haughton and], Transformations in the Gold-Copper Alloys, etc., 554

Peacock (Prof. A. D.), Problems in Parthenogenesis, 941

Peacock (M. A.), [G. W. Tyrrell and], The Petrology of Iceland, 881

Peake (H. J. E.), Age of Certain Gravels in the New Forest Area, 378

Pear (Prof. T. H.), Voice and Personality, 657

Pearce (T. J. P.), [Prof. M. W. Travers, L. E. Hockin, and], Influence of Hydrogen on Chemical Changes in Silica Vessels, 66

Pearl (Prof. R.), Psychology and Organised Religion, 1047; The Operations of the Bureau for Contraceptive Advice, 180

Pearn (Dr. O. P. N.), Mental Nursing (Simplified), 892

Pearsall (Pilling and], Nitrogen Content of Apples in Storage, 549

Pearson (H.), Erasmus Darwin, 1731–1802, 1032

Pearson (Dr. J.), False Killer Whales in Ceylon Waters, 839

Pearson (R. S.), and others, Research in Wood Preservation, 1083

Peddie (Prof. W.), Modern Views on Magnetism, 623

Pedersen (Dr. K. O.), Temperature Stability and Denaturation of Serum Albumin, 150

Peek (B.), Rapid Current on Jupiter, 192

Peers (Sir Charles), Address to the Annual Congress of Archæological Societies, 900

Peltier (J.), Search for Want of Symmetry and Faults in Ferromagnetic Test Pieces, 733

Pénau (H.), [Mlle. D. van Stolk, J. Guilbert, H. Simonnet, and], Pure Carotene and Vitamin A, 199; [Mlle. D. van Stolk, J. Guilbert, and], Carotene and Vitamin A, 467

Penrose, Jr. (Prof. R. A. F.), [death], 666

Pentelow (F. T. K.), A New Locality for *Gammarus chevreuxi* Sexton, 797

Perelmann (F.), [I. Kablukov and], The Heat of Combustion of Certain Organic Halogenic Compounds, 127

Perier (A. L.), The Maxillofacial Correlations, 734

Perkin (D.), [A. Archangelskii and], Origin of the Ferrous Deposits in the Lipetsk Area, 163

Perkins (E. B.), and T. Snook, Control of Pigment Migration in the Chromatophores of Crustaceans, 423

Perkins (Jacob), The Work of, 1070

Perkins (Dr. M.), Acromegaly in the Far North, 491; Light of Glow-worms, 905

Perotti (R.), The Struggle of Cereals against *Stretta*, 735

Perret (A.), and R. Perrot, The Hydrolysis of Nitrosyl Chloride and of Nitrogen Peroxide by Caustic Potash, 1086

Perrot (R.), [A. Perret and], The Hydrolysis of Nitrosyl Chloride and of Nitrogen Peroxide by Caustic Potash, 1086

Perry (Prof. R. B.), A Defence of Philosophy, 964

Petch (T.), Entomogenous Fungi, 874

Petri (L.), A Method for detecting the Exceptional Presence of Mercury in Vegetable Tissues, 647

Petrie (Sir Flinders), Experiments in Prophylaxis, 35

Pettet [Morgan and], Identification of Hydroxylic Compounds, 37

Pfeil (L. B.), [D. G. Jones, W. T. Griffiths, and], Nickel-Copper Alloys of High Elastic Limit, 502

Phelan (Prof. J. W.), [Prof. A. A. Blanchard and], Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. Fourth edition, 92

Phillip (J.), J. D. Scott, and J. Y. Moggridge, Photochemical Measurements of Light Intensity in Two Common Vegetation Types in Tropical Africa, 162

Phillips (A. C.), [Sir Gilbert Walker and], The Forms of Stratified Clouds: Part 1, Experimental; Part 2, Discussion, 917

Phillips (Dr. F. C.), appointed University Lecturer in Petrology in Cambridge University, 1048; On Crystals of Brookite Tabular Parallel to the Basal Plane, 977

Philp (Dr. J.), and Prof. C. L. Huskins, A Satellite missing from Ever-sporting Stocks, 970

Philpot (J. St. L.), [F. A. Askew, Miss H. M. Bruce, Dr. R. K. Callow, T. A. Webster, and], Crystalline Vitamin D, 758

Piccard (A.), E. Stahel, and F. Dony, The Absorption of the penetrating Gamma Rays by Lean Screens 12-30 cm. thick, 846

Pickard (J. N.), and Prof. F. A. E. Crew, The Scientific Aspects of Rabbit Breeding, 512

Picon and Cogné, Study of some Sulphides of the Rare Earths, 882

Piggot (C. S.), Radium in Hawaiian Lavas, 840

Pilling and Pearsall, Nitrogen Content of Apples in Storage, 549

Pirrone (Dr. F.), Acceleration of Fermentation by Algæ and Sea-water, 419; [L. Sanzo and], Irradiation of Sea Water by Ultra-Violet Rays and its Action on the Velocity of Alcoholic Fermentation of Glucose Solutions, 806

Pitt (A.), [Prof. J. C. McLennan, A. C. Burton, J. O. Wilhelm, and], Superconductivity at High Frequencies, 1004

Pitt (W. J.), A Dwarf Chamæleon with Two Litters, 407

Pittard (J. J.), The Bitumen of the Urgonian Limestone and the Molasse of Pyrimont (Ain), 734

Pizón (S.), [K. Dziewonski and], A New Method of Synthesis of Dinaphthopyrone, 279

Placzek (Dr. G.), Evidence for the Spin of the Photon from Light-Scattering, 410

Planck (Prof. Max), Positivismus und reale Aussenwelt, 289

Plaskett (Prof. H. H.), appointed Savilian professor of astronomy in Oxford University, 930
Plowe (Janet), [Prof. W. Seifriz and], Extensibility of Protoplasm, 1045
Pochin (E. E.), elected Michael Foster Research Student in Physiology in Cambridge University, 161
Pohl (Prof. R. W.), translated by Winifred M. Deans, Physical Principles of Electricity and Magnetism, 134
Pokrowski (Prof. G. I.), An Effect of X-Rays on Matter, 875
Polack, Which Colours do all Colour-blind People fail to distinguish ? 1050
Polonovski (M.): and A. Lespagnol, Two New Sugars from Human Milk, Gyrolactose and Allolactose, 125; and R. Hazard, Some Physiological Effects of Chlorotropane, 734
Pons (Jean Louis), Centenary of the Death of, 610
du Pont de Nemours (E. I.), Artificial Rubber, 1044
Poole (Dr. T.), A New Method of Identification, 904
Popova-Wassina (E. T.), A Vigorous Naked Sheep, 866
Popovitch-Schneider (Mme. V.), Extension of Héle-Shaw's Method to Cyclic Movements, 386
Porcherel (A.), [C. Fromageot and], The Action of Pancreatin upon Different Types of Wool, 1013
Porter (Prof. J. T.), [death], 666
Posnjak (Dr. E.), [F. C. Kracek, S. B. Hendricks, and], Group Rotation in Solid Ammonium and Calcium Nitrates, 410
Posnjak [Ross, Henderson, and], A New Uranium Mineral, 155
Post and Gatty, Flight round the Earth, 60
Powell (Prof. H. C.), The Culture of the Orange and Allied Fruits, 955
Power (J. H.), On the Herpetological Fauna of the Lobatsi-Linokana Area, 126
Pratesi (P.), Reactions of Addition to Unsaturated Organic Compounds, 1050; [M. Betti and], Optical Resolution of Racemic Aldehydes (2), 1014
Pratje (O.), Helgoland und die Zerstörung seiner Felskuste durch das Meer, 657
Prausnitz (Dr. P. H.) und Dr. J. Reitstötter, Elektrophorese, Elektroosmose, Elektrodialyse in Flüssigkeiten, 988
Prelog (V.), The Sapogenin of Beetroot, 127
Pressland (A. J.), A. M. Liapounov, 1857–1918, 138
Preston (J. M.), Anistropy due to Flow in Cellulose Sols, 796
Prettre (M.), Ignition of Mixtures of Acetaldehyde and Air, 503
Prianischnikov (D.), and V. V. Butkevitch, The Physiological Characteristics of Potassium Salts, 163
Price (J. A.), awarded the Earl of Durham Prize of the Institution of Naval Architects, 420
Pringle-Pattison (Prof. A. S.), [death], 437; [obituary article], 575
Procter (Dr. Joan B.), [death], 544; [obituary article], 664
Prost (M.), [M. Curie and], The Radiation accompanying the Hydration of Quinine Sulphate, 386
Pruthi (Dr. Hem Singh), Effects of Inadequate Feeding on Insect Metamorphosis, 869
Pryde (J.), and R. T. Williams, The Pyranoid Structure of Glucuronic Acid and of Theophylline Arabinoside, 187
Przibram (Prof. K.), Faraday and Austria, 351
Pugh (W.), Influence of Fluoride Ions upon the Reduction of Potassium Permanganate (1), 682
Pulvertaft (R. J. V.), appointed University Reader in Pathology in London University, 805
Pumphrey (R. J.), appointed University Demonstrator in Zoology in Cambridge University, 880
Pupin (Prof. M. I.), awarded the John Fritz gold medal, 868
Puppo (A.), The Storm of July 24, 1930, in the Treviso-Udine District, 199; and P. Longo, 466
Puri (Dev Raj), Mimicry in Indian Butterflies, 459
Purser (G. L.), The Early Stages of Development of the Vertebrates, 42
Putnoky (Dr. F.), [Dr. N. Goldstern and], Illumination in Factories, 1080

Quéré (H.), The Oxidation of the Alcohols by the Acetic Ferments, considered as a Form of Cell Respiration, 770
Quilico (A.), and M. Freri, Azopyrrole Blacks (3), 595
Quintin (Mlle. M.), The Activity Coefficient of the Bivalent Copper Ion in Solutions of its Sulphate, 1050

Rabaté (J.), [C. Charaux and], The Biochemical Study of the Genus *Salix*, 199
Radoslavoff (B. M.), Earthquakes and Mineral Springs, 677
Rafałowski (S.), Structure of the Raman Band of Water, 546; The Fine Structure of Spectral Lines of Light scattered by Liquids, 495; The Raman Bands in Water, 978
Raitt (W.), The Digestion of Grasses and Bamboo for Paper-Making, 949
Rakshit (Jitendra Nath), Association Theory of Solution and Inadequacy of Dissociation Theory, 852
Ramage (H.), and J. H. Sheldon, Mineral Content of Eyes, 376
Raman (Sir C. V.): Atoms and Molecules as Fitzgerald Oscillators, 795; Doppler Effect in Light-Scattering, 636; India's Debt to Faraday, 362; The Angular Momentum of Light, 545; and S. Bhagavantam, Evidence for the Spin of the Photon from Light-Scattering, 114; Experimental Demonstration of Spin of Light, 576; Spin of Light Quanta, 727; and S. W. Chinchalkar, A New Type of Magnetic Birefringence, 758
Ramdas (Dr. L. A.), and L. P. Venkiteshwaran, Spectrum of Glow-worm, 726
Ramsauer (C.), R. Kollath, and D. Lilienthal, Collision Properties of Protons, 911
Ramsbottom (J.), Forestry Research in Great Britain, 118
Ramsey (A. S.), Hamilton's 'Characteristic Function', 167
Ramsey (F. P.), edited by R. B. Braithwaite, The Foundations of Mathematics: and other Logical Essays, 620
Rao (Prof. Basrur Sanjiva), and M. R. Aswathnarayana Rao, Reaction between Hydrogen Sulphide and Sulphur Dioxide, 413
Rao (Dr. K. R.), and J. S. Badami, Resonance Spectrum of Hydrogen, 585; The Structure of the Spectrum Se III, 496
Rao (Prof. L. Rama), Occurrence of *Lithothamnion* in the South Indian Cretaceous, 225, 873
Rao (M. R. Aswathnarayana), [Prof. Basrur Sanjiva Rao and], Reaction between Hydrogen Sulphide and Sulphur Dioxide, 413
Rao (S. Ramachandra): Diamagnetism and the Colloidal State, 153; and G. Sivaramakrishnan, Diamagnetism of Liquid Mixtures, 872
Rashleigh (E. C.), The Guayra Falls of the Parana, 549
Rasmussen (E.), and H. Swenson, Intensity Anomalies in Rare Gas Spectra, 188
Ratcliffe (F. N.), The Flying Fox in Australia, 122
Ratner (A.), [V. Chlopin and], Distribution of a Dissolved Substance between the Crystalline and the Fluid Phase, 387
Ray (B. B.), [Dr. A. K. Das, D. N. Dasgupta, and], Measurement of Pressure and Temperature in the Upper Atmosphere, 878
Ray (Dr. B. B.), and B. B. Datta, Part-Absorption in X-Rays, 224
Rây (Sir P. C.), Synthesis of Ethyl Thio-aceto-acetate, 189
Rayleigh (Lord), Mercury Line Spectrum in Fluorescence, 905; The Mercury Band Spectrum in Fluorescence, 724
Rayner (Dr. M. C.), Mycorrhiza in Relation to Forestry, 1011
Read (Prof. Carveth), [obituary article], 1067
Read (Prof. J.), A Chinese Alchemist, 509; An Introduction to Organic Chemistry, 742; Chemistry through the Ages, 321; Essential Oils (Bedson Lecture), 864
Reck (Prof. H.), [Dr. L. S. B. Leakey, A. T. Hopwood, and], Age of the Oldoway Bone Beds, Tanganyika Territory, 724; [Dr. L. S. B. Leakey, A. T. Hopwood, and], New Yields from the Oldoway Bone Beds, Tanganyika Territory, 1075
Redman (R. O.), elected a Fellow of St. John's College, Cambridge, 768

Redshaw (L.), awarded the Vickers-Armstrong scholarship of the Institution of Naval Architects, 768
Reichel (Sir Harry R.), [death], 179
Reid (H. G.), [R. B. Mooney and], The Absorption Spectra of Cyanogen and the Cyanogen Halides, 882; [R. B. Mooney and], Ultra-Violet Absorption Spectra of Cyanogen and the Cyanogen Halides, 271
Reid (W. F.), [death], 930
Reidemeister (Prof. K.), Vorlesungen uber Grundlagen der Geometrie, 626
Reilly (Prof. J.), Review of Recent Advances in Analytical Chemistry, vol. 1, 208; B. Daly, and P. J. Drumm, Diazotisation of Aminophenylpyrazoles, 162; M. Hayes, and P. J. Drumm, Lichenin, 162; N. Noonan, and P. J. Drumm, The Evaluation of the Menthone Content of Peppermint Oil, 845
Reinach (S.), Orpheus: a History of Religions. Revised and partly rewritten. Translated by Florence Simmonds, 628
Reisner (Dr. G. A.), Ancient Egyptian Sealings, 1079
Reitstötter (Dr. J.), [Dr. P. H. Prausnitz und], Elektrophorese, Elektroosmose, Elektrodialyse in Flüssigkeiten, 988
Renaud (Dr. E. B.), Central Wyoming Pictographs, 910; Colorado and Folsom Points, 190
Rendle (Dr. A. B.), Dr. Richard Wettstein, 436
Rendle (B. J.), Timber of the British Douglas Fir, 971
Rennet (Miss Nita), [Sir J. Arthur Thomson and], Antarctic Alcyonaria, Madreporaria, and Antipatharia, 71
Restaino (S.), [F. Zambonini and], Praseodymium and Thallous Sulphates, 1014
Reymond (F.), and Tcheng da tchang, The Separation of Polonium and of Protactinium fixed on Tantalum Oxide, 386
Reyner (J. H.), Modern Radio Communication. Third edition, 1057
Reynolds (J. H.), The Hakemite Tables of Ebn Jounis, 913
Reynolds (Miss T. M.), [J. C. Earl and], The Celluloses of Two Water Plants, 316
Reynolds (W. C.), Charged Aerosols and Ball Lightning, 584
Ricardo (H. R.), The High-Speed Internal-Combustion Engine. New edition, 886
Rice (D. Talbot), [Dr. L. H. Dudley Buxton and], Human Remains from Kish, 798
Rice (F. O.), and H. T. Byck, Collision between Organic Molecules and Surfaces, 228
Rice (O. K.), On the Transfer of Energy between Atoms at Collision, 83
Rich (F.), Phytoplankton from South African Pans and Vleis, 316
Richards (D.), appointed a Tutor for Adult Education in Birmingham University, 80
Richards (P. W.), awarded a Frank Smart prize of Cambridge University, 80
Richardson (Prof. O. W.), Isolated Quantised Magnetic Poles, 582
Richey (J. E.), and others, The Geology of Ardnamurchan, North-west Mull and Coll, 619
Richmond (Dr. Droop), [death], 437
Richter (G. H.), [W. D. Bancroft and], Reversible Coagulation in Living Tissue (3), 423; [W. D. Bancroft and], Reversible Coagulation in Living Tissue (4), 846
Rideal (Prof. E. K.), Treatise on Physical Chemistry, 429
Riéty (L.), and G. Salager, An Electromotive Force of Filtration of Abnormal Value, 1050
van Rijn (Dr. J. F. L.), Die Glykoside: Chemische Monographie der Pflanzenglykoside. Zweite auflage von Prof. H. Dieterle, 959
Riley (N. D.), The Comma Butterfly in England, 760
Rimer (G.), [D. Epstein, J. W. C. Gunn, E. Epstein, and], The Adrenal Secretion of *Xenopus lœvis*, 126
Rinck (E.), Diagram of Solidification of the Calcium-Sodium Alloys, 163
Rindl (M.), The Alkaloids of the Bark of *Strychnos henningsii*, 200
Ritchie (Prof. J.), Science and Philosophy of Life, 1056
Rivard (Adjutor), awarded the Lorne Pierce medal of the Royal Society of Canada, 275
Rivera (V.), Factors exciting Increase of Vegetal Neoplasms by *B. tumefaciens*, 806
Roberti (G.), Hydrogenation of the Nitrogen Compounds contained in Primary Tar, 735
Roberts (E.), and W. E. Carroll, Mexican Hairless Swine, 866
Roberts, Jr. (F. H. H.), Pit-Dwellings at Kiatuthlanna, Eastern Arizona, 154
Roberts (J. E.), [Prof. R. Whiddington and], Electron Exchange Phenomena in the Excited Atom, 966
Robertson (A.), Application of the Simonis Reaction to Monohydric Phenols, 908
Robertson (Sir Robert), and B. A. Ellis, Faraday's "Chemical Manipulation", 371
Robinson (G. M.), and Prof. R. Robinson, Constitution of Anthocyanins, 413
Robinson (H.), [S. C. Blacktin and], Electrification of Coal Dust, 498
Robinson (Prof. R.), [G. M. Robinson and], Constitution of Anthocyanins, 413
Robinson and others, Synthesis of Anthocyanins, 912
Robinson [Briscoe, Stoddart, and], Rhenium Compounds, 192, 729
Robson (A.), [C. V. Durell and], Advanced Trigonometry, 92
Roche (Mme. A.), [A. Leulier and], The Mechanism of the Antiglycosuric Action of Santonine, 422
Roche (J.), and A. Bendrihem, The Combination of Globin with Hæmatins of Various Origins, 646
Rodger (Sir Alexander), Forestry in the Empire, 833
Rodolico (F.), Diopside and Tremolite from Monte Spinosa in the Campigliese, 1014
Rolfe (H. G.), presented with the Pereira Medal of the Pharmaceutical Society, 667
Rollefson and Booher, Photochemical Decomposition of Hydrogen Iodide, 72
Rolleston (Dr. J. D.), A Legend concerning Sir Benjamin Ward Richardson, 996
Rollier (Dr.), La Clinique—Manufacture Internationale, 1072
Roman (H. L.), [M. Lemarchands and], Action of Anhydrides upon Metals, 163
Rosa (Prof. D.), L'Ologénèse: nouvelle théorie de l'évolution et de la distribution géographique des êtres vivants, 429
Rose (D. C.), Tests of Combinations of Lighting Units, 1034
Rosenberg (Prof. O.), elected an honorary fellow of the Royal Microscopical Society, 834
Rosenblum (S.), The Long Path α-Rays emitted by $ThC+C'$ and some Determinations of the Velocities of the α-rays, 1050
Rosenhain (Dr. W.), elected president of the New International Association for Testing Materials, 1935, 644
Rosenholtz, (Dr. J. L.), The Elements of Ferrous Metallurgy, 626
Rosewood (A.), Disasters at the Moon's Third Quarter, 997
Ross (C. S.), and P. F. Kerr, Kaolin Minerals, 875
Ross, Henderson, and Posnjak, A New Uranium Mineral, 155
Rosseland (Prof. S.), Astrophysik auf atomtheoretischer Grundlage, 615
van Rossem (A. J.), Land Birds of Sonora, Mexico, 190
Rossi (Prof. B.), Absorption and Diffusion of the Penetrating Corpuscular Radiation in Lead and Iron, 806; Magnetic Experiments on the Cosmic Rays, 300; Measurements on the Absorption of the Penetrating Corpuscular Rays coming from Inclined Directions, 408
Rossier (P.), An Astrophysical Formula; the Calculation of the Apparent Diameter of a Star, 734; Nature of Purkinje's Phenomenon, 235
Rossini (F. D.), The Heat of Combustion of Methyl Alcohol, 555
Roulleau (J.), [R. Audubert and], The Rôle of the Phenomena of Photoconductance in the Photovoltaic Effect, 555
Roux (A.), [L. Guillet, J. Cournot and], The Influence of Occluded Gases on the Mechanical Properties of Metallurgical Products, 978
Rowe (C. H.), A Characteristic Property of Systems of Paths, 1086
Rowell (P. F.), title of Honorary Member of the Société Française des Électriciens conferred upon, 834

Rowland (Rev. J. P.), The North Sea Earthquake of June 7, 15, 147
Rowntree (S.), Some Industrial Problems of To-day, 331
Roychoudhury (S. P.), [Prof. J. N. Mukherjee and], Hydrolytic Adsorption of Activated Charcoal, 412
Rumbold (G.), The Origin of Life. Second Impression, 243
Rupp (H. M. R.), The Orchids of the South Maitland Coalfields, with description of a new *Dendrobium* from Bullahdelah, 279
Ruse (H. S.), On the Definition of Spatial Distance in General Relativity, 882
Russell (A.), British Mineral Collectors and Dealers in the Seventeenth, Eighteenth, and Nineteenth Centuries, 42
Russell (Sir John), The Changing Outlook in Agriculture, 539, 1027
Russell (Dr. W. K.), Ultra-Violet Radiotherapy, 953
Rutgers (J. J.), Modification of Pregl's Method for Determining Nitrogen, 421
Rutherford (Lord), conferment upon, of an honorary degree by the University of Freiburg im Breisgau, 756, 833; Helium and its Properties, 137; and Dr. C. D. Ellis, Origin of γ-rays, 415, 805; F. A. B. Ward, and W. B. Lewis, Long-Range α-Particles, 37
Rutherford (Sir Ernest) [Lord], Dr. J. Chadwick, and Dr. C. D. Ellis, Radiations from Radioactive Substances, 3
Rutzler, jr. (J. E.), [W. D. Bancroft and], Reversible Coagulation in Living Tissue, 280, 1014
Rybicka (Mme. M.), [W. Swietolawski, Mme. W. Solodkowska, and], An Adiabatic Microcalorimeter, 126
Rydberg (Dr. P. A.), [death], 437

Saegusa (Prof. H.), and S. Shimizu, Anomalous Variation of the Electrical Conductivity of Quartz with Temperature at the Transformation Point, 835
Saha (Prof. M. N.), and Y. Bhargava, The Spin of the Photon, 870
Saidman (J.): The Comparative Biological Properties of High Frequency and Very High Frequency Currents, 1013; J. Meyer, and R. Cahen, The Local Effects in the Rat due to Electric Fields of very High Frequency, 387
Saini (H.), and J. Weiglé, A possible Transformation of Maleic Acid into Fumaric Acid, 235
de Saint-Just (F.), [C. Le Camus and], Magnetic and Electrical Observations in the Sahara, 882
de Saint-Périer (Dr. R.), La Grotte d'Isturitz. 1: Le Magdalénien de la Salle de Saint-Martin, 988
Salager (G.), [L. Riéty and], An Electromotive Force of Filtration of Abnormal Value, 1050
Salceanu (C.), The Natural and Magnetic Rotary Polarisation of some Organic Compounds Studied in the Liquid State, 82
Saller (Dr. K.), Leitfaden der Anthropologie, 624
Salmon (Dr. E. H.), Materials and Structures: a Textbook for Engineering Students, Vol. 1: The Elasticity and Strength of Materials, 617
Sambon (Dr. L. W.), [death], 437; [obituary article], 486
Sampson (Dr. J.), [death], 863; [obituary article], 898
Sampson (Prof. R. A.), elected President of the Philosophical Society of the University of Durham, 723
Samuel (G.), and J. G. Bald, *Thrips tabaci* as a Vector of Plant Virus Disease, 494
Samuel (Sir Herbert), acceptance of the Presidency of the British Institute of Philosophy, 64
Samuel (Dr. R.), Absorption Spectra of Complex Salts, 729
Sandford (Dr. K. S.), and Dr. W. J. Arkell, Palæolithic Man and the Nile-Faiyum Divide; a Study of the Region during Pliocene and Pleistocene Times, 287
Sandström (A.), Multiple Ionisation and Secondary X-Ray Absorption Edges, 759
Sanfourche (A.), The Electrometric Titration of Phosphoric Acid, 82
Sanzo (L.), and F. Pirrone, Irradiation of Sea Water by Ultra-Violet Rays and its Action on the Velocity of Alcoholic Fermentation of Glucose Solutions, 806
Sapir (Dr. E.), Shoshonean Linguistics, 379
Satoh (Shun-ichi), Atomic Hydrogen occluded in Iron Nitride, 457
Saunders (A. R.), Maize in South Africa, 1060
Saunders (Prof. F. A.), A Survey of Physics for College Students, 134; A Survey of Physics, 628
Saunders (T. R. B.), reappointed Demonstrator in Engineering in Cambridge University, 916
Savage (R. E.), Distribution of Herring and Plankton, 1079
Say (Dr. M. G.), award to, of the Coopers Hill War Memorial Prize and Medal, 1072
Scarborough (Prof. J. B.), Numerical Mathematical Analysis, 962
Scarth (Prof. G. W.), An Elementary Course in General Physiology. Part 1: Principles and Theory, 563; [Prof. F. E. Lloyd and], An Elementary Course in General Physiology. Part 2: Laboratory Exercise, 563
Ščegoleva-Barovskaja (T.), New Mordellidæ (Coleoptera) in the Collections of the Zoological Museum of the Academy of Sciences, 337
Schaafsma (Dr. A.), Bands in the Spectrum of Barium Hydride, 1042
Schaefer (Prof. C.), Gauss's Investigations on Electrodynamics, 339
Schaffer (Prof. F. X.), Lehrbuch der Geologie. Teil 3. Lief. 1, 956
Schälly (E.), The Observation of Streaks in Chemical Studies: (4) *D*-streaks and Allied Phenomena, 468
Schedler (A.), and M. Toperczer, The Distribution of Declination in Austria at the Epoch 1930·0, 43
Scheele, Carl Wilhelm, The Collected Papers of, Translated by Dr. L. Dobbin, 1023
Schidlof (A.), Application of Wave Mechanics to Nuclear Physics, 734
Schmidt (C. F.), [K. K. Chen and], Ephedrine and related Substances, 629
Schmidt (Prof. J.), Eels and Conger Eels of the North Atlantic, 602
Schmuck (N. Louise), [C. W. Metz and], Differences between Chromosome Groups of Soma and Germ-line in *Sciara*, 423
Schneiderhöhn (Prof. H.), und Prof. P. Ramdohr, Lehrbuch der Erzmikroskopie; Erzmikroskopische Bestimmungstafeln: Anhang zum Lehrbuch der Erzmikroskopie, 889
Schnoutka [Malaprade and], The Separation and Estimation of Boric Acid and Alumina, 315
Schoeller (W. R.), and C. Jahn, The Quantitative Preparation of Titanium from Tantalum and Niobium, 845; [E. F. Waterhouse and], The Separation of the Earth Acids from Metals of the Hydrogen Sulphide Group, 845
Schoenlein (H. W.), [Prof. M. Levine and], A Compilation of Culture Media for the Cultivation of Micro-organisms, 244
Schofield (J. F.), The Occupation of Great Zimbabwe, 791
Schonland (Dr. B. F. J.), Lightning Phenomena, 799; and Dr. T. E. Allibone, Branching of Lightning, 794; and C. A. Coppens, Point Discharge Measurements below Thunderstorms, 200
Schopfer (W. H.), Influence of Yeast Extracts and Concentrates of B Vitamins on the Sexuality of a Fungus, 734
Schuchert (Prof. C.), Building of the Northern Appalachians, 227; Outlines of Historical Geology. Second edition, 513
Schuler (Dr. H.), and J. E. Keyston, Changes of Intensity in the Hyperfine Structure of Lines, 911
Schultz (Prof. A. H.), Man and the Primates, 1043
Schultz (Dr. F.), Estimation of Bromine in Organic Compounds, 72
Schultz [Sturtevant and], A Hypothesis of 'Sub-genes', 273
Schulze (Dr. W. M. H.), Short Wave Reception and Ultra-Radiation, 837
Schuster (Sir Arthur), awarded the Copley Medal of the Royal Society, 821; presented with the Copley Medal of the Royal Society, 973
Schuster (G.), [J. Bougault and], Composition of Karité Butter, 682
Schutz (W.), [Dr. E. Bergmann and], Structure of the Azides, 1077
v. Schwarz (Dr. M.), Microscopic Examination of Metals by Polarised Light, 800

Scott (Prof. Charlotte A.), [death], 863
Scott (J. D.), [J. Phillip, J. Y. Moggridge, and], Photochemical Measurements of Light Intensity in two common Vegetation Types in Tropical Africa, 162
Scrase (F. J.), Deep-Focus Earthquakes, 228
Scupin (Prof. H.), Die Nordsudetische Dyas: eine stratigraphisch-palaogeographische Untersuchung, 892
Seaman [Jones, Lewis, and], Flame Temperatures, 1081
Sears, jr. (J. E.), Determination of the Yard in Terms of the Wave-length of Light, 965
Seeder (W. A.), [Prof. E. Gorter and], A Method of Studying Surface Films, 413
Segré (E.), and Dr. C. J. Bakker, Zeeman Effect of a Forbidden Line, 1076
Seguin (L. and A.), and A. Labarthe, An Apparatus for the Study of the Phenomena of Injection and of Combustion in Motors by the Ultra-Cinematograph, 421
Seidell and Birckner, Anti-Neuritic Vitamin, 229
Seifriz (Prof. W.), and Janet Plowe, Extensibility of Protoplasm, 1045
Seligman (Prof. C. G.), Acromegaly among the old Northmen, 221; Acromegaly in the Far North, 492
Sellards (A. W.), Behaviour of the Virus of Yellow Fever in Monkeys and Mice, 555
Semičev (E.), The Fundamental Features of Electrodynamic relations in Electromagnetic Machinery, 126
Senderens (J. B.), The Comparative Hydration of Sulphuric Acid and of the Alkaline Bisulphates, 199; The Catalytic Dehydrogenation, in the Gas Phase, of the Fatty Alcohols in the presence of Pumice carrying Sulphuric and Phosphoric Acids, 162
Serbescu (P.), [G. Bertrand and], The Toxic Power of Aluminium compared with that of Iron, Nickel, and other Metals, 466
Serbinoff (A.), [M. Neumann and], Limits of Gaseous Explosions, 1040
Sergi (Prof. S.), The Roman Neanderthal Skull, 306
Setchell (W. A.), and N. L. Gardner, Marine Algæ from the Pacific, 191
Seth (Prof. J. B.), A Method of obtaining Air Currents of different Humidities, 638
Seth-Smith (D.), Breeding from Colour Varieties, 379
Seward (Prof. A. C.), Fossil Plants from the Bokkeveld and Witteberg Beds of South Africa, 1012; Plant Life through the Ages: a Geological and Botanical Retrospect, 559
Seward (Prof. S. S.), The Paradox of the Ludicrous, 988
Sewell (Lieut.-Col. R. B. S.), The Evolution of the Excretory System in Cercariæ, 459
Seyewetz (A.), [A. Lumière and], Preparation of Fine Grain Negative Images by Development, 1086
Shalowitz (A. L.), The Physical Basis of Modern Hydrographic Surveying, 1014
Shapley (Dr. H.), Flights from Chaos: a Survey of Material Systems from Atoms to Galaxies, 615
Sharpey-Schafer (Sir E. A.), elected president of the Royal Society of Edinburgh, 793; The Physiology of Internal Secretion (John Mallet Purser Lecture), 437, 441
Shaw (Sir Napier), A Century of Meteorology, 925; The Energy of Horizontal Atmospheric Motion, 226
Shearcroft (W. F. F.), Post-Primary Science. Book 1: First Year's Course, 960
Sheldon (J. H.), [H. Ramage and], Mineral Content of Eyes, 376
Sherman (Prof. H. C.), and S. L. Smith, The Vitamins, 743
Sherrington (Sir Charles), conferment upon, of an Honorary Doctorate by the University of Berne, 681
Shiga (T.), [T. Ito and], On Scorodite from Kiura Mine, Bungo, Kiushiu, Japan, 977
Shimizu (S.), [Prof. H. Saegusa and], Anomalous Variation of the Electrical Conductivity of Quartz with Temperature at the Transformation Point, 835
Shimotomai (N.), Chromosome Multiples in *Chrysanthemum* and *Potentilla*, 72
Shinôda (Osamu), Starch Digestion in Silkworms, 497
Shorter (L. R.), Introduction to Vector Analysis: with many fully worked Examples and some Applications to Dynamics and Physics, 626
Shute (P. G.), [Col. S. P. James, W. D. Nicol, and], The Prevention of Malarial Infection in Human Beings, 404
Siegbahn (Prof. M.), conferment upon, of an honorary degree by the University of Freiburg im Breisgau, 756, 833
Signorini (A.), The Profile of Bridge Piers, 43
Silver (J.), [J. C. Munch and], The Pharmacology of Thallium and its use in Rodent Control, 383
Silvester (N. L.), Hail Storm, June 14, at Doncaster, 35
Simonnet (H.), [Mlle. D. Van Stolk, J. Guilbert, H. Pénau, and], Pure Carotene and Vitamin A, 199
Simpson (E. S.), and D. G. Murray, A New Siderolite from Bencubbin, Western Australia, 977
Simpson (Dr. G. C.), The Polar Year 1932–1933, 793
Simpson (Sir William), [death], 544; [obituary article], 695
Singer (Dr. C.), A Short History of Biology: a General Introduction to the Study of Living Things, 132; The Beginnings of Science, 7
Singh (Balwant), [V. I. Vaidhianathan and], Magnetism of Colloidal Gold, 302
Sinitsin (D. F.), Life-Cycle of *Moniezia expansa*, 676
Sinnatt (Dr. F. S.), appointed director of Fuel Research under the Department of Scientific and Industrial Research, 1072
de Sitter (Prof. W.), Accuracy of the Heliometer, 274; elected an honorary member of the American Astronomical Society, 634; The Evolution of the Universe, 706; Theories of the Birth of the Planetary System, 972
Sivaramakrishnan (G.), [S. Ramachandra Rao and], Diamagnetism of Liquid Mixtures, 872
Sjögren and Svedberg, Molecular Weight of Insulin, 380
Skeats (Prof. E. W.), Granites of Eastern Australia, 307
Skinner (H. D.), Elsdon Best, 929
Skinner (Dr. H. W. B.), The Excitation Potentials of Metallic Lithium 114
Slater (F. P.), Cotton Growing in Egypt, 766, 1002
Slater (I. G.), [D. Hanson and], Unsoundness in Aluminium Sand-castings, 502
Sloan (Dr. H.), [E. O. Lawrence and], Production of High-Speed Canal Rays without the use of High Voltages, 83
Slouka (H.), The Mass of Saturn's Ring, 972
Smail (J. Cameron), The late Sir Francis Ogilvie, 118
Smart (Prof. W. M.), Text-Book on Spherical Astronomy, 207
Smirnov (N. S.), Two New Species of Rotatoria from the Ussuri Region, 467
Smith (A. St. Alban), conferment upon, of the Silver Medal of the Zoological Society of London, 332
Smith (D. E.), [D. H. Tennant, M. S. Gardiner, and], Nature of Golgi Substance, 728
Smith (D. M.), The Spectrographic Assay of some Alloys of Lead, 554, 802
Smith (Engr.-Capt. E. C.), Faraday and his Contemporaries, 333; Science in the City of London, 515
Smith (E. H.), Cooling Effects of Ice on the Oceans, 840
Smith (Sir Frank), Academic Research and National Dividends, 1069
Smith (Rev. F.), [obituary], 899
Smith (F. Campbell), [J. R. Marrack and], The Study of Specific Combination in Immunity Reactions, 1077
Smith (Prof. G. Elliot): Evolutionary Tendencies in the Jaws and Teeth, 501; Man's Remote Ancestry, 4; and others, Early Man: His Origin, Development and Culture, 951
Smith (Dr. J. Henderson), Plant Virus Diseases, 635
Smith (J. W.), Distillation of Dry Liquids, 971
Smith (Dr. Kenneth M.), A Textbook of Agricultural Entomology, 943; Insect Vectors and Virus Diseases of Plants, 379; Virus Diseases of Plants and their relationship with Insect Vectors, 915
Smith (M. L.), [B. Topley and], Function of Water Vapour in the Dissociation of a Salt Hydrate, 302
Smith (Prof. N. J. G.), Making conditions Unsuited to Infectious Diseases, 801
Smith (P.), [E. Patricia Allen and], Selection of Skilled Apprentices for the Engineering Trades, 463
Smith (P. I.), [Ivy Evelyn Norman and], Leather Crafts Manual, 1060
Smith (S. G.), Cytology of *Anchusa* and its Relation to the Taxonomy of the Genus, 493
Smith (S. L.), [Prof. H. C. Sherman and], The Vitamins, 743
Smith (Prof. Sydney), Alcohol and Behaviour, 630
Smith (W. Campbell), On a New Meteoric Stone from Suwahib, Arabia, 977

Smithells (Dr. C. J.): Impurities in Metals: their Influence on Structure and Properties. Second edition, 627; S. V. Williams, and E. J. Grimwood, Melting Nickel-Chromium Alloys in Hydrogen, 595
Smuts (General J. C.), elected Rector of St. Andrews University, 916; The Evolution of the Universe, 718
Smyth (Prof. H. D.), Negative Ions, 677
Snell and McElvain, Aceto-acetic Ester Condensation, 229
Snook (T.), [E. B. Perkins and], Control of Pigment Migration in the Chromatophores of Crustaceans, 423
Snyder (H.), Bread: a collection of Popular Papers on Wheat, Flour, and Bread. With Biographical Sketch by A. L. Winton, 953
Soddy (Prof. F.), The Corpuscular Explanation of Cosmic Rays, 408
Solodkowska (Mme. W.), [W. Swietolawski, Mme. M. Rybicka, and], An Adiabatic Microcalorimeter, 126
van Someren (E. H. S.), [H. W. Bronsdon], Application of the Spectrograph to the Analysis of Non-ferrous Metals and Alloys, 554, 802
Southern (R.), and A. C. Gardiner, Reports from the Limnological Laboratory (2), 1013
Speakman (J. B.), and Mercia C. Hirst, Constitution of the Keratin Molecule, 1073
Spence (Dr. R.), The Slow Combustion of Acetylene, 153; Slow Combustion of Hydrocarbons, 873
Spencer (Prof. J. F.), [V. C. G. Trew and], Diamagnetism of Liquid Mixtures, 152
Spencer (Dr. L. J.), Hoba (South-West Africa), The Largest known Meteorite, 42; Twelfth List of New Mineral Names, 42
Spikes (W. H.), The Properties of Matter, 396
Spilsbury (R. S. J.), Duration and Magnitude of a Lightning Discharge, 872
Spinks (J. W. T.), Photosensitised Decomposition of Ozone by Bromine, 548
Sreenivasaya (M.), and H. B. Sreerangachar, Contraction Contents of Enzyme-Substrate Reactions, 585
Sreerangachar (H. B.), [M. Sreenivasaya and], Contraction Constants of Enzyme-Substrate Reactions, 585
Stahel (E.), [A. Piccard, F. Dony, and], The Absorption of the Penetrating Gamma Rays by Lead Screens 12-30 cm. thick, 846
Staig (R. A.), The Fabrician Types of Insects in the Hunterian Collection at Glasgow University, Coleoptera, Part 1, 1035
Stainforth (Flight-Lieut. G. H.), Aeroplane Speed Record, 490, 611
Stair (R.), [W. W. Coblentz, J. M. Hogue, and], The Spectral Erythemic Reaction of the Human Skin to Ultra-Violet Radiation, 555; [A. Q. Tool and], Ultra-Violet Window Glass, 549
Stanbury (Florence A.), [Dr. W. R. G. Atkins and], Illumination and Tree Growth, 191
Stanton (Sir Thomas), [death], 404; [obituary article], 485
Stayt (Dr. H. A.), The Bavenda, 614
Steatite and Porcelain Products, Ltd., Value of Modern Research in Industry, 1033
Stechschulte (Rev. V. C.), Deep-Focus Earthquakes, 673
Steele (Dr. Catherine C.), appointed Lecturer in Agricultural Chemistry and Physics at Swanley Horticultural College, 197
Steele (S.), An Investigation of Infra-Red Radiation from an Engine, 185
Steffensen (Prof. J. F.), Some Recent Researches in the Theory of Statistics and Actuarial Science, 286
Stein (Sir Aurel), causes for abandonment of his expedition in Chinese Turkestan, 144
Step (E.), [obituary], 863
Stephen (A. C.), Growth of the Cockle, 379
Stern (E. A.), The Combined Action of Metals and X-Rays on Luminous Bacteria, 503; [G. Nadson and], Action of the Ultra-Violet and X-Rays on the Yeast Cell, 467; The Combined Action of Metals and of X-Rays on Yeasts, 503
Stetson (Prof. H. T.), Man and the Stars, 615
Stewart (C. J.), Determination of Position in High Latitudes, with particular reference to Aircraft Observation, 212
Stewart (Prof. G. W.), The Viscosity of Liquids, 727
Stewart (Prof. G. W.), and Prof. R. B. Lindsay, Acoustics: a Text on Theory and Applications, 779
Stewart (Major O.), Cross-Country Flying, 961; Flying as a Career, 961
Stieber (A.), [L. Hackspill, R. Hocart, and], Crystallised Boron, 1013
Stirling (Dr. J. D.), appointed to the staff of the Hannah Dairy Research Institute, 81
Stoddart [Briscoe, Robinson, and], Rhenium Compounds, 192, 729
van Stolk (Mlle. D.), J. Guilbert, and H. Pénau, Carotene and Vitamin A, 467
Stone (Edith W.), Joseph Henry, 542
Stone (Dr. W.), awarded the Otto Hermann medal of the Hungarian Ornithological Society, 670
Storey (Dr. H. H.), A New Virus Disease of the Tobacco Plant, 187
Størmer (Prof. C.), The Nature of Cosmic Rays, 83
Stott (Miss Emma), awarded a Woolmen Company medal, 757
Stott (V.), Pivots and Jewels, 273
Stoyko (N.), [R. Jouast and], The Propagation of Short Radio-electric Waves, 82
Strafford (N.), [T. Callan and], Examination of Dyed Leather in Cases of Alleged Dermatitis, 733
Straneo (P.), The Unitary Theory of Gravitation and Electricity (2), 1014; (3), 1050
Strassmann (Prof. P.), Aus der Medizin des Rinascimento. An der Hand des "Leben von Benvenuto Cellini" nach der Übersetzung Goethes, 173
Stratton (Dr. S W.), [death], 696; [obituary article], 928
Streeter (Dr. G.), Human Embryology, 804; and others, Development of the Egg, 1005
Strelnikov (J. D.), Influence of the Solar Radiations on the Temperature of the Bodies of Insects, 125
Strömberg (G.), Velocity of Light from the Spiral Nebulæ, 587
Stroobant (Prof. P.), Galactic Rotation, 764; Rotation of the Galaxy and the Solar Apex shown by the Radial Velocities of the Helium Stars, 846; and others, New List of Astronomers and Observatories, 73
Strumza (M. V.), [L. Binet and], The Hæmatopoietic Power of Carotene, 387
Stuart (Sir Campbell), appointed Chairman of the Beit Fellowships for Scientific Research, 161
Stubbs (S. G. B.), and E. W. Bligh, Sixty Centuries of Health and Physick: the Progress of Ideas from Primitive Magic to Modern Medicine, 939
Stulz (E.), [E. Le Breton, F. Mocoroa, and], The Proteolytic Ferments of the Intestinal Juice and of the Pancreatic Juice, 422
Sturtevant and Schultz, A Hypothesis of 'Sub-genes', 273
Subrahmanyan (Dr. V.), appointed Professor of Biochemistry at the Indian Institute of Science, Bangalore, 1049
Sucksmith (W.), Gyromagnetic Effect for Salts of the Iron Group, 640
Sudhoff (Prof. K.), elected President of the International Council of the International Congress of the History of Science and Technology, 79
Suess (Prof. E.), Centenary of the Birth of, 251
Sugden (Dr. S.), [Prof. G. T. Morgan and], Paramagnetism of Bivalent Silver, 31
Sugiura (Y.), The Diffraction of Proton Waves, 1006
Sussmilch (C. A.), The Bathurst Senkungsfeld, 467
Susz (B.), [E. Briner and], The Maximum Concentration of Endothermic Compounds at High Temperatures, 83
Sutton (H.), and L. F. Le Brocq, The Protection of Magnesium Alloys against Corrosion, 502
Sutton (L. E.), Structure of the Azides, from their Electric Dipole Moments, 639
Sutton (T. C.), Structure of the Azide Group, 872
Suzuki (Seitarô), Constitution of the White Dwarf Stars, 838
Švagr (E.), [Prof. B. Brauner and], A Physico-chemical Study of the Sulphates of the Rare Earths, 1013
Svedberg (Prof.), The Molecular Weights of the Proteins in their Native State, 999; [Sjogren and], Molecular Weight of Insulin, 330
Sverdrup (H. U.), Audibility of the Aurora Polaris, 457

Swarth (H. S.), Birds of the Galapagos Islands, 762
Swellengrebel (Prof. N. H.), Malaria in South Africa, 497
Swenson (H.), [E. Rasmussen and], Intensity Anomalies in Rare Gas Spectra, 188
Swietolawski (W.), and Mlle. E. Bartoszewiczowna, Application of the Adiabatic Microcalorimeter to the Determination of the Heat of Adsorption and Vaporisation, 126; Mme. M. Rybicka, and Mme. W. Solodkowska, An Adiabatic Microcalorimeter, 126; and Mlle. L. Wajcenblit, The Ternary Heteroazeotrope formed of Carbon Disulphide, Acetone, and Water, 918
Swinburne (Major U. P.), [death], 863
Swinnerton (Prof. H. H.), Outlines of Palæontology. Second edition, 173
Szabó (I.), Absterben und Entwicklung, 382
Szent-Györgyi (Prof. A.), Chemical Nature of the Tigroid, 761

Takvorian (S.), Investigation on Element 61 by means of the X-Rays, 82
Talavera (F.), and L. A. Faustino, Industrial Shells of the Philippines, 676
Talbot (P. Amaury), Anthropology in Nigeria, 285
Talbot (Col. the Hon. M. G.), 437
Tallarico (G.), Biological Value of the Products of Manured or Artificially Fertilised Soil, 595
Tallent (Violet K.), Eclipse Plumage in the Mallard, 672
Tannery (Paul), Mémoires scientifiques de, Publiés par L.-L. Heiberg et H.-G. Zeuthen. Tome 10 (Suppt. au Tome 6): Sciences modernes, généralités historiques, 1892–1930. Édité avec la collaboration de J. Pérès, 613
Tavener (P. A.), The Canada Goose and its Races, 874
Tawney (R. H.), Equality (Halley Stewart Lectures, 1929), 964
Taylor (Brook), Bicentenary of the Death of, 1068
Taylor (Prof. H. S.), Activated Adsorption of Hydrogen by Zinc and Chromium Oxides, 636
Taylor (J. W.), [obituary], 666
Taylor (R.), [Prof. G. T. Morgan and], Syntheses of Ethyl Alcohol, 38
Tchakirian (A.), [C. Levaditi, J. Bardet, A. Vaisman, and], The Distribution of Gallium in the Organism, 466
Tcheng da tchang, [F. Reymond and], The Separation of Polonium and of Protactinium fixed on Tantalum Oxide, 386
Teegan (J. A. C.), A Spark Method of Measuring High Resistance, 585
Tempany (Dr. H. A.), and G. E. Mann, Principles of Tropical Agriculture, 954
Temple (Dr. G.), An Introduction to Quantum Theory, 960
Tennant (D. H.), M. S. Gardiner, and D. E. Smith, Nature of Golgi Substance, 728
Terada (Prof. T.), Curvature of Island and Mountain Arcs, 498
Terzi (A. J. Engel), and S. Maulik, Dr. L. W. Sambon, 486
Thomas (B.), Alarms and Excursions in Arabia, 956
Thomas (J. A.), Action of Sea Water, in which Carotene has remained, on the Experimental Development of *Paracentrotus lividus*, 978
Thomas (Prof. O.), translated by B. Miall, The Heavens and the Universe, 244
Thomas (P. E.), [R. Fosse, A. Brunel, and]: Application of the Quantitative Spectrophotometric Analysis of Allantoin, 421; [R. Fosse, A. Brunel, and], The Quantitative Analysis of Very Small Quantities of Allantoin at High Dilutions, 315
Thomas (Prof. T. Y.): On the Unified Field Theory (3), 83; The Elementary Theory of Tensors: with Applications to Geometry and Mechanics, 626
Thompson (C. J. S.), The Mystery and Lore of Monsters: with Accounts of some Giants, Dwarfs, and Prodigies, 90
Thompson (Prof. D'Arcy W.), Embryology and the Theory of Polyhedra, 31
Thompson (Prof. F. C.), [E. L. Francis and], The Drawing of Non-ferrous Wires, 554; [H. Greenwood and], Wires drawn through Rotating Discs, 152
Thompson (G. A.), awarded the John Gray Jubilee Scholarship, 805
Thompson (J. E.), A Manual of the Slide Rule: its History, Principle, and Operation. Second printing, 563.
Thompson (W. G.), awarded the Ferranti Scholarship of the Institution of Electrical Engineers, 581
Thompson (Prof. W. P.), Chromosome Homologies in Wheat, Rye, and Aegilops, 640
Thoms (Prof. H.), presented with the Hanbury Memorial Medal, 667; the work of, 667
Thomson (Prof. G. P.), The Wave Mechanics of Free Electrons, 47
Thomson (J.), The Ionising Efficiency of Electronic Impacts in Air, 81
Thomson (Sir J. Arthur), and Prof. P. Geddes, Life: Outlines of General Biology. 2 Vols., 1056; and Miss Nita Rennet, Antarctic Alcyonaria, Madreporaria, and Antipatharia, 71
Thomson (Sir J. J.), and others, James Clerk Maxwell, 607
Thomson (W. A.), A Method of Recording Bright Sunshine, 15
Thon (N.), [C. Marie and], The Phenomena of Expansion presented by certain Electrolytic Deposits of Metals, 421
Thornton (Prof. W. M.), Measurement of High Voltages, 875
Thouvenin (J.), [G. Bruhat and], The Double Refraction produced by the Compression of Amorphous Silica and Crystallised Quartz and its Dispersion in the Ultra-Violet, 1050
Ti (Sou Phou), Action of Ethylmagnesium Bromide on *N*-diethylmonochloracetamide, 199
Tickner (Dr. F. W.), One Touch of Nature: a Literary Nature Study Reader for Boys and Girls, 624
Tiercy (G.): Silvering Telescope Mirrors, 236; The Systematic Use of the Rotation of the Transit Instrument, 734; Variation of the Radial Velocity of U Aquilæ, 682
Tilley (Dr. C. E.), elected Professor of Mineralogy and Petrology in Cambridge University, 41; elected a Fellow of Emmanuel College, Cambridge, 804
Tillyard (Dr. R. J.), Kansas Permian Insects, 414
Timoshenko (Prof. S.), Strength of Materials. 2 Parts, 617
du Toit (Prof. P. J.), elected President of the South African Association, 802
Tolman (R. C.), On Thermodynamic Equilibrium in a Static Einstein Universe, 164
Tolmatchev (P. I.), The Equilibrium in Solutions of Barium Nitrate in Nitric Acid at the Temperatures of 0° and 25°, 163
Tomaschek (Prof. R.), Lines of Large Frequency Shift in the Raman Spectra of Crystals, 495
Tomlinson (H.), [obituary article], 58
Toms (Dr. H.), School Certificate Magnetism and Electricity, 431
Tookey (W. A.), The Internal Combustion Engine and its Performance, 634
Tool (A. Q.), and R. Stair, Ultra-Violet Window Glass, 549
Toperczer (M.), [A. Schedler and], The Distribution of Declination in Austria at the Epoch 1930·0, 43
Topley (B.), Absolute Rates of Heterogeneous Gas Reactions, 115; and M. L. Smith, Function of Water Vapour in the Dissociation of a Salt Hydrate, 302
Totton (Capt. A. K.), Symbiotic Algæ of Corals, 760
Toul (F.), [F. Novotny and], The Estimation of Traces of Elementary Oxygen, 1013
la Tour du Pin (D.), The Elective Fixation of Medicinal Ions by the Electromagnet, 199
Townsend (C. H.), Age of the Giant Tortoises of Galapagos, 227
Tranzschel (W.), An Æcidium of *Puccinia pygmæa* Erikss. on *Berberis*, 467
Travers (Prof. M. W.), L. E. Hockin, and T. J. P. Pearce, Influence of Hydrogen on Chemical Changes in Silica Vessels, 66
Tremblot (R.), Application of (Optical) Interference to some Problems of Flow at High Velocities, 733
Trevino (S. N.), [C. E. Parmenter, C. A. Bevans, and], Articulation of Isolated Sounds, 380
Trew (V. C. G.), and Prof. J. F. Spencer, Diamagnetism of Liquid Mixtures, 152

Trillat (A.), Experiment on Infection by Air, 235
Trimen (H.), A Hand-Book to the Flora of Ceylon. Part 6: Supplement, A. H. G. Alston, 891
Troisier (J.), and R. Cattan, Exanthematic Fever in Man, without Visible Symptoms, caused by *Rhipicephalus sanguineus*, 422
Trombe (F.), [M. Billy and], The Preparation of Pure Cerium, 734
Troughton (E. Le G.), Three New Bats, of the genera *Pteropus*, *Nyctimene*, and *Chaerephon*, from Melanesia, 387
Troup (Dr. W. A.), Therapeutic Uses of Infra-Red Rays, 953
Trueman (Prof. A. E.), The Evidence of Palæontology with regard to Evolution, 990
Trumpler (Dr. R. J.), Distance of the Great Nebula in Orion, 73
Tschermak (E.), Some Flower Anomalies and their Mode of Inheritance in Primulas, 43
Tsuboi (Prof. C.), Crust Movements after the Tango Earthquake of 1927, 380
Tsvetkov (A.), On the Fundamental Psycho-physical Law, 503
Tubangui (A.), Echinostomes from Rats, 227
Tucholski (T.), Spectra of Metals obtained by Explosive Reactions, 126
Tugarinov (A.), A Fossil Ostrich from Transbaicalia, 127
Tung (Y. M.), [T. Komai and], Anal Gland of *Squilla*, 762
Tunmann (Dr. A.), Pflanzenmikrochemie: ein Hilfsbuch beim mikrochemischen Studium pflanzlicher Objekte. Zweite Auflage bearbeitet von Prof. L. Rosenthaler, 953
Turcev (A.), [F. Loewinson-Lessing, V. Mitkevitch, and], Experiments in the Artificial Magnetisation of Limonites, 127
Turnbull (C.), Carbon Contacts, 968
Turnbull (Prof. H. W.), Our Mathematical Ancestry, 739
Turner (E. P.). Trees used in State Afforestation in New Zealand, 417
Tutin (F.), The Comma Butterfly in England, 1041
Tutton (Dr. A. E. H.), Determination of the Yard in Wave-lengths of Light, 840, 965
Twort (F. W.), conferment upon, of the title of professor, 975
Twyman (F.), The 'Spekker' Photometer for Ultra-violet Spectrophotometry, 770; and A. Harvey, The Validity of the Schwarzschild Relation as applied to the Use of the Logarithmic Sector, 770; and C. S. Hitchen, Estimation of Dissolved Metals, 587
Tyndall-Biscoe (R.), Southern Rhodesian Geology, 971
Tyrrell (G. W.), and M. A. Peacock, The Petrology of Iceland (2), 881

Ulich (Prof. H.), Chemische Thermodynamik: Einfuhrung in die Lehre von den chemischen Affinitaten und Gleichgewichten, 52
Ullyett (P.), awarded a Frank Smart Prize of Cambridge University, 80
Upasaka (E.), A Heathen's Thoughts on Christianity, 892
Urey (H. C.), Prediction of Isotopes, 498
Urion (E.), 1, 2-Cyclohexanedione or Dihydropyrocatechol, 315

Vaidhianathan (Dr. V. I.): Valency and Diamagnetism of Titanium in the Tetrachloride, 189; and Balwant Singh, Magnetism of Colloidal Gold, 302
Vaidya (W. M.), [Prof. A. Fowler and], Spectrum of Carbon Disulphide Flames, 192
Vaillant (Dr. G. C.), Models of Temples in Central America, 823
Vaillant (P.), The Constitution of Solutions deduced from Absorption Measurements, 918
Vaisman (A.), [C. Levaditi, J. Bardet, A. Tchakirian, and], The Distribution of Gallium in the Organism, 466
Valle (G.), Experimental Investigations on the Flash Discharge, 806
Vandel (Prof. A.), La parthénogenèse, 941
Van Name (Dr. W. G.), New North and South American Ascidians, 71
Van Stolk (Mlle. D.), J. Guilbert, H. Pénau, and H. Simonnet, Pure Carotene and Vitamin A, 199
Vareton (E.), [G. Mezzadroli and], Action of Ultra-short Electromagnetic Waves (2-3 metres) on Amylase, 43
Vassitz (Prof. M.), Recent Excavations at Vinča, 842
Veil (Mlle. Suzanne), The Diffusion and Cataphoresis of Methylene Blue in Gelatin, 1013
Velluz (L.), [L. Debucquet and], Organic Compounds of Tungsten and Molybdenum containing Sulphur, 422
Venkateswaran (S.), Light Scattering in Liquids, 870
Venkiteshwaran (L. P.), [Dr. L. A. Ramdas and], Spectrum of Glow-worm, 726
Vereschagin (G.), Influence of Lake Baikal on the Summer Thermic Régime of the River Angara, 467
Vernadskij (V.), The Concentration of Radium by Plants, 127; and A. Vinogradov, Chemical Composition of *Lemna* as a Specific Character, 770; and A. Vinogradov, The Chemical Composition of *Lemna* as Characteristic of the Species, 882
Vernon (Dr. W. H. J.), and L. Whitby, Control of Humidity of Air Currents, 837
Viets (Dr. H. R.), A Brief History of Medicine in Massachusetts, 135
Vigoureux (P.), Quartz Resonators and Oscillators, 961
Villard (P.), The Reduction of Soda, 978
Villat (Prof. H.), Mécanique der fluides, 654
Vinassa (P.), Valency and Symmetry, 1014
Vincent (H.), A Theory of the Constitution of Antibodies, 1049; New Researches on the Cryptotoxins, 918
Vinogradov (A.), [V. Vernadskij and], Chemical Composition of *Lemna* as a Specific Character, 770; Chemical Composition of *Lemna* as Characteristic of the Species, 882
Vitali (G.), The Calculation of a Lens, 1050
Vlodavec (N.), The Extraction of Alumina and Alkalis from the Nephelines and Nephelinites of the Chibin Mountains, 770
Vogel (W.), [M. Hochstacter, E. Bowden, and], An Improved Method of Constructing High-voltage Cables, 933
Volterra (Prof. V.), Italian Physicists and Faraday's Researches, 342; Leçons sur la théorie mathématique de la lutte pour la vie. Rédigées par M. Brelot, 963
Vonwiller (O. U.), A Generation of Electron Theory, 200
Voskuil (Dr. W. H.), Minerals in Modern Industry, 508
Vowles (H. P.), Origins of Power Engineering, 800; and Mrs. Vowles, The Work of Jacob Perkins, 1070
Vrkljan (V. S.), The Velocity of Light, 269
Vsessviatsky (S.), The Origin of Comets of Short Period, 1045

Wad (Yeshwant D.), [A. Howard and], The Waste Products of Agriculture: their Utilisation as Humus, 854
Waddington (H. G.), [obituary], 179
Wager (L. R.), Jointing and Tectonics of the Craven Area, 460
Wainer (Papish and], The Discovery of Element No. 87, 789
Wait (W. E.), Oceanic Bird Wanderers to Ceylon, 728
Wajcenblit (Mlle. L.), [W. Swietoslawski and], The Ternary Heteroazeotrope formed of Carbon Disulphide, Acetone, and Water, 918
Wakeman (R. L.), [R. Lespieau and], The Preparation of the Trimethylene Hydrocarbons, 235; [R. Lespieau, M. Bourguel, and], The Raman Effect in Chemistry, 503
Wales (Prince of), The Application of Modern Science to Modern Industry, 60
Walker (Sir Gilbert), and A. C. Phillips, The Forms of Stratified Clouds. Part 1, Experimental; Part 2, Discussion, 917
Walker (H. C.), Charts and Data on Marine Boiler Design: a Summary of the Standard Formulæ in Chart Form with Tables and Notes, 962
Walker (M. E. M.), Pioneers of Public Health: the Story of some Benefactors of the Human Race, 6
Waller (W. W.), 'All or None': a Question of Nomenclature, 70

Warburg (Prof. O.), awarded the Nobel Prize for Medicine for 1931, 789
Ward (F. A. B.), [Lord Rutherford, W. B. Lewis, and], Long-Range α-Particles, 37
Ward (Dr. J.), appointed head of the Department of Civil and Mechanical Engineering of Huddersfield Technical College, 916
Warner (S. G.), Histological Polarisation of Lateral Giant-fibres in the Crayfish, 164
Warner (W. L.), Marugin Warfare, 910
Warren (Prof. E.), The Spermatogenesis of Ticks, 454
Wasiutynski (J.), The Variable Star AK Herculis, 1081
Waterhouse (E. F.), and W. R. Schoeller, The Separation of the Earth Acids from Metals of the Hydrogen Sulphide Group, 845
Waterhouse (H.), and R. Willows, Effects of Cold-Rolling and of Heat-Treatment on some Lead Alloys, 502
Waters (N. F.), Inheritance of Body Weight in Domestic Fowl, 846
Waters (Dr. W. A.), A Connexion between Fluorescence and Free Neutral Radicals, 905
Waters (W. T.), Size-inheritance in Poultry, 1005
Watkins (A. E.), appointed University Lecturer in Cytology in Cambridge University, 844
Watson (Dr. C.), The 'Vital' Factor in Diet, 154
Watson (E. A.), The Coil Ignition System, 865
Watson (F. R.), Bibliography of Acoustics of Buildings, 904
Watson and Sons (Electro-Medical), Ltd.: Catalogues of Diathermy Apparatus and Equipment for X-ray Therapy, 266; Portable X-ray Medical Unit, 1007
Watt (R. A. Watson), and O. F. Brown, Radio Research in the British Empire, 755
Watt (W. S.), appointed Meteorologist to the Commonwealth of Australia, 634
Wattenberg (Dr. H.), [Dr. K. Buch, H. W. Harvey, and], Apparent Dissociation Constants of Carbon Dioxide in Sea-water of different Salt Contents, 411
Watts (late Dr. W. Marshall), Index of Spectra. Appendix Z: Iron and Iron Oxide, 1060
Wavre (R.), From the Human Scale to the Terrestrial Scale, 236; The Theory of Potential (1 and 2), 682
Wayland (E. J.), *Homo sapiens* and African Prehistory, 1003; Progress of the Geological Survey of Uganda, 1919–1929, 331; The Katwe Crater-lake, Uganda, 977
Wayling (H. G.), Faraday's London Friends, 482
Weatherall (R.), Mortality among Plants and its Bearing on Natural Selection, 33
Webb (C. S.), New Light on the Habits of Trogons, 935
Webb [Le Fèvre and], Molecular Weight Determinations, 38
Webster (G. W.), The Fulani of Northern Nigeria, 874
Webster (T. A.), [F. A. Askew, Miss H. M. Bruce, Dr. R. K. Callow, J. St. L. Philpot, and], Crystalline Vitamin D, 758
Wedgwood (G. A.), Young's Modulus for Steel in Two Directions in a Bar, 733
Wedmore (E. B.), A. M. Cassie, and W. B. Whitney, Electric Circuit Breaker Research, 675
Weiglé (J.), [H. Saini and], A Possible Transformation of Maleic Acid into Fumaric Acid, 235
Weinfurtner [Fink and], Methylene Blue Stain for Yeast Cells, 306
Weintroub (S.), appointed an Assistant Lecturer in Physics at University College, Southampton, 278
Weir (Dr. J.), Carboniferous Bellerophons, 497
Weiss (Prof. F. E.), Segregation of Floral Characters in the Wild Oxslip, 305
Wellcome (Dr. H.), Benefactions of, 931; foundation of a Gold Medal in connexion with the Royal Anthropological Institute, 904
Wellish (Prof. E. M.), Photoelectrons and Negative Ions, 547
Westaway (F. W.), Craftsmanship in the Teaching of Elementary Mathematics, 950
Weston (W. A. R. Dillon), Effect of Light on Urediniospores of Black Stem Rust of Wheat, *Puccinia graminis tritici*, 67
Wettstein (Prof. R.), [death], 404; [obituary article], 436
Weygandt (Prof. C.), The Wissahickon Hills: Memories of Leisure Hours out of doors in an Old Countryside, 208
Weymouth (Miss A. I.), The Palo Alto Tree, 904
Whale (P. B.), The Macmillan Committee's Report on Finance and Industry, 730
Whearty, jr. (S. F.), [W. D. Bancroft and], Activation by Charcoal, 280
Wheat (W. N.), [W. M. Hampton and], Recent Developments in Optical Glass Manufacture, 926
Wheeler [Kirkby and], Explosions in Closed Cylinders, 729
Wheeler (W. H.), awarded a Beit Fellowship for Scientific Research, 161; [Prof. W. A. Bone, R. P. Frazer, and], Flame Propagation in an Electric Field, 274
Whiddington (Prof. R.), and J. E. Roberts, Electron Exchange Phenomena in the Excited Atom, 966
Whitaker (A.), Physics in Sound Recording, 933
Whitby (L.), [Dr. W. H. J. Vernon and], Control of Humidity of Air Currents, 837
White (H. E.), Wave-mechanical Models of Atoms, 228
Whitehead (Dr. T.), Respiration of Healthy and Leaf Roll Potatoes, 967
Whitlock (T. G.), Elementary Applied Aerodynamics, 654
Whitney (W. B.), [E. B. Wedmore, A. M. Cassie, and], Electric Circuit Breaker Research, 675
Whitney (Prof. W. R.), Faraday's Researches and the United States, 353
Whittaker (Prof. E. T.), awarded the Sylvester Medal of the Royal Society, 821; presented with the Sylvester Medal of the Royal Society, 974
Whitworth (H. F. W.), The Mineralogy and Origin of the Natural Beach Sand Concentrate of N.S.W., 316
Whyte (L. L.), Critique of Physics, 964
Whytlaw-Gray (Prof. R.), [H. S. Patterson, W. Cawood, and], The Atomic Weight of Fluorine, 375
Wickens (C. H.), Editor: J. Stonham, Commonwealth Bureau of Census and Statistics, Canberra. Official Year Book of the Commonwealth of Australia. No. 23, 1930, 514
Wieland (Prof. H.), elected a Foreign Member of the Royal Society, 64
Wigginton (R.), Coal and its Use, 1024
Wigglesworth (Dr. V. B.), Excretion of Uric Acid, 116; The Extent of Air in the Tracheoles of some Terrestrial Insects, 917
Wigham, A Peat Fuel Power Station in Russia, 406; Industrialisation in Russia, Progress of, 544
Wilcocks (Prof. R. W.), Intelligence, Environment, and Heredity, 801
Wilhelm (J. O.), [Prof. J. C. McLennan, A. C. Burton, A. Pitt, and], Superconductivity at High Frequencies, 1004
Wilkins (Sir Hubert), presented with the gold medal and diploma of the Italian Royal Geographical Society, 184; Progress of the *Nautilus* Expedition, 439
Willey (Dr. E. J. B.), and S. G. Foord, An Oxidisable 'Active Nitrogen', 493
Williams (A. E.), The Coco-nut Oil Industry, 755
Williams (J. G.), Textiles on Test: a Study for Distributor and Consumer of the Wearing and Washing Properties of Fabrics and Garments, 855
Williams (R. C.), [J. Pryde and], The Pyranoid Structure of Glucuronic Acid and of Theophylline Arabinoside, 187
Williams (Prof. S. R.), Magnetic Phenomena: an Elementary Treatise, 623
Williams (S. V.), [Dr. C. J. Smithells, E. J. Grimwood, and], Melting Nickel-Chromium Alloys in Hydrogen, 595
Willis (Prof. B.), Living Africa: a Geologist's Wanderings through the Rift Valleys, 87
Willoughby (Dr. W. G.), Public Health—To-day and To-morrow, 143
Willows (R.), [H. Waterhouse and], Effects of Cold-Rolling and of Heat-Treatment on some Lead Alloys, 502
Wilmore (Dr. A.), The Groundwork of Modern Geography: an Introduction to the Science of Geography. Third edition, 955
Wilson (Sir Arnold), The Epic and the Tragedies of Civilisation, 902
Wilson (Dr. Isabel), How You Work: an Introduction to the Human Body, 136

Winegarden (H. M.), [H. Borsook and], Work of the Kidney in the Production of Urine; The Energy Cost of the Excretion of Urine, 83
Wintemberg (W. J.), Indian Archæology in Eastern Canada, 1005
Winterbotham (Brig. H. S. L.), The Small-scale Maps of the Ordnance Survey, 997
Winton (Dr. F. R.), appointed University Lecturer in Physiology in Cambridge University, 420
Wishart (Dr. J.), Mathematics for Actuaries and others, 286
Withers (R. B.), Development of the Tabulate Coral, *Pleurodictyum megastomum*, 127
Woldman (Dr. N. E.), Physical Metallurgy Laboratory Manual, 779
Woldstedt (Dr. P.), Das Eiszeitalter: Grundlinien einer Geologie des Diluviums, 394
Wolf (Prof. A.), Textbook of Logic, 6
Wolf (Prof. M.), The Faint Outer Satellites of Jupiter, 912
Wolfenden (J. H.), Measurement of the Electricity liberated during the Downgrade Reactions of Organic Compounds, 69
Wolff (Prof. L. K.), [A. Emmerie, M. v. Eekelen, and], Vitamin A and the Antimony Chloride Reaction, 495
Wolfke (Prof. M.), and Dr. J. Mazur, Change of Dielectric Polarisation of Carbon Disulphide with Temperature, 871; Change of Dielectric Polarisation of Nitrobenzene with Temperature, 584
Wolfram (Dr. R.), The Sword Dances of Austria, 823
Wollan (E. O.), Scattering by Diatomic Gases, 1014
Woo (Y. H.), The Intensity of Total Scattering of X-rays by Gases (1 and 2), 1014
Wood (H. E.), Encke's Comet, 156
Wood (J. G.), [T. G. B. Osborn, T. B. Paltridge, and], The Autecology of *Stipa nitida*: a Study of a Fodder Grass in Arid Australia, 918
Wood (Prof. R. W.), and G. H. Dieke, Analysis of Complicated Band Spectra with the Aid of Magnetic Rotation Spectra, 545
Wood (W. A.), Anomalous X-ray Diffraction Intensities, 272; Lattice-distortion of Cold-drawn Constantan Wire, 917
Woodman (Dr. H. E.), Home-grown Feeding Stuffs, 298
Wooster (Nora), Crystal Structure of Molybdenum Trioxide: a Correction, 35
Wormell (Dr. T. W.), reappointed Observer in Meteorological Physics in Cambridge University, 420
Wragg (A.), [J. E. Newson and], The Failure of High-strength Brass, 503
Wulf (O. R.), and E. H. Melvin, Ultra-violet Spectrum of Ozone, 763
Wulff (J.), [Dr. J. B. Green and], Hyperfine Structure of Thallium II, 409
Wüst (K.), [Prof. K. Fajans and], Translated by B. Topley: A Textbook of Practical Physical Chemistry, 852
Wylie (C. C.), Calendar Reform, 841
Wynn-Williams (Dr.), An Application of Thyratrons, 307

Yakimach (A.), Phosphate of Trivalent Manganese and of Aluminium, 315
Yio (Ouang Te), The Physiological Nature of the Diastase secreted by the Eclosion Gland in the Plagiostomes (*Scylliorhinus canicula*), 846
Yokoya (Dr. Zu), Larval Freshwater Shrimps from Japan, 874
Yonge (Dr. C. M.), Symbiotic Algæ of Corals, 760; The Significance of the Relationship between Corals and Zooxanthellæ, 309
Yorke (D.), Bird Migrants at Rossitten, 440
Young (Dr. J. S.), appointed Musgrave Professor of Pathology in Queen's University, Belfast, 804

Zachariasen (W. H.), Structure of XO_3 Groups in Crystals, 274
Zachvatkin (A.), Periodic Variations in the Level and in the Chemical Composition of the Water of Lake Gusinœ, Transbaikalia, 422
Zambonini (F.), and S. Restaino, Praseodymium and Thallous Sulphates, 1014
Zeeman (Prof. P.), Faraday's Researches on Magneto-Optics and their Development, 365; J. H. Gisolf, and T. L. de Bruin, Magnetic Resolution and Nuclear Moment of Rhenium, 637
von Zeerleder (A.), Influence of Variations in Heat-treatment and Ageing on Duralumin, 554
Zeidenfeld (S.), X-Ray Fibre Photography, 70
Zeller (A.), Resistance Experiments on Red Algæ, 467
Zinner (Prof. E.), Die Geschichte der Sternkunde: von den ersten Anfängen bis zur Gegenwart, 986

TITLE INDEX

α-Particles, Long-Range, Lord Rutherford, F. A. B. Ward, and W. B. Lewis, 37
α-Rays, The Long Path, Emitted by $ThC+C'$ and some determinations of the Velocities of the α-Rays, S. Rosenblum, 1050
Aberdeen University, Conferment of Doctorates, 124
Abraxas, Effect of certain Substances and of Heat on Cells of, Prof. J. B. Gatenby and Joyce C. Hill, 31
Absorption Spectra of Crystals at Low Temperatures as references in the Measurement of Stellar Velocities, S. Freed, 33
Absterben und Entwicklung, I. Szabó, 382
Academic Research and National Dividends, Sir Frank Smith, 1069
Accelerometer, A Remote Electrically Recording, with particular reference to Wheel-Impact Measurements, Dr. F. Aughtie, 918
" Accredited Higher Institutions ", 733
Acetaldehyde and Air, Ignition of Mixtures of, M. Prettre, 503
Aceto-Acetic Ester Condensation, Snell and McElvain, 229
Acetylene, The Slow Combustion of, R. Spence, 153
Acheron, H.M.S., The Machinery of, 111
Acid: Ethyl Sulphite, The Chloride of, and the Neutral Mixed Alkyl Sulphites, P. Carré and P. Mauclère, 386; Igneous Rocks, The Origin of, Prof. A. Holmes, 120
Acido-proteolytes and Thermophiles in the Pasteurisation of Milk, C. Gorini, 43
Acoustical Problems of Broadcasting Studios, N. Ashbridge, 844
Acoustics: a Text on Theory and Applications, Prof. G. W. Stewart and Prof. R. B. Lindsay, 779; of Buildings, Bibliography of, F. R. Watson, 904
Acromegaly: in the Far North, Prof. L. Hogben, 375; Dr. M. Perkins, 491; Prof. C. G. Seligman, 492; among the Old Northmen, Prof. C. G. Seligman, 221
Acrorhynchus baicalensis Rubtzoff (Turbellaria, Rhabdocœla) from Lake Baikal, N. Nasonov, 127
Actinomycetales, The, H. L. Jensen (1), 279
Activated Adsorption, Prof. W. E. Garner, 583
'Active Nitrogen', An Oxidisable, Dr. E. J. B. Willey and S. G. Foord, 493
Activity Coefficients and the Debye-Huckel Equation, 499
Administrators, Scientific Men as, 237
Adobe Brick Analysis for Plant Contents, G. W. Hendry, 1006
Adrenaline: Formation of, in the Suprarenal Gland, J. E. Abelous and R. Argaud, 682; Hypertensive action of, The Influence of Dextrorotatory Pseudo-Cocaine on the, F. Mercier, 1050
Æneas, Elements of the Trojan Planet, C. J. Krieger, 764
Aerobacter, Bacteria belonging to the Sub-genus, M. Grimes and A. J. Hennerty, 162
Aerodynamics, Elementary Applied, T. G. Whitlock, 654
Aeroplane: Flight: between Australia and England, Record, J. A. Mollison, 266; Round the Earth on a 'Small Circle' Course, Post and Gatty, 60; Manual, The Light, F. D. Bradbrooke, 961; Speed Records by Flight-Lieut. J. N. Boothman and Flight-Lieut. G. H. Stainforth, 490; Survey of Peru, 172
Aeroplanes and Mosquitoes, 1072
Aerosols: Charged, and Ball Lightning, W. C. Reynolds, 584; Highly Charged, A Curious Phenomenon shown by, W. Cawood and H. S. Patterson, 150; Properties of, S. C. Blacktin, 968
Africa: Botanical visit to, Hutchinson, 218; Living, a Geologist's Wanderings through the Rift Valleys, Prof. B. Willis, 87; in Transition, Lord Lugard, 730; Native Administration in, 685; View, Prof. J. S. Huxley, 87
African: Languages and Cultures, International Institute of, Grant to the, by the Rockefeller Foundation, 265; Prehistory, *Homo sapiens* and, E. J. Wayland, 1003; Settlement and the Origin of Rift Valleys, Prof. J. W. Gregory, 87
Agar-liquefying Bacteria, Distribution of, H. Nicol, 1041
Agricultural: Botany, National Institute of, Policy of the, Prof. Engledow, 184; Entomology, A Textbook of, Dr. Kenneth M. Smith; Dr. A. E. Cameron, 943; Devices in Germany, New, R. Borlase Matthews, 297; Research Council, Sir William Dampier appointed Secretary of the, 299
Agriculture: and Physics, 391; International Aspects of, 597; Science and, in New Zealand, 981; The Changing Outlook in, Sir John Russell, 1027; The International Institute of, Dr. A. Hobson, 737; The Waste Products of: their Utilization as Humus, A. Howard and Yeshwant D. Wad, 854
Agriculturists, British and Danish, Exchange of, 181
Air: and Gases, Flow and Measurement of, A. B. Eason. Second edition, 654; Condensation of, into Liquid, Prof. E. O. von Lippman, 666; Currents: Control of Humidity of, Dr. P. A. Buxton; Dr. W. H. J. Vernon and L. Whitby, 837; of Different Humidities, A Method of obtaining, Prof. J. B. Seth, 638; in the Tracheoles of some Terrestrial Insects, Extent of, Dr. V. B. Wigglesworth, 917; Oxygen, and Nitrogen, The Specific Heats of, from 20° C. to 370° C., P. S. H. Henry, 1049; Pollution at Pittsburgh, H. B. Meller, 307; -pressures upon a Bird's Wing, Lieut. R. R. Graham, 119; Warm and Cold Saturated, Mixing of, K. Hidaka, 911
Aircraft Observation, Determination of Position in High Latitudes, with particular reference to, C. J. Stewart, 212
Airships *R* 38, *R* 101, and others, Causes of the Loss of, A. Krylov, 683
Air Speed Record, New World, Flight-Lieut. G. H. Stainforth, 611
Aitken Condensation Nuclei, A. R. Hogg, 908
AK Herculis, The Variable Star, J. Wasiutynski, 1081
Alchemical Apparatus, Prof. J. R. Partington, 118
Alchemie, Entstehung und Ausbreitung der, Prof. E. O. von Lippmann. Band 2: Ein Lese- und Nachschlage-Buch, 774
Alchemist, The Travels of an: the Journey of the Taoist Ch'ang-Ch'un from China to the Hindukush at the Summons of Chingiz Khan. Recorded by his Disciple, Li Chih-Ch'ang. Translated with an Introduction by A. Waley, 509
Alchemy, History of, Dr. E. J. Holmyard, 774
Alcohol: and Behaviour, Prof. Sydney Smith, 630; Combustion of, by the Pœcilotherm, M. Nicloux, 682
Alcoholic Fermentation: Action of various Halogen Derivatives on, P. Cayrol, 770; The Kinetics of the, J. Medvedev, 163
Alcohols, Oxidation of the, by the Acetic Ferments, H. Quéré, 770
Aldehydes, The Ozonation of, and the Theory of Active Molecules, E. Briner, A. Demolis, and H. Paillard, 235
Algebra: A School, as far as the Advanced Course in the School Certificate Stage, A. M. Bozman, 1061
Alginic Acid: On, its Mode of Occurrence and its Constitution, T. Dillon and Annie McGuinness, 162
Alkaline Diacid Phosphates, Action of Heat on the, L. Hackspill and R. Lauffenburger, 682
'All or None': a Question of Nomenclature, W. W. Waller, 70
Allantoin: Application of the Quantitative Spectrophotometric Analysis of, to the Blood of some Mammals and to the Seed of numerous Plants, R. Fosse, A. Brunel, and P. E. Thomas, 421; The Quantitative analysis of very small quantities of, at High Dilutions, R. Fosse, A. Brunel, and P. E. Thomas, 315
Alloys, New High Permeability, G. W. Elmen, 764
Alpine Plants, The Diurnal Course of Transpiration of Two, F. Chodat and Suzanne Kann, 126
Alternating Current Supply, Control of Frequency of, 330

Aluminium: Sand-castings, Unsoundness in, D. Hanson and I. G. Slater, (1), (2), 502; -Silicon Alloys, The Macro-etching of, Dr. W. Hume-Rothery, 503; The Toxic Power of, compared with that of Iron, Nickel, and other Metals, G. Bertrand and P. Serbescu, 466

American: Astronomical Society, Prof. W. de Sitter elected an Honorary Member and W. S. Adams President of the, 634; College Sport, Current Development in, 197; Educational Progress in 1930, 420; Indian, Physical Anthropology of the, Prof. W. E. Le Gros Clark, 740; Ornithologists' Union, Elections in connexion with the, 998; Universities, Doctorates in Science conferred by, 501

Amides, Velocities and Heats of Saponification of the, E. Calvet, 235

Aminophenylpyrazoles, Diazotisation of, Prof. J. Reilly, B. Daly, and P. J. Drumm, 162

Ammeter for Measuring very Minute Alternating Currents, An, P. J. Kipp and Zonen, 183

Ammonium, Solid, Group Rotation in, and Calcium Nitrates, F. C. Kracek, S. B. Hendricks, and Dr. E. Posnjak, 410

Amorphous Carbon, The Critical Increment of the Absorption of Hydrogen on, at 400°-520° C., Dr. F. E. T. Kingman, 272; Silica and Crystallised Quartz, The Double Refraction produced by the Compression of, and its Dispersion in the Ultra-Violet, G. Bruhat and J. Thouvenin, 1050

Ampère, A. M., the house of, presented to the French Society of Electricians, 111

Amulets and Superstitions, Sir E. A. Wallis Budge, 204

Amylase, Action of Ultra-Short Electromagnetic Waves (2-3 metres) on, G. Mezzadroli and E. Vareton, 43

Anchusa, Cytology of, and its Relation to the Taxonomy of the Genus, S. G. Smith, 493

Anemusite (with reference to Pacifiles of Barth), D. Beliankin, 422

Angara, Influence of Lake Baikal on the Summer Thermic Régime of the River, G. Vereschagin, 467

Anhydrides, Action of, upon Metals, M. Lemarchands and H. L. Roman, 163

Animal: Aggregations: a Study in General Sociology, Prof. W. C. Allee, 940; Biology, Principles of, Prof. L. Hogben, 242; Ecology and Evolution, C. Elton, 243; Genetics, Imperial Bureau of, Bibliographies of the, 865; *Quarterly Bulletin* of the, 866; Year Book, The, Capt. C. W. Hume, 102

Animals under Human Control, Variation of, 934

Anisotropy due to Flow in Cellulose Sols, J. M. Preston, 796

Annual Tables of Constants and Numerical Data for Chemistry, Physics, Biology, and Technology, 662

Antarctic: Alcyonaria, Madreporaria, and Antipatharia, Sir J. Arthur Thomson and Miss Nita Rennet, 71; Research Expedition, The British Australian New Zealand, 79

Anthocyanins: Constitution of, G. M. Robinson and Prof. R. Robinson, 413; Synthesis of, Robinson and others, 912

Anthropological Bulletins of the Zoological Survey of India, 756

Anthropologie, Leitfaden der, Dr. K. Saller, 624

Anthropology: and Native Administration, 86; in Nigeria, P. Amaury Talbot, 285; Training of Colonial Probationers in, Col. T. C. Hodson, 458

Antibodies, A Theory of the Constitution of, H. Vincent, 1049

Antimony Electrode, The, as a Means for *p*H Measurements, A. C. Leeman, 682

Anti-Neuritic Vitamin, Seidell and Birckner, 229

Anura, Vascular System of the, Abnormalities of the, Dr. C. H. O'Donoghue, 42

Appalachians, Northern, Building of the, Prof. C. Schuchert, 227

Apples in Storage, Nitrogen Content of, Pilling and Pearsall, 549

Apprentices for the Engineering Trades, Selection of Skilled, E. Patricia Allen and P. Smith, 463

Aquaria, The Sunless Keeping of, 406

U Aquilæ, Variation of the Radial Velocity of, G. Tiercy, 682

Arabia, Alarms and Excursions in, B. Thomas, 956

Araucanos, The Eggs of, C. A. Finsterbusch, 697

Archæological Societies, Congress of, Address to the, Sir Charles Peers, 900

Archæologist, a Great, Unofficial Moments of, S. R. K. Glanville, 131

Archæology and Surveying in Southern Rhodesia, 500

Arcs, Island and Mountain, Curvature of, Prof. T. Terada, 498

Arctic: and Adjacent Regions, Some General Structural Features of the, O. Holtedahl, 125; Institute of the U.S.S.R., Bulletin of the, No. 5, 219

Argentine Republic, The, and the Transmission of Rhythmic Time Signals, 217

Aristotle, The Works of, Translated into English. Physica, by R. P. Hardie and R. K. Gaye, 396

Armadas of the Sky: the Problem of Armaments, P. Murphy, 963

Aromatic Substitution Products with Fluorine, W. D. Bancroft and J. E. Whearty, Jr., 280

Arsenic Chloride, Action of, upon Nickel, G. Arrivaut, 82

Art, Works of, Scientific Methods applied to the Examination and Preservation of, Conference on, 147

Ascidians, New North and South American, Dr. W. G. Van Name, 71

Asebotoside (Asebotine): The Constitution of, its Identity with Phlorizoside (Phlorizine), M. Bridel and Mlle. A. Kramer, 978

AsH, The Band Spectrum of, G. E. Kimball and J. R. Bates, 969

Asiderite Meteorite, Fall of an, in the Extreme South of Tunis, A. Lacroix, 643

Astronomers and Observatories, New List of, Prof. P. Stroobant and others 73

Astronomy: A New History of, Dr. J. K. Fotheringham, 986; an Introduction, Prof. R. H. Baker, 563; for all, 615; Spherical, Text-Book on, Prof. W. M. Smart, 207; The Year's Progress in, Dr. H. L. Alden, 801

Astrophysical Formula, An, P. Rossier, 734

Astrophysik auf atomtheoretischer Grundlage, Prof. S. Rosseland, 615

Atlantic: Foraminifera, J. A. Cushman, 798; South, Velocity of Deep Currents in the, G. E. R. Deacon, 267

Atlas céleste, E. Delporte 690

Atmospheric: Electric Fields, Utilisation of, A. Brasch and F. Lange, 380; Large Ions, Mobilities of, R. K. Boylan, 1013; Ionisation, Prof. J. J. Nolan and Dr. P. J. Nolan, 971; Motion, Horizontal, The Energy of, Sir Napier Shaw, 226; Pollution, Prevention of, 649

Atolls, The Formation of, 206

Atom, Excited, Electron Exchange Phenomena in the, Prof. R. Whiddington and J. E. Roberts, 966

Atomic: Hydrogen Occluded in Iron Nitride, Shun-ichi Satoh, 457; Synthesis and Stellar Energy, Dr. R. d'E. Atkinson, 194; Systems and Optical Activity, Spatial Arrangements of; Methods, Results, and Problems of Precise Measurements at High Temperatures; The Constitution and Structure of Ultramarines, F. M. Jaeger, 852; Weight, The Unit of, Dr. F. W. Aston, 73[illegible]; Weights Deduced from Mass-Spectra, Dr. F. W. Aston, 460

Atoms: and Molecules as Fitzgerald Oscillators, Sir C. V. Raman, 795; at Collision, On the Transfer of Energy between, O. K. Rice, 83; Wave-Mechanical Models of, H. E. White, 228

Atropine, Action of, in Counteracting the Effects of Pituitrin and of Pilocarpine Injected into the Cerebral Ventricles, H. Cushing, 280

Aurora: Polaris, Audibility of the, H. U. Sverdrup, 457; The Nature of the, Prof. J. Kaplan, 191

Australasia: The Gasteromycetes of, G. H. Cunningham (12), 595; (13), 918

Australia: a Female Aboriginal Skull found in the Jervois Ranges, Prof. F. Wood Jones, 440; An American Collecting Expedition to, 63; Commonwealth of: Official Year Book of the, No. 23, 1930. Prepared by C. H. Wickens. Editor: J. Stonham, 514; W. S. Watt appointed Meteorologist to the, 634; Eastern, Granites of, Prof. E. W. Skeats, 307; Need for the Protection of Mammals in, 935; Taxes on Books in, 900; Vanishing Life of, 425

Australian: Aborigines, Food of, C. Daley, 762; Council for Scientific and Industrial Research, Annual Report of the, 62; Diptera, J. R. Malloch, 595, 918; Flora and Fauna, Preservation of the, Sir James W. Barrett, 1041; Fossil King-Crabs, Two New, F. Chapman, 683; Fungi, Catalogue of, 635; National Research Council, Proposed changes in Constitution, etc., 611; Zebra-finch, Pugnacity of the, Dr. E. Hopkinson, 866
Austria: Distribution of Declination in, at the Epoch 1930.0, A. Schedler and M. Toperczer, 43; Faraday and, Prof. K. Przibram, 351; The Sword Dances of, Dr. R. Wolfram, 823
Auto-frettage, and the Theory of Strain, 49
Avoleum, a Preparation made from Mammalian Liver, British Drug Houses, Ltd., 147
Axolotl, Regeneration of the Extremities in the, under the Influence of X-Rays, E. Litchko, 127
Azide Group, Structure of the, T. C. Sutton, 872
Azides: Structure of the, from their Electric Dipole Moments, L. E. Sutton, 639; Structure of the, Dr. E. Bergman and W. Schutz, 1077
Azopyrrole Blacks, A. Quilico and M. Freri (3), 595

B. tumefaciens, Factors exciting Increase of Vegetal Neoplasms by, V. Rivera, 806
Babirusa of Celebes, The, 697
Bacille Calmette-Guèrin Vaccine, The, A. S. Griffith, 145
Bacteria, Luminous, The Combined Action of Metals and X-Rays on, E. Stern, 503
Bacterial: Flora of Certain Fish, G. Cannicci, 735; Plant Pathogens, Manual of, Charlotte Elliott, 953
Bacteriology in relation to Medicine, A System of. Vol. 6, J. A. Arkwright and others, 888
Bacteriophage, The, and its Clinical Applications, Prof. F. d'Herelle. Translated by Prof. G. H. Smith, 431
Bacterium granulosa of Noguchi in its relations with the Etiology of Trachoma, The, C. Nicolle and U. Lombroso, 81
Balun Bidai, I. H. N. Evans, 762
Band Spectra, Complicated, Analysis of, with the Aid of Magnetic Rotation Spectra, Prof. R. W. Wood and G. H. Dieke, 545
Banks Island, Melanesia, The Petrographic Character of, A. Amstutz, 734
Barbituric Derivatives, Some Reactions of Certain, J. Bougault and J. Guillou, 770
Baridiinæ, On (Curculionidæ), mostly from New Guinea, A. M. Lea, 279
Barium: Hydride, Bands in the Spectrum of, Dr. A. Schaafsma, 1042; Nitrate in Nitric Acid, The Equilibrium in Solutions of, at the Temperatures of 0° and 25°, P. I. Tolmatchev, 163; Strontium and, New Isotopes of, Dr. F. W. Aston, 221
Barley and its Wort, Nitrogen Contents of, L. R. Bishop, 308
Bathurst Senkungsfeld, The, C. A. Sussmilch, 467
Bathyliths, Notes on, and Some of their Implications, W. R. Browne, 806
Bats, Three New, of the genera *Pteropus*, *Nyctimene*, and *Chearephon*, from Melanesia, E. Le G. Troughton, 387
Bauxite in the Upper Sann Valley, Genesis of, E. Dittler and O. Kuhn, 467
Bavenda, The, Dr. H. A. Stayt, 614
Beagle, The Voyage of the, 1831–1836, 1065, 1068
Bedford College for Women, Opening of New Building, 14
Beetroot, The Sapogenin of, V. Prelog, 127
Beilstein's Handbuch der organischen Chemie, A Brief Introduction to the Use of, Prof. E. H. Huntress, 136
Beit Fellowships for Scientific Research, Sir Campbell Stuart appointed Chairman and Sir Alfred Beit a Trustee of the; award of Fellowships to W. H. Wheeler and J. I. Armstrong, 161
Belfast: Naturalists' Field Club, S. A. Bennett awarded the Club Medal, 757; Queen's University of, Dr. J. S. Young appointed Musgrave Professor of Pathology, 804
Bellerophons, Carboniferous, Dr. J. Weir, 497
Benzene: and Toluene, Raman Spectra of, L. E. Howlett, 796; into Methane, The Transformation of, A. Mailhe and Creusot, 422; Nitrobenzene and, Melting Points of, Prof. I. Masson, 726
Bergey's Manual of Determinative Bacteriology: a Key for the Identification of Organisms of the Class Schizomycetes, D. H. Bergey, and others. Third edition, 6
Bermuda Oceanographic Expedition, The, Dr. W. Beebe, 406
Berne University, conferment of Honorary Doctorates on Sir Charles Sherrington and Prof. H. Cushing, 681
Beryllium Ferrite and the Ferric Oxide arising from its Decomposition, H. Forestier and M. Galand, 978
Betelgeux, The Variability of, B. W. Kukarkin, 764
Bibliography of Science, Classification for, Dr. S. C. Bradford, 268
Bichler and Napieralski, The Synthesis of, M. Decker, 467
Biochemistry in America, 90
Biocolloidologie, Traité de, W. Kopaczewski. Tome 1: Pratique des colloïdes. Deux. édition. Fasc. 3: Mésures capillaires et électriques, 852
Biologischen Arbeitsmethoden, Handbuch der, Herausgegeben von Prof. E. Abderhalden: Lief. 331. Abt. 9. Teil 4, Heft 4 (Schluss), 396; Lief. 346. Abt. 9. Teil 7, Heft 1, 431
Biology: as a Real Profession, Plea for, Dr. H. Martin Leake, 666; A Short History of, A General Introduction to the Study of Living Things, Dr. C. Singer, 132; and Civilisation, Dr. H. H. Dale, 897; Historical Aspects of, Prof. L. Hogben, 132; Progressive, Sir Frederick Gowland Hopkins, 923
Bird: Migration in Switzerland, Dr. K. Bretscher, 676; Migrants at the Rossitten, D. Yorke, 440; Sanctuaries in the Royal Parks of England, Report on, for 1930, 1071; Song and Weather, H. G. Alexander, 549
Birds: Migration of, Dr. J. Grinnell, 329; of the Galapagos Islands, H. S. Swarth, 762; Speed of Flight of, T. H. Harrisson, 586
Birmingham University: award of Doctorates; Dr. A. S. Barnes appointed Dean of the Faculty of Medicine; Dr. R. H. Hopkins appointed Adrian Brown Professor of Brewing; R. D. Lockhart, Professor of Anatomy; and P. Gray and D. Richards, Resident staff Tutors of Adult Education; Prof. A. M. Carr-Saunders to be Muirhead Lecturer for another year, 80; S. Lees appointed Professor of Mechanical Engineering, 278; Ore-dressing Laboratory of the Mining Department of, Opening of the, 1068; Conferment of Honorary Degrees, 1069
Birth Control, Ministry of Health Circular on, 298
Birthdays and Research Centres, 41, 125, 162, 198, 234, 278, 314, 385, 420, 465, 502, 553, 594, 645, 681, 733, 768, 805, 881, 916, 976, 1012, 1049, 1085
Bismuth, Double Sulphates of, with Alkali Metals (2), L. Malossi, 1050
Bison, European, in the Caucasus, 633
Bitumen of the Urgonian Limestone and the Molasse of Pyrimont (Ain), The, J. J. Pittard, 734
Black: Sea Sprat, The, L. Berg, 770; Spur Area (Healesville), Geology and Petrology of the, A. B. Edwards, 467
Blepharoceridæ of Japan, Sirô Kitakami, 640
Blind, National Institute for the, Report for Year ending March 31, 1931, 868
Blood: of Aquatic Animals, The Composition of the, and its Bearings upon the possible Conditions of Origin of the Vertebrates, Prof. W. J. Dakin, 66; Serum, The Physical Properties of the, and of the Proteins separated from this Serum by the Acetone Method, etc., C. Achard, A. Boutaric, and M. Doladilhe, 555
Bopyrid Parasite, A New, from the Coast of N.S.W., Prof. W. J. Dakin, 595
Boric Acid and Alumina, Separation and Estimation of, Malaprade and Schmoutka, 315
Boron, Crystallised, L. Hackspill, A. Stieber, and R. Hocart, 1013
Botanical: Congress, Fifth International, Cambridge, 16–23 August 1930. Report of Proceedings. Edited by F. T. Brooks and Dr. T. F. Chipp, 778; Society and Exchange Club of the British Isles, Report for 1930, 668

Botany, The Advancement of, Prof. T. G. Hill, 538, 780
Bottle-Pipe Resonator, The, A. E. Bate, 270
Bovine Tuberculosis and the Pasteurisation of Milk, 36
Boys's Soap Solutions, Effect of Light on the Surface Tension of, Prof. L. D. Mahajan, 496; Dr. P. Lecomte du Nouy, 674
Braconid Parasite, Polyembryony in a, H. L. Parker, 190
Bradford Technical College, *Journal of Research* of the, 845
Braille Models for Teaching Electricity and Magnetism, Dr. F. W. Alexander, 698
Brain: and Mind, A. Lynch, 954; Mind, and the External Signs of Intelligence, Dr. B. Hollander, 815
Brandy, Alcoholic Strength of, A Formula for the Determination of the, P. Balavoine, 279
Brass, High-strength, The Failure of a, J. E. Newson and A. Wragg, 503
Bread: a Collection of Popular Papers on Wheat, Flour, and Bread, H. Snyder. With Biographical Sketch by A. L. Winton, 953
Breeding from Colour Varieties, J. C. Laidlay; D. Seth-Smith, 379
Bretons et Anglais aux V^e et VI^e siècles, F. Lot, 61
Brewster Medal of the American Ornithologists' Union, award of the, to Mrs. F. M. Bailey, 998
Bridge Piers, The Profile of, A. Signorini, 43
Brighter Biochemistry, No. 8, 490
Brinell Indentations in Cold-rolled Metal, The Diameter Measurement of Certain, H. O'Neill, 595
Britain and World Trade: Quo Vadimus and other Economic Essays, A. Loveday, 955
British: Association: Centenary Meeting of the, Programmes of Sections, 230; The Faraday and, Centenaries, 328; Centenary Meeting, The, 483; Centenary Celebration at Liverpool, 520; Centenary Meeting, Presidential Address, 521; Summaries of Addresses of Presidents of Sections, 530-540; Commemorative Service at Liverpool Cathedral, 572; Sectional Meetings and Discussions, 573; Sir Alfred Ewing elected President of Meeting for 1932, 575; a Retrospect, 1831–1931, O. J. R. Howarth. Centenary (second) Edition, 687; London and the, 687; Sidelights on the, 982; Australian New Zealand Antarctic Research Expedition, The, 79; of Commercial Seed Analysts, Annual Meeting of the, 265; *Birds*, August, 332; Chemical Industry, A History of the, Dr. S. Miall, 45; Coal Trade, Influence of Modern Hydro-Electric Power Development on the, Dr. Brysson Cunningham, 397; Coleopterous Fauna, Additions to the, H. St. J. Donisthorpe, 155; Douglas Fir, Timber of the, B. J. Rendle, 971; Empire Cancer Campaign: Eighth Annual Report, 664; Gift to the, by Sir William A. Morris, 440; Engineering Standards Association, Reorganisation of the, 997; Institute of Philosophy, Sir Herbert Samuel elected President of the, 64; Mineral Collectors and Dealers in the 17th, 18th, and 19th Centuries, A. Russell, 42; Museum: Lord Ilchester and Prof. J. Stanley Gardiner elected Trustees of the, 299; (Natural History): Acquisitions by the, 15, 181; the Diptera of Patagonia and South Chile, 407; Fiftieth Anniversary of the Opening of the, 578; Post-cards of British Trees, 671; Acquisitions by the, 755, 935; Optical Instruments, Exhibition of, 500; Patent System, Reform of the, 165; School of Archæology: in Athens, Report of the, 934; in Palestine, Work of the, Miss D. A. E. Garrod, 297; *Wood Preserving Association, Journal of the*, No. 1, 903
Broadcasting: Educational, Prof. Winifred Cullis, 877; Studios, Acoustical Problems of, N. Ashbridge, 844; the Song of the Nightingale, 217
Bromine in Organic Compounds, Estimation of, Prof. F. Schultz, 72
Bronze, The Metallurgy of, H. C. Dews, 627
Browne, Buckston, Farm for Surgical Research, Foundation-stone laid of the, 101
Brunton's, Guy, Expedition to Middle Egypt, Exhibition of the Finds of, 63
Budgerigars, The Breeding of, 60
Budget, Reductions under the, 487
Buenos Aires, Museum of Anthropology and Ethnography, Reorganisation of the, 903
Building Science Abstracts, 936
Bull, The Cult of the, in Scotland, A. D. Lacaille, 874
Bunsen Society in Vienna, The German, Prof. F. Paneth, translated by Dr. R. W. Lawson, 94
Burroughs, John, The Slabsides Book of, 834
Bushman, A Fossil, found in the Zuurberg Mountains, South Africa, F. W. FitzSimons, 611

Cable and Wireless Communications of the World, The, F. J. Brown. Second edition, 1057
Cables: High-voltage, Improved Method of constructing, M. Hochstadter, W. Vogel, and E. Bowden, 933; Steel-cored Aluminium, E. T. Painton, 1070
Caird, Sir James, Travelling Scholarships, award of the, 81
Calcium: Fluoride Method for the Determination of Fluoride, The, S. G. Clarke and W. N. Bradshaw, 1086; Triphosphate in a Soluble Form, A New Method for getting, P. Jolibois and G. Chaudron, 315
Calculus: Advanced, a Sequel to an Elementary Treatise on the Calculus, late Prof. G. A. Gibson, 851; Upwards and Downwards in the, 851
Calcutta School of Tropical Medicine, etc., Annual Report of the, 148
Calendar Reform, 38, 800; C. C. Wylie, 841
California Academy of Sciences, Report of Museum and Aquarium for 1930, 331
Calliphora ochracea Schiner (Diptera, Calliphoridæ), The Life-history of, Mary E. Fuller, 280
'Calorex' Glass, Tests with, Chance Bros. and Co., Ltd., 277
Cambridge: Philosophical Society, election of Officers, 834; University: Dr. C. E. Tilley elected Professor of Mineralogy and Petrology, 41; award of the Harkness Scholarship to Miss F. E. S. Caldwell and of Frank Smart prizes to P. W. Richards and P. Ullyett, 80; D. Keilin elected Quick Professor of Biology; W. J. Heasman appointed Senior Curator and G. J. Kerrich Junior Curator of the Museum of Zoology; E. E. Pochin elected Michael Foster Research Student in Physiology, 161; resignation of Dr. A. Harker; Dr. F. R. Winton appointed University Lecturer in Physiology; Dr. G. E. Holmes University Lecturer in Pharmacology, 420; Dr. T. W. Wormell reappointed Observer in Meteorological Physics; Dissertations approved for Degrees, 420; award of Research Exhibitions, 501; election of Prof. G. H. Hardy, L. C. Young, and H. S. M. Coxeter to Fellowships at Trinity College; A. H. Chapman appointed Official Secretary to the Engineering Department; Sir R. H. Biffen given the title of Professor Emeritus, 732; Gift from the Goldsmiths Company; J. W. A. F. Balfour-Browne elected a Frank Smart Student in Zoology; G. Bateson and R. O. Redman elected Fellows of St. John's College, 768; A. G. Brighton appointed Curator of the Sedgwick Museum of Geology; Prof. C. E. Tilley elected a Fellow of Emmanuel College; V. V. Narlikar elected an Isaac Newton Student and H. R. Hulme an additional Isaac Newton Student, 804; A. E. Watkins appointed University Lecturer in Cytology, Dr. E. J. Maskell University Lecturer in Plant Physiology, W. J. Dowson University Lecturer in Mycology, G. C. Grindlay University Demonstrator in Experimental Psychology, and E. H. B. Boulton reappointed University Lecturer in Forestry; H. R. Barnell appointed Frank Smart Student in Botany, 844; R. J. Pumphrey appointed University Demonstrator in Zoology; Grant to L. C. Beadle from the Balfour Fund, 880; Prof. A. Einstein appointed Rouse Ball Lecturer for 1931–32; Prof. D. Keilin elected a Fellow of Magdalene College; Dr. C. G. Lamb reappointed Reader in Electrical Engineering, and T. R. B. Saunders University Demonstrator in Engineering, 916; Dr. H. C. Darby appointed University Lecturer in Geography; recommended Recognition of certain Sub-departments, 1011; Dr. F. C. Phillips appointed University Lecturer in Petrology; recommendation of the General Board concerning Forestry in the University Curriculum, 1048

Canada: Goose, The, and its Races, H. A. Tavener, 874; North-West Territories of, Development of the Hudson Bay Region and the, Dr. Brysson Cunningham, 53; Royal Society of, Annual Meeting in Toronto, 275
Canal Rays, The Production of High-speed, without the Use of High Voltages, E. O. Lawrence and D. H. Sloan, 83
Cancer: A Method of Diagnosis of, Dr. Bendien, 438; and Scientific Research, Dr. Barbara Holmes, 136; Ministry of Health Memorandum on, 65; Research: 664; and the Scientific Method, Dr. Ellice McDonald, 407; Fund, Imperial, Report of the, 931
Canning Industry, English, Progress of the, 16
Cape Observatory, Report of the, 73
Capper Award, Dr. L. O. Howard recipient of the, 64
Caramel, The Analytical Characters of, regarded as a Colouring Matter for Food, P. Balavoine, 83
Carbon: Contacts, C. Turnbull; Prof. C. V. Boys, 968; Dioxide in Sea-water of Different Salt Contents, Apparent Dissociation Constants of, Dr. K. Buch, Dr. H. Wattenberg, and H. W. Harvey, 411; Disulphide: Change of Density of, with Temperature, Dr. J. Mazur, 673; Change of the Dielectric Constant of, with Temperature, Dr. J. Mazur, 761; Change of Dielectric Polarisation of, with Temperature, Prof. M. Wolfke and Dr. J. Mazur, 871; Flames, Spectrum of, Prof. A. Fowler and W. M. Vaidya, 192
Carbonaceous Minerals, The Classification of, Prof. H. Briggs, 72
Carboniferous Plants from Sinai, Prof. A. C. Seward, 1012
Carbonisation Test, Low Temperature, 841
Carbonyl Sulphide, Infra-red Absorption Spectrum of, C. R. Bailey and A. B. D. Cassie, 637
Carnegie: Foundation for the Advancement of Teaching, Annual Report, 880; United Kingdom Trust, The, 194
Carotene: and Vitamin A, Mlle. D. van Stolk, J. Guilbert, and H. Pénau, 467; Cause of the Transformation of, into Vitamin A, H. S. Olcott and D. C. McCann, 998; Pure, and Vitamin A, Mlle. D. van Stolk, J. Guilbert, H. Pénau, and H. Simonnet, 199; The Hæmatopoietic Power of, L. Binet and M. V. Strumza, 387; The Isolation of, from the Suprarenal Glands, O. Bailly and R. Netter, 1086
Carpenter, Edward, an Appreciation, Edited by G. Beith, 892
Catalytic Dehydrogenation, in the Gas Phase, of the Fatty Alcohols in the Presence of Pumice carrying Sulphuric and Phosphoric Acids, J. B. Senderens, 162
Cathode Phenomena in the Glow Discharge, Prof. A. Guntherschulze and F. Keller, 840
Caucasus to the Volga, Through the, Dr. F. Nansen. Translated by G. C. Wheeler, 319
Cavendish, Henry, 1731–1810, 608
Ce^{+++} Ion in Solution, Absorption Spectra of the, Prof. D. M. Bose and S. Datta, 270
Cellular Permeability: M. V. L. Homes, 1005; Action of Light upon, F. Chodat, 126
Cellulose: Lacquers, Dr. T. H. Durrans, 192; Sols, Anisotropy due to Flow in, J. M. Preston, 796
Central: America, Models of Temples in, Dr. G. C. Vaillant, 823; Asiatic Expeditions. The Permian of Mongolia: a Report on the Permian Fauna of the Jisu Honguer Limestone of Mongolia and its relations to the Permian of other parts of the World, Prof. A. W. Grabau. With a Chapter on the Relations of the Jisu Honguer Formation to the General Geology of Mongolia, by Dr. C. P. Berkey and F. K. Morris, 956; Australian Parrot, Strange acquirement of a, A. W. Mullen, 579
Cercariæ, Excretory System in, The Evolution of the, Lieut.-Col. R. B. S. Sewell, 459
Cerebro-Spinal Fever, Certain Aspects of the Control of, 332
Cerium, Pure, Preparation of, M. Billy and F. Trombe, 734
Ceylon, Flora of, A Hand-Book to the, H. Trimen. Part 6: Supplement, A. H. G. Alston, 891
Chamæleon, A Dwarf, with Two Litters, W. J. Pitt, 407
Changing World, The, 404
Charcoal: Activated, Hydrolytic Adsorption of, Prof. J. N. Mukherjee and S. P. Roychoudhury, 412; Activation by, W. D. Bancroft and S. F. Whearty, Jr., 280
Chastity: The Girdle of, a Medico-Historical Study, Dr. E. J. Dingwall, 628
Chelonia, Evolution in the, P. E. P. Deraniyagala, 273
Chemical: Analysis of Special Steels, Steel-making Alloys, their Ores, Graphites, and Bearing Metals, Rapid Methods for the, C. M. Johnson. Fourth edition, 288; Composition: an Account of the Methods by which Atomic Weights and Molecular Formulæ have been determined Dr. A. K. Goard, 958; Engineer, The, 622; Engineering, Elements of, Prof. W. L. Badger and Prof. W. L. McCabe, 622; Engineers, Institution of, H. W. Cremer appointed Honorary Secretary of the, 756; Forces, Nature of, 948; Industries, Safety Work in, 1; Industry: A History of the British, Dr. S. Miall, 45; Society of, Jubilee Celebrations of the: Dr. H. F. Gillbe, 157; Prof. G. T. Morgan, 226; Manipulation, Faraday's, Sir Robert Robertson and B. A. Ellis, 371
Chemie: anorganischen, Handbuch der, Herausgegeben von Prof. R. Abegg, Dr. F. Auerbach, und Prof. I. Koppel. Band 4, Abt. 3. Teil 2. A Lief. 1, 625; physikalischen, Lehrbuch der, Prof. K. Jellinek: Funf Bande. Band 3: Die Lehre von der Statik chemischer Reaktionen in verdunnten Mischungen (Losungen). Erste und zweite Auflage. Lief. 9, 852; Funf Bande. Lief. 10 (Band 4): Die Lehre von der Statik chemischer Reaktionen (Schlussteil) und die Lehre von der chemischen Kinetik. Erste und zweite Auflage, 958
Chemische: Bindung als elektrostatische Erscheinung, A. E. van Arkel und J. H. de Boer. Deutsche, von den Verfassern autorisierte Ausgabe von L. Klemm und W. Klemm, 816; Thermodynamik: Einführung in die Lehre von den chemischen Affinitaten und Gleichgewichten, Prof. H. Ulich, 52
Chemistry: Analytical, Recent Advances in, Vol 1: Organic Chemistry, Editor: Dr. C. Ainsworth Mitchell, 208; *and Industry*, Special Number, 101; Applied, in Technical Colleges, 678; for Matriculation, Dr. G. H. Bailey and H. W. Bausor. Third edition, 173; Inorganic: and Theoretical, A Comprehensive Treatise on, Dr. J. W. Mellor. Vol. 11, 957; Systematic, from the Standpoint of the Periodic Law, Prof. R. M. Caven and Dr. G. D. Lander. New edition, 209; in Technical Schools and Colleges in England and Wales, Instruction in, 678; Makers of, Dr. E. J. Holmyard, 321; of the Vitamins, Sir F. Gowland Hopkins and others, 842; Organic: An Introduction to, Prof. J. Read, 742; for Medical, Intermediate Science, and Pharmaceutical Students, Prof. A. K. Macbeth. Second edition, 657; Fundamentals of, Prof. H. F. Lewis, 957; Physical: A Textbook of Practical, Prof. K. Fajans and K. Wüst. Translated by B. Topley, 852; A Treatise on, a Cooperative Effort by a Group of Physical Chemists, Edited by Prof. Hugh S. Taylor. Second edition. In 2 volumes; Prof. C. K. Rideal, 429; and Colloidal, 852; Laboratory Technique in, 814; Practical, Prof. A. Findlay. Fifth edition, 959; Physiological, in the United States, The Development of, Prof. R. H. Chittenden, 90; Quantitative Pharmaceutical, containing Theory and Practice of Quantitative Analysis applied to Pharmacy, Prof. G. L. Jenkins and Prof. A. G. DuMez, 958; Synthetic Inorganic, a Course of Laboratory and Classroom Study for First Year College Students, Prof. A. A. Blanchard and Prof. J. W. Phelan. Fourth edition, 92; through the Ages, Prof. J. Read, 321
Cheshunt Experimental and Research Station, Report for 1931, 1071
Children, Young: Intellectual Growth in, Dr. Susan Isaacs. With an Appendix on Children's "Why" Questions, by Nathan Isaacs, 777; The Behaviour of, Jean Ayling, 777
Chimie, l'Union Internationale de, Dixième Conférence de, Liége, 14-20 septembre 1930. Rapports sur les hydrates de carbone (glucides), 656
China: National Medical Journal of, Aug.-Oct., 998; Nationalism and Science in, 469; Sir James Barrett, 1035

Chinese: Alchemist, A, Prof. J. Read, 509; Alchemy, Prof. J. R. Partington, 1074; Turkestan, Archæological and Geographical Exploration in, Reason for Abandonment of, Sir Aurel Stein, 144
Chlorides in Dairy Products and Biological Material, Determination of, W. L. Davies, 733
Chloro-tropane, Some Physiological Effects of, M. Polonovski and R. Hazard, 734
Choosing a Career, Methods of, F. M. Earle and others. Edited with a Preface by Dr. C. S. Myers, 393
Christianity, A Heathen's Thoughts on, E. Upasaka, 892
Chromosome Homologies in Wheat, Rye, and Aegilops, Prof. W. P. Thompson, 640
Chromosomes and Constitution, A. A. Moffett, 875
Chromosphere, Height of the, in 1930, G. Abetti, 1014
Chronic Deafness, Treatment of, by the Electro-phonoide Method of Zund-Burguet, Dr. G. C. Cathcart. Second edition, 563
Chrysanthemum and *Potentilla*, Chromosome Multiples in, N. Shimotomai, 72
Cinematograph, An Ultra-rapid, giving from 2000 to 3000 Images per second, E. Huguenard and A. Magnan, 163
Citrus Growing in Southern Rhodesia, 60
City and Guilds of London Institute, Report for 1930, 501
Civil: Engineering Design, A. A. Fordham, 962; Engineers, Institution of, awards of the, 834; Service, The Royal Commission on the, 201
Civilisation: Biology and, Dr. H. H. Dale, 897; The Epic and the Tragedies of, Sir Arnold Wilson, 902
Climatology, A. A. Miller, 514
Clinique-Manufacture Internationale, La, Dr. Rollier, 1072
Clockmakers' Company, Three-hundredth Anniversary of the, 1032
Clocks, Electric Pendulum, Prof. C. V. Boys, 651
Coagulation, Reversible, in Living Tissue (2), W. D. Bancroft and J. E. Rutzler, Jr., 280
Coal: and its Uses, R. Wigginton, 1024; Dust, Electrification of, S. C. Blacktin and H. Robinson, 498; Resources, National, The Physical and Chemical Survey of, 490
Cobalt Nitrosodithiocarbamates, L. Cambi and A. Gagnasso, 683
Cochita, New Mexico, Folk-Tales of the, Ruth Benedict, 970
Cockle, Growth of the, A. C. Stephen, 379
Cockroach, Temperature and Humidity Relations of the, D. L. Gunn, 186
Coco-nut Oil Industry, The, A. E. Williams, 755
Cod, The Greenland, 731
Cohesion, The Nature of, Prof. J. E. Lennard-Jones, 462, 763
Coil Ignition Systems for Motor Cars, E. A. Watson, 865
Cold: -blooded Animals, On the Metabolism of, Daphne L. Coulston, 316; Common, Cause of the, Dochez, Mills, and Kneeland, Jr., 438
Colloidal: (Explosive) Powders, Temperature of Deflagration of, A. Michel-Lévy and H. Muraour, 421; Gold, Magnetism of, V. I. Vaidhianathan and Balwant Singh, 302; Humic-mineral Complexes, Behaviour in an Electric Field of, C. Antoniani, 735; State, Diamagnetism and the, S. Ramachandra Rao, 153
Colloids: a Textbook, Prof. H. R. Kruyt. Translated by Prof. H. S. van Klooster. Second edition, 852; Coagulation of, by Electrolytes, Dr. B. N. Desai and P. M. Barve, 907
Colonial Office appointments, 112, 266, 670, 834, 998
Colorado: and Folsom Points, Dr. E. B. Renaud, 190; University, Theses presented to, 384
Colour Vision, Young's Theory of, Sir John H. Parsons, 123
Colours, Which, do all Colour-blind People fail to distinguish? Polack, 1050
Combustion, The Heat of, of Certain Organic Halogenic Compounds, I. Kaklukov and F. Perelmann, 127
Comet: New, 1931 *b*, 192; New Bright, 1931 *c*, 308; New, 841; Notes, Prof. G. van Biesbroeck, 416; Ryves, 1931 *c*, 381
Cometary: Observation by Bessel in 1832, A Possible, 121; Orbits and the Orbit of Pluto, Proximities of, G. Fayet, 163
Comets, 308, 876
Comets of Short Period, The Origin of, S. Vsessviatsky, 1045
Comma Butterfly in England, The, Dr. F. S. Dawe; N. D. Riley, 760; F. Tutin, 1041
Communications, Sir Oliver Lodge, 932
Conduits, Leçons sur les, Prof. C. Camichel, 209
Conejo, Explotación del, en la Argentina, 112
Congress, Washington, Report of the Librarian of, 219
Coniferous Plantation, The Artificial, and its Place in Forestry, E. P. Turner, 417
Constantan Wire, Lattice-distortion of Cold-drawn, W. A. Wood, 917
Contraceptive Advice, Bureau for, Statistical Report on Operations of the, Prof. R. Pearl, 180
Contraceptives, Chemical, Spermicidal Power of, J. R. Baker, 119
Co-operation between Scientific and Technical Societies and Institutions, Association for the Promotion of, Annual General Meeting, 996
Coopers Hill War Memorial Prize and Medal, award of the, to Dr. M. G. Say, 1072
Co-ordination, An Aspect of, Prof. J. Kenner, 1000
Copepod, A New Parasitic, Isokiti Harada, 37
Copper: Alloys, Oxidation of Some, J. S. Dunn, 594; and Copper-rich Alloys in the Form of Thin Strip, Physical Testing of, M. Cook and E. C. Larke, 554; Brittleness in, C. Blazey, 594; Ion, Activity Coefficient of the Bivalent, in Solutions of its Sulphate, Mlle. M. Quintin, 1050; -magnesium Alloys, The, W. R. D. Jones (4), 595; on Bismuth, Orientated Deposits of, Prof. Yosimiti Hori, 412; The Work-hardening Capacity and Elongation Properties of, H. O'Neill and J. W. Cuthbertson, 595
Coral Reefs and Atolls: being a Course of Lectures delivered at the Lowell Institute at Boston, February 1930, Prof. J. Stanley Gardiner, 206
Corals: and Zooxanthellæ, The Significance of the Relationship between, Dr. C. M. Yonge, 309; Symbiotic Algæ of, Capt. A. K. Totton; Dr. C. M. Yonge, 760
Corea, The Wolf of, Yoshio Abe, 71
Cornbrash, The Stratigraphical Distribution of the, J. A. Douglas and W. J. Arkell (2), 125
Cornish Geology, Handbook of, E. H. Davison. Second edition, 779
Corn-snake, A North American, and Moles, D. Butler, 579
Corona, Changes of the, in the Sunspot Cycle, Dr. W. J. S. Lockyer, 229

CORRESPONDENCE.

Abraxas, Effect of Certain Substances and of Heat on Cells of, Prof. J. B. Gatenby and Joyce C. Hill, 31
Acetylene, The Slow Combustion of, R. Spence, 153
Acromegaly: among the old Northmen, Prof. C. G. Seligman, 221; Prof. L. Hogben, 375; in the Far North, Dr. M. Perkins, 491; Prof. C. G. Seligman, 492
Active Nitrogen, An Oxidisable, Dr. E. J. B. Willey and S. G. Foord, 493
Adsorption, Activated, Prof. W. E. Garner, 583
Aerosols: Charged, and Ball Lightning, W. C. Reynolds, 584; Highly Charged, A Curious Phenomenon shown by, W. Cawood and H. S. Patterson, 150; Properties of, S. C. Blacktin, 968
African Prehistory, *Homo sapiens* and, E. J. Wayland, 1003
Agar-liquefying Bacteria, Distribution of, H. Nicol, 1041
Air Currents: Control of Humidity of, Dr. P. A. Buxton; Dr. W. H. J. Vernon and L. Whitby, 837; of Different Humidities, A Method of obtaining, Prof. J. B. Seth, 638
Aitken Condensation Nuclei, A. R. Hogg, 908
Alchemical Apparatus, Prof. J. R. Partington, 118
"All or None": a Question of Nomenclature, W. W. Waller, 70
Ammonium, Solid, Group Rotation in, and Calcium Nitrates, F. C. Kracek, S. B. Hendricks, and Dr. E. Posnjak, 410
Anchusa, Cytology of, and its relation to the Taxonomy of the Genus, S. G. Smith, 493
Anisotropy due to Flow in Cellulose Sols, J. M. Preston, 796
Anthocyanins, Constitution of, G. M. Robinson and Prof. R. Robinson, 413
Anthropology, Training of Colonial Probationers in, Col. T. C. Hodson, 458

AsH, The Band Spectrum of, G. E. Kimball and J. R. Bates, 969
Atmospheric Motion, Horizontal, The Energy of, Sir Napier Shaw, 226
Atoms and Molecules as Fitzgerald Oscillators, Sir C. V. Raman, 795
Aurora Polaris, Audibility of the, H. U. Sverdrup, 457
Australian Flora and Fauna, Preservation of the, Sir James W. Barrett, 1041
Azide Group, Structure of the, T. C. Sutton, 872
Azides, Structure of the: from their Electric Dipole Moments, L. E. Sutton, 639; Dr. E. Bergmann and W. Schütz, 1077
Band Spectra, Analysis of Complicated, with the Aid of Magnetic Rotation Spectra, Prof. R. W. Wood and G. H. Dieke, 545
Barium: Hydride, Bands in the Spectrum of, Dr. A. Schaafsma, 1042; Strontium and, New Isotopes of, Dr. F. W. Aston, 221
Benzene: and Toluene, Raman Spectra of, L. E. Howlett, 796; Melting Points of Nitrobenzene and of, Prof. I. Masson, 726
Bibliography of Science, Classification for, Dr. S. C. Bradford, 268
Black Stem Rust of Wheat, *Puccinia graminis tritici*, Effect of Light on Urediniospores of, W. A. R. Dillon Weston, 67
Blood of Aquatic Animals, The Composition of the, and its bearings upon the Possible Conditions of Origin of the Vertebrates, Prof. W. J. Dakin, 66
Bottle-Pipe Resonator, The, A. E. Bate, 270
Boys's Soap Solutions, Effect of Light on the Surface Tension of, Prof. L. D. Mahajan, 496; Dr. P. Lecomte du Nouy, 674
Carbon: Contacts, C. Turnbull; Prof. C. V. Boys, 968; Dioxide in Sea-Water of different Salt Contents, Apparent Dissociation Constants of, Dr. K. Buch, Dr. H. Wattenberg, and H. W. Harvey, 411; Disulphide: Change of Density of, with Temperature, Dr. J. Mazur, 673; Change of the Dielectric Constant of, with Temperature, Dr. J. Mazur, 761; Prof. M. Wolfke and Dr. J. Mazur, 871
Carbonyl Sulphide, Infra-Red Absorption Spectrum of, C. R. Bailey and A. B. D. Cassie, 637
Ce^{+++} Ion in Solution, Absorption Spectra of the, Prof. D. M. Bose and S. Datta, 270
Cellulose Sols, Anisotropy due to Flow in, J. M. Preston, 796
Charcoal, Activated, Hydrolytic Adsorption of, Prof. J. N. Mukherjee and S. P. Roychoudhury, 412
Chemical Industry, Society of, Jubilee Celebrations of the, Prof. G. T. Morgan, 226
Chinese Alchemy, Prof. J. R. Partington, 1074
Cockroach, Temperature and Humidity Relations of the, D. L. Gunn, 186
Colloidal State, Diamagnetism and the, S. Ramachandra Rao, 153
Colloids, Coagulation of, by Electrolytes, Dr. B. N. Desai and P. M. Barve, 907
Comma Butterfly in England, The, Dr. F. Sherwill Dawe; N. D. Riley, 760; F. Tutin, 1041
Co-ordination, An Aspect of, Prof. J. Kenner, 1000
Copper on Bismuth, Orientated Deposits of, Prof. Y. Hori, 412
Corals, Symbiotic Algæ of, Capt. A. K. Totton; Dr. C. M. Yonge, 760
Corpuscular Rays, Penetrating, coming from Inclined Directions, Measurements on the Absorption of the, Prof. B. Rossi, 408
Cosmic: and γ-Radiation, Biological Effects of, Prof. J. H. Orton and S. T. Burfield, 376; Evolution and Earthly Needs, Prof. H. E. Armstrong, 761; Rays: and Gamma Rays, Similarity between, Prof. R. A. Millikan and Dr. I. S. Bowen, 582; Magnetic Experiments on the, Prof. B. Rossi, 300; The Corpuscular Explanation of, Prof. F. Soddy, 408
Cotton Growing in Egypt, N. W. Barritt, 1001; F. P. Slater, 1002
Crystal Structure, Representation of, Prof. E. B. Bailey, 869
Crystals, Absorption Spectra of, at Low Temperatures as references in the Measurement of Stellar Velocities, S. Freed, 33
Cyanogen and the Cyanogen Halides, Ultra-Violet Absorption Spectra of, R. B. Mooney and H. G. Reid, 271
Daylight, Actinic Value of, Records of, G. J. Gibbs, 35
Deep Currents in the South Atlantic, Velocity of, G. E. R. Deacon, 267
Diamagnetism: and the Colloidal State, S. Ramachandra Rao, 153; of Liquid Mixtures, V. C. G. Trew and Prof. J. F. Spencer, 152
Doppler Effect in Light-Scattering, Sir C. V. Raman, 636
Dulcitol in a Red Seaweed, Occurrence of, Dr. P. Haas and Prof. T. G. Hill, 378
'Dust Devils', Rotation of, J. Durward, 412
Earthquakes, Deep-Focus, Rev. V. C. Stechschulte, 673
Eclipse Plumage in the Mallard, Violet K. Tallent, 672
Electric Circuit Breaker Research, E. B. Wedmore, A. M. Cassie, and W. B. Whitney, 675
Electrical: Conductivity of Quartz, Anomalous Variation of the, with Temperature at the Transformation Point, Prof. H. Saegusa and S. Shimizu, 835; Resistance and Energy of Magnetisation, A New Relation between, Prof. W. Gerlach and E. Englert, 151
Electricity Liberated during the Downgrade Reactions of Organic Compounds, Measurement of the, J. H. Wolfenden, 69
Electron: Diffraction Patterns, A Focusing Method for Producing, Dr. A. A. Lebedeff, 491; Exchange Phenomena in the Excited Atom, Prof. R. Whiddington and J. E. Roberts, 966
Electrons, Polarisation of a Beam of, by Scattering, E. G. Dymond, 149; N. F. Mott, 454
Embryology and the Theory of Polyhedra, Prof. D'Arcy W. Thompson, 31
Enzyme-Substrate Reactions, Contraction Constants of, M. Sreenivasaya and H. B. Sreerangachar, 585
Esperanto in Scientific Literature, R. M. Morris-Owen, 969
Ethane, Methane and, The Slow Combustion of, Prof. W. A. Bone, 188; Dr. E. Mardles, 304
Ethyl Thio-aceto-acetate, Synthesis of, Sir P. C. Rây, 189
Eurytemora thompsoni, A. Willey: a New European Record, A. G. Lowndes, 967
Ewing's Model of the Magnetic Atom, The Specific Heat of Ferromagnetics and, Dr. J. R. Ashworth, 1003
Eyes, Mineral Contents of, H. Ramage and J. H. Sheldon, 376
Fæcal Pellets, The Form of, and Specific Identification, Prof. R. Macdonald, 68
Ferromagnetics, The Specific Heat of, and Ewing's Model of the Magnetic Atom, Dr. J. R. Ashworth, 1003
Fitzgerald Oscillators, Atoms and Molecules as, Sir C. V. Raman, 795
Flack, Martin, Group-Capt., Sir Leonard Hill, 496
Flint, The Age of, M. Burton, 32
Flower Colour, Chemical Effect of a Mendelian Factor for, Hon. Mrs. M. W. Onslow, 373
Fluorescence: and Free Neutral Radicals, A Connexion between, Dr. W. A. Waters, 905; Mercury Line Spectrum in, Lord Rayleigh, 905
Fluorine: The Atomic Weight of, H. S. Patterson, Prof. R. Whytlaw-Gray, and W. Cawood, 375; Prof. E. Moles, 966; The Heat of Dissociation of, Manohar S. Desai, 34
Forestry: Practice and Research, A. C. Forbes, 31; Research in Great Britain, F. T. Brooks; J. Ramsbottom, 118
Free Neutral Radicals, A Connexion between Fluorescence and, Dr. W. A. Waters, 905
Gamma Rays, Cosmic Rays and, Similarity between, Prof. R. A. Millikan and Dr. I. S. Bowen, 582
Gammarus chevreuxi Sexton, A New Locality for, F. T. K. Pentelow, 797
'Gapes' in Chickens, The Treatment of, Dr. W. R. G. Atkins, 585
Gas Reactions, Heterogeneous, Absolute Rates of, B. Topley, 115
Gaseous Explosions, Limits of, M. Neumann and A. Serbinoff, 1040
Geiger: Counter, A Counting Device for use with the, Dr. J. C. Jacobsen, 674; Counters, Coincidences between, A Method of Recording, Dr. J. C. Jacobsen, 185
Gelatine, Soluble Substances in, Condition of Sparingly, Dr. T. R. Bolam, 222; Dr. S. C. Bradford; Dr. B. N. Desai, 223

Glow-worm, Spectrum of, Dr. L. A. Ramdas and L. P. Venkiteshwaran, 726
Glow-worms, Light of, Dr. M. Perkins, 905
Glucuronic Acid, The Pyranoid Structure of, and of Theophylline Arabinoside, J. Pryde and R. T. Williams, 187
Gold, Colloidal, Magnetism of, Dr. V. I. Vaidhianathan and Balwant Singh, 302
Gravels in the New Forest Area, Age of certain, M. C. Burkitt, 222 ; H. Bury, 377 ; H. J. E. Peake, 378
Gravity Anomalies, Major E. A. Glennie, 1004
Green Auroral Line, Excitation of the, Prof. J. Kaplan, 304
Hail Storm, June 14, at Doncaster, N. L. Silvester, 35
Harvard Museum Expedition to Australia, The, Prof. J. Stanley Gardiner, 457
Helix aspersa, the Common Snail, Outgrowths from Pieces of, Prof. J. B. Gatenby, 1002
High Resistance, A Spark Method of Measuring, J. A. C. Teegan, 585
Homo sapiens and African Prehistory, E. J. Wayland, 1003
Humidity in the Upper Air, Graphical Indication of, Dr. C. W. B. Normand, 583
Hydrocarbons : Slow Combustion of, Dr. R. Spence, 873 ; The Peroxidation of, during Combustion in Air, Dr. E. Mardles, 116
Hydrogen : Activated Adsorption of, by Zinc and Chromium Oxides, Prof. H. S. Taylor, 636 ; Atomic, occluded in Iron Nitride, Shun-Ichi Satoh, 457 ; Influence of, on Chemical Changes in Silver Vessels, Prof. M. W. Travers, L. E. Hockin, and T. J. P. Pearce, 66 ; Resonance Spectrum of, Dr. K. R. Rao and J. S. Badami, 585 ; Sulphide and Sulphur Dioxide, Reaction between, Prof. Basrur Sanjiva Rao and M. R. Aswathnarayana Rao, 413 ; The Critical Increment of the Adsorption of, on Amorphous Carbon at 400°-520° C., F. E. T. Kingman, 272
Hyperfine Structure, Isotopic Displacement in, J. H. Bartlett., Jr., 408
Immunity Reactions, The Study of Specific Combination in, J. R. Marrack and F. Campbell Smith, 1077
Indium and Thallium, Arc Spectra of, Fine Structure in the, Dr. A. L. Narayan, 675
Infra-Red Radiation from an Engine, An Investigation of, S. Steele, 185
Insect Metamorphosis, Effects of Inadequate Feeding on, C. Dover, 303 ; Dr. Hem Singh Pruthi, 869
Ions, Negative, Photoelectrons and, Dr. J. L. Hamshere, 871
Isotopes of Lead, Nuclear Moments of the : Relative Values of the $g(I)$ Factors of Pb(207) and Tl, Prof. J. C. McLennan, M. F. Crawford, and L. B. Leppard, 301
Jumping Negative Glow, The, W. A. Leyshon, 795
Keratin Molecule, Constitution of the, J. B. Speakman and Mercia C. Hirst, 1073
‘ Lapides palmati ’ mentioned in the “ Historia Naturalis ” of the Elder Pliny, The, Dr. K. C. Bailey, 672
Lavoisier, Priestley and, Sir Philip Hartog, 797
Lead, Isotopes of, Nuclear Moments of the : Relative Values of the $g(I)$ Factors of Pb(207) and Tl, Prof. J. C. McLennan, M. F. Crawford, and L. B. Leppard, 301
Lepidosiren, The Double Lateral Line of, J. T. Cunningham, 377
Light Quanta : Spin of, Sir C. V. Raman and S. Bhagavantam, 727 ; The Angular Momentum of, Sir C. V. Raman, 545 ; The penetration of, through Successive Layers of Tissue Paper, Dr. W. R. G. Atkins, 545 ; The Velocity of, Dr. V. S. Vrkljan, 269 ; Scattering, Doppler Effect in, Sir C. V. Raman, 636 ; in Liquids, S. Venkateswaran, 870
Lightning : Ball, Charged Aerosols and, W. C. Reynolds, 584 ; Branching of, Dr. B. F. H. Schonland and Dr. T. E. Allibone, 794 ; Major J. L. P. Macnair, 969 ; Discharge, Duration and Magnitude of a, R. S. J. Spilsbury, 872 ; Unusual, H. E. Beckett and A. F. Dufton, 189 ; Capt. C. J. P. Cave, 378
Liquid Mixtures : Diamagnetism of, V. C. G. Trew and Prof. J. F. Spencer, 152 ; Dr. H. Buchner, 301 ; Prof. E. van Aubel, 455 ; S. Ramachandra Rao and G. Sivaramakrishnan, 872 ; The Viscosity of, Prof. G. W. Stewart, 727 ; Prof. E. N. da C. Andrade, 835
Lithium : Constitution of, Dr. F. W. Aston, 149 ; Hydride, Isotope Effect in the Band Spectrum of, Prof. Gisaburo Nakamura, 759 ; Metallic, The Excitation Potentials of, Dr. H. W. B. Skinner, 114
Lithothamnion in the South Indian Cretaceous, Occurrence of, Prof. L. Rama Rao, 225, 873
London Skull, The, C. N. Bromehead, 118
Loudspeaker Frequency Response Curves in terms of Loudness, Subjective Interpretation of, D. A. Oliver, 268
Magnetic : Birefringence, A New Type of, Sir C. V. Raman and S. W. Chinchalkar, 758 ; Experiments on the Cosmic Rays, Prof. B. Rossi, 300
Magnetisation, Energy of, Electrical Resistance and, A new relation between, Prof. W. Gerlach and E. Englert, 151
Magneto-Electric Saturation Effect, The, Dr. O. E. Frivold and S. Koch, 675
Mallard, Eclipse Plumage in the, Violet K. Tallent, 672
Matter : Life : Mind, A. Eagle ; W. W. L., 906 ; Dr. W. D. Lighthall, 907 ; Dr. M. Copisarow, 1042
Meatal Notch, The External, as a Primitive Character, Prof. F. Wood Jones, 458
Melanism in Moths, Inheritance of, A. W. McKenny Hughes, 496
Mercury : Band, Spectrum in the, Fluorescence, Lord Rayleigh, 724 ; Cadmium, and Zinc, High Frequency Discharge of, The Forbidden Lines in the, J. Okubo and E. Matuyama, 224 ; Line Spectrum in Fluorescence, Lord Rayleigh, 905 ; Measurements of the Height of a Large Drop of, R. S. Burdon, 456
Methane and Ethane, The Slow Combustion of, Prof. W. A. Bone, 188 ; Dr. E. Mardles, 304
Molecules, Atoms and, as Fitzgerald Oscillators, Sir C. V. Raman, 795
Molybdenum Trioxide : Crystal Structure of, a Correction, Nora Wooster, 35
Monohydric Phenols, Application of the Simonis Reaction to, A. Robertson, 908
Mosquito Larvæ, Ultra-Violet Rays and, Dr. M. E. MacGregor, 68
Mousterian (Levalloisian) Implements, Derived early, in the Melt-water Gravels of the Coombe Rock Glaciation, J. P. T. Burchell, 909
Multiple Ionisation and Secondary X-Ray Absorption Edges, A. Sandstrom, 759
National Needs, L. A. Fenn, 909
Nemertean, A New and Peculiar Marine, from the Australian Coast, Prof. W. J. Dakin and Mahalah G. C. Fordham, 796
Neon-Helium Bands, Dr. M. J. Druyvesteyn, 1076
Nitrobenzene : Change of Dielectric Polarisation of, with Temperature, Prof. M. Wolfke and Dr. J. Mazur, 584 ; Melting Points of, and of Benzene, Prof. I. Masson, 726
Œnothera, Origin of Chromosome Linkage in, Prof. R. A. Gates and D. G. Catcheside, 637
Œstrus-producing Hormones, Dr. G. F. Marrian and A. Butenandt, 305
Ogilvie, Sir Francis, The late, J. Cameron Smail, 118
Oldoway : Bone Beds : Tanganyika Territory, Age of the, Dr. L. S. B. Leakey, A. T. Hopwood, and Prof. H. Reck, 724 ; New Yields from the, Dr. L. S. B. Leakey, A. T. Hopwood, and Prof. H. Reck, 1075 ; Human Skeleton, The, J. Reid Moir, 797
Opacity Coefficient, The Relativistic, R. C. Majundar and D. S. Kothari, 909
Oxlip, Wild, Segregation of Floral Characters in the, Prof. F. E. Weiss, 305
Oxygen and Everest, N. E. Odell, 1037
Ozone, Photosensitised Decomposition of, by Bromine, J. W. T. Spinks, 548
Phosphorus, Green Flame of, Band Spectrum of the, Dr. E. B. Ludlam, 271
Photoelectrons and Negative Ions, Prof. E. M. Wellish, 547 ; Dr. J. L. Hamshere, 871
Photon : Evidence of the Spin of the, from Light-Scattering, Sir C. V. Raman and S. Bhagavantam, 114 ; Dr. G. Placzek, 410 ; The Spin of the, Prof. W. N. Saha and Y. Bhargava, 870 ;
Plants, Mortality among, and its bearing on Natural Selection, R. Weatherall, 33

Polarisation of Downcoming Wireless Waves in the Southern Hemisphere, Prof. E. V. Appleton, 1037
Polarity and Vapour Pressure, Dr. A. R. Martin, 456
Polyhedra, Embryology and the Theory of, Prof. D'Arcy W. Thompson, 31
Potassium, β-Radiation of, A Hard Component of the, D. Bocciarelli, 374
Potatoes, Respiration of Healthy and Leaf Roll, Dr. T. Whitehead, 967
Pottery with Flint Implements of Upper Palæolithic Facies from Swanscombe, Kent, J. P. T. Burchell, 548
Precipitation, Periodic, in the Absence of Colloids, Prof. J. W. McBain, 1042
Prickly-Pear, Control of, by the Cochineal Insect, C. T. Jacob, 117; W. B. Alexander, 226; T. V. Ramakrishna Ayyar, 837
Priestley and Lavoisier, Sir Philip Hartog, 797
Prophylaxis, Experiments in, Sir Flinders Petrie, 35
Proteins in their Native State, Molecular Weights of the, Prof. The Svedberg, 999
Puccinia graminis tritici, Effect of Light on Urediniospores of Black Stem Rust of Wheat, W. A. R. Dillon Weston, 67
Quantised Magnetic Poles, Isolated, Prof. O. W. Richardson, 582
Quantum-Mechanical Models of a Nucleus, R. H. Fowler, 453
Quartz, Anomalous Variation of the Electrical Conductivity of, with Temperature at the Transformation Point, Prof. H. Saegusa and S. Shimizu, 835
Radioactivity and Earth Movements, Prof. A. Holmes, 496
Rainfall as Carbohydrates, Conservation of, Prof. W. A. Osborne, 378
Raman: Band of Water, Structure of the, S. Rafałowski; Dr. G. Bolla, 546; Lines due to Co-ordination Bond, Prof. D. M. Bose and S. Datta, 725; in Liquids, Fine Structure of, Dr. A. Langseth, 225; Scattering in Gases, Intensity of, S. Bhagavantam, 272; Scattering, Polarisation of, by Hydrogen Gas, S. Bhagavantam, 70; Spectra: Effect of Pressure on, S. Bhagavantam, 188; of Benzene and Toluene, L. E. Howlett, 796; of Crystals, Lines of Large Frequency Shift in the, Prof. R. Tomaschek, 495; of Liquid Mixtures, P. Krishnamurti, 639
Rare Gas Spectra, Intensity Anomalies in, E. Rasmussen and H. Swenson, 188
Relativistic Opacity Coefficient, The, R. C. Majumdar and D. S. Kothari, 909
Resonator, The Bottle-Pipe, A. E. Bate, 270
Rhenium, Magnetic Resolution and Nuclear Moment of, Prof. P. Zeeman, J. H. Gisolf, and T. L. de Bruin, 637
Rocks, Lead Content of, Prof. G. Hevesy and Dr. R. Hobbie, 1038; Prof. A. Holmes, 1039
Rotatory Magnetic Polarisation, Prof. E. van Aubel, 1004
Rubidium Spectrum, Hyperfine Structure in the, D. A. Jackson, 34
Salt Hydrate, Dissociation of a, Function of Water Vapour in the, B. Topley and M. L. Smith, 302
Salts, Dehydration of, Dr. M. Copisarow, 838
Science, Bibliography of, Classification for, Dr. S. C. Bradford, 268
Scientific Abstracting Services, Organisation of, A. A. Eldridge, 1004
Seedlings in some Grasses, Latency of, H. G. Chippindale, 1075
Serum Albumin, Denaturation of, Temperature Stability and, Prof. K. O. Pedersen, 150
Ship-Waves, Rhythmic Breaking of, Prof. Kerr Grant, 838
Short-Wave Reception and Ultra-Radiation, Dr. W. M. H. Schulze, 837
Silica Vessels, Chemical Changes in, Influence of Hydrogen on, Prof. M. W. Travers, L. E. Hockin, and T. J. P. Pearce, 66
Silver, Bivalent, Paramagnetism of, Prof. G. T. Morgan and Dr. S. Sugden, 31
Simonis Reaction, Application of the, to Monohydric Phenols, A. Robertson, 908
Snakes, Insectivorous, Prof. F. J. Meggitt, 413
Sound in Tubes: Velocity of, Ultrasonic Method, G. S. Field, 117
Space Lattice, A Two-Dimensional, Dr. R. C. Menzies 907; W. Baker, 1078
Special Lines of Light scattered by Liquids, The Fine Structure of, S. Rafałowski, 495
Spectrum Se III, The Structure of the, J. S. Badami and Dr. K. R. Rao, 496
Stars: White Dwarf, Constitution of the, Seitarô Suzuki, 838; White Dwarf, The Internal Temperature of, Prof. E. A. Milne, 999
Stellar Velocities, Measurement of, Absorption Spectra of Crystals at Low Temperatures as References in the, S. Freed, 33
Stratified Clouds, Electrical Conditions in, Dr. M. Grabham, 969
Strontium and Barium, New Isotopes of, Dr. F. W. Aston, 221
Superconductivity: a Polarisation Phenomenon, Prof. J. C. McLennan, 373; at High Frequencies, Prof. J. C. McLennan, A. C. Burton, A. Pitt, and J. O. Wilhelm, 1004
Surface Films, A Method of Studying, Prof. E. Gorter and W. A. Seeder, 413
Temperature Stability and Denaturation of Serum Albumin, Prof. K. O. Pedersen, 150
Thallium: II, Hyperfine Structure of, Dr. J. B. Green and J. Wulff; Dr. J. Schuler and J. E. Keyston, 409; and Uranium, Constitution of, Dr. F. W. Aston, 725; Indium and, Arc Spectra of, Fine Structure in the, Dr. A. L. Narayan, 675
Theophylline Arabinoside, The Pyranoid Structure of Glucuronic Acid and of, J. Pryde and R. T. Williams, 187
Thrips tabaci as a Vector of Plant Virus Disease, G. Samuel and J. G. Bald, 494
Ticks, The Spermatogenesis of, Prof. E. Warren, 454
Tigroid, Chemical Nature of the, Prof. A. Szent-Györgyi, 761
Titanium in the Tetrachloride, Valency and Diamagnetism of, Dr. V. I. Vaidhianathan, 189
Toluene, Benzene and, Raman Spectra of, L. E. Howlett, 796
Tomlinson, the late Mr. Herbert, J. J. Abraham, 153
Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium, Structure of the, J. A. A. Katelaar, 303
Turbulence in a River, Dr. H. Jeffreys, 1078
Ultra-: Radiation, Short Wave Reception and, Dr. W. M. H. Schulze, 837; Violet: Light of the Sky, An Apparatus for Recording the, Dr. P. W. Cunliffe, 35; Radiation, Measurement of, A. F. Dufton and H. E. Beckett, 223; Rays and Mosquito Larvæ, Dr. M. E. MacGregor, 68
Uranium, Thallium and, Constitution of, Dr. F. W. Aston, 725
Uric Acid, Excretion of, Dr. V. B. Wigglesworth, 116; Dr. J. Needham, 152
Uteroverdin, Dr. R. Lemberg, Prof. J. Barcroft, and Dr. D. Keilin, 967
Virus Disease of the Tobacco Plant, A New, Dr. H. H. Storey, 187
Viruses, Nature of, Prof. A. E. Boycott, 727
Viscosity of Liquids, The, Prof. G. W. Stewart, 727; Prof. E. N. da C. Andrade, 835
Vitamin: A and the Antimony Chloride Reaction, A. Emmerie, M. v. Eekelen, and Prof. L. K. Wolff, 495; D, Crystalline, F. A. Askew, Miss H. M. Bruce, Dr. R. K. Callow, St. J. L. Philpot, and T. A. Webster, 758
Water Vapour in the Dissociation of a Salt Hydrate, Function of, B. Topley and M. L. Smith, 302
Weiss Units, The Theoretical Magneton Numbers in, Dr. C. J. Gorter, 68
White Dwarf Stars, Constitution of the, Seitarô Suzuki, 838
Wires drawn through Rotating Dies, H. Greenwood and Prof. F. C. Thompson, 152
Wood Fibres, The Tertiary Wall of, S. H. Clarke, 1078
World List of Scientific Periodicals, The, Sir Peter Chalmers Mitchell, 70
X-Ray: Diffraction Intensities, Anomalous, W. A. Wood, 272; Fibre Photography, S. Zeidenfeld, 70
X-Rays, Part-Absorption in, Dr. B. B. Ray and B. B. Datta, 224
Yard, Determination of the, in terms of the Wave-length of Light, J. E. Sears, Jr.; Dr. A. E. H. Tutton, 965
Yeast, Oxidation Reduction Potential of Complex Iron Compounds in, T. B. Coolidge, 223
Zeeman Effect of a Forbidden Line, E. Segrè and Dr. C. J. Bakker, 1076

Corrosion Problems, Thin Films in Relation to, U. R. Evans, 489
Cosmic: and γ-Radiation, Biological Effects of, Prof. J. H. Orton and S. T. Burfield, 376; Evolution and Earthly Needs, Prof. H. E. Armstrong, 761; Problems: an Essay on Speculative Philosophy, Prof. J. S. Mackenzie, 628; Radiation, Fluctuations in, G. Hoffmann, 120; Rays: and Gamma Rays, Similarity between, Prof. R. A. Millikan and Dr. I. S. Bowen, 582; Magnetic Experiments on the, Prof. B. Rossi, 300; The Corpuscular Explanation of, Prof. F. Soddy, 408; The Nature of, Prof. C. Størmer, 83
Cosmical Constant, The, and the Wave Equation, Sir Arthur Eddington, 763
Cotton: Cross-Pollination in, Dr. M. A. Fikry, 1080; Growing in Egypt, Dr. W. L. Balls, and others; F. P. Slater, 766; N. W. Barritt, 1001; F. P. Slater, 1002
Craven Area, Jointing and Tectonics of the, L. R. Wager, 460
Crayfish, Lateral Giant-fibres in the, Histological Polarisation of, S. G. Warner, 164
Creative Science and Industry, 317
Cresols, A Method of separating the, and the Properties of Pure *m*-Cresol, G. Darzens, 315
Crime as Destiny: a Study of Criminal Twins, Prof. J. Lange. Translated by Charlotte Haldane, 630
Crimea, Rodents from the Quaternary Deposits in the, A. A. Birula, 127
Criminal Statistics, 1929, 61
Crompton Medal of the Institution of Automobile Engineers, Award of the, to Dr. S. J. Davies and E. Giffen, 635
Cross, Dorothy Temple, Fellowships, Award of, 220
Cruciferous Flower, Structural Features of the, Dr. Agnes Arber, 1043
Crude Oil, Relation between the Yield of, and the Composition of Retortable Carbonaceous Minerals, H. Briggs, 42
Crustacea, Musculature of, Dr. R. J. Daniel, 970
Crust-Movements after the Tango Earthquake of 1927, Prof. C. Tsuboi, 380
Cryptotoxins, New Researches on the, H. Vincent, 918
Crystal: Palace Show, Exhibits at the, 995; Structure Representation of, Prof. E. B. Bailey, 869
Crystallisation Centre, The Nature of a, A. Glazunov, 128
Crystallography, The New, Prof. W. L. Bragg, 511
Crystals: of Brookite Tabular Parallel to the Basal Plane, F. C. Phillips, 977; Structure of XO_3 Groups in, W. H. Zachariasen, 274
Cuckoo, Feeding of a Yearling, 296
Culture Media, A Compilation of, for the Cultivation of Micro-organisms, Prof. M. Levine and H. W. Schoenlein, 244
Cuprous Oxide: Cells, Variation in the Spectrum of the Sensibility of, P. Auger and C. Lapicque, 646; Photoelectric Cells, Sensibility of, of the Type with Copper Grid, L. Dubar, 918
Current Economic Theory in Relation to the Five-Year Plan, M. Dobb, 790
Currents, Deep, in the South Atlantic, Velocity of, G. E. R. Deacon, 267
Cyanidin Chloride, Constitution of, Dr. M. Nierenstein, 587
Cyanogen: and the Cyanogen Halides, Ultra-Violet Absorption Spectra of, R. B. Mooney and H. G. Reid, 271; The Absorption Spectra of, and the Cyanogen Halides, R. B. Mooney and H. G. Reid, 882
1, 2-Cyclohexanedione or Dihydro-pyrocatechol, E. Urion, 315

Dabtara abyssin, Le livre de recettes d'un, M. Griaule, 204
Dairy Research, Sir William Dampier, 1071
Daylight, Actinic Value of, Records of, G. G. Gibbs, 35
Dean, Bashford, Memorial Volume, Archaic Fishes, Edited by Dr. E. W. Gudger, 182
Death and Development, Prof. E. W. MacBride, 382
Debye-Huckel Equation, Activity Coefficients and the, 499
Decimal Classification, Universal, 680
Delphinium, Mutable Genes in, Demerec, 676
Demography, History of, 940
Deserts and the Birth of Civilisations, A. J. McInerny, 475
Deutschlands, Stratigraphie, Handbuch der vergleichenden, Alluvium, Schriftleitung, late Prof. J. Stoller. Unter Mitwirkung von K. von Bulow und W. Dienemann, 1025
Diamagnetism: and the Colloidal State, S. Ramachandra Rao, 153; of Liquid Mixtures, S. Ramachandra Rao and G. Sivaramakrishnan, 872
Diatomic Gases, Scattering by, E. O. Wollan, 1014
Diatoms Growing on Stones on the Black Sea Littoral near Sebastopol, N. F. Alexeenko, 422
Dielectric Constant, The, and Chemical Constitution, A. Chrétien, 163
Diencephalon, A possible 'Parasympathetic Centre' in the, H. Cushing, 422
Diet: and Disease, 326; The 'Vital' Factor in, Dr. C. Watson, 154
Diffusion for the Infinite Plane Sheet, A. T. McKay, 733
Dinaphthopyrone, A New Method of Synthesis of, K. Dziewonski and S. Pizoń, 279
Dinoflagellates, Japanese, Prof. C. A. Kofoid, 154
Diopside and Tremolite from Monte Spinosa in the Campigliese, F. Rodolico, 1014
Diptera of Patagonia and South Chile, Part 6, fasc. 2, 112
Disasters at the Moon's Third Quarter, A. Rosewood, 997
Discharge: Tubes and their Technical Applications, N. L. Harris and H. G. Jenkins, 330; without Electrodes, The Theory of the, F. Esclangon, 82
Disease, Diet and, 326
Dissociable Organic Oxides, Researches on the, C. Dufraisse and M. Badoche, 422
Dissolved Substance, Distribution of a, between the Crystalline and the Fluid Phase, V. Chlopin and A. Ratner, 387
Diving Devices, Modern, Capt. G. C. C. Damant, 324
Domestic Animals, The Sensibility of, to the Virus of Exanthematic Fever, G. Blanc and J. Caminopétros, 503
Dominance, Evolution of, Dr. R. A. Fisher, 1079
Donohoe Comet Medal, award of the, to M. Nagata, 868
Doppler Effect in Light-Scattering, Sir C. V. Raman, 636
Drumm Storage Battery, Use of, in Ireland, 994
Dry: Cleaner, Practical, Scourer and Garment Dyer. Edited by W. T. Brannt and J. B. Gray. Sixth edition, 1060; Liquids, Distillation of, J. W. Smith, 971
Drying, Mechanism of, Dr. G. Bozza, 380
Dulcitol in a Red Seaweed, Occurrence of, Dr. P. Haas and Prof. T. G. Hill, 378
Duralumin, Influence of Variations in Heat-treatment and Ageing on, A. von Zeerleder, 554
Durham University, Philosophical Society of, election of officers, 723
'Dust Devils', Rotation of, J. Durward, 412
Dyestuff Industry: Advances in the, Prof. F. Mayer, 792; The, Prof. H. E. Armstrong, 542
Dynamic Universe, The, Prof. J. Mackaye, 288

β-ethylnaphthaline and its Hydrogenation Products, G. Lévy, 163
Ear, The Cupula of the, R. E. Bowen, 846
Early Man in North-East Yorkshire, F. Elgee, 776
Earth: Interior of the, Composition of the, A. A. Bless, 280; Physics of the: Volcanology; The Figure of the Earth; Meteorology; The Age of the Earth, Dr. H. Jeffreys, 984; Movements, Radioaction, and, Prof. A. Holmes, 496
Earthquake: in Western China, 407; Recorded at Kew, 332; The Idu (Japan) of Nov. 26, 1930, Dr. C. Davison, 552; The North Sea, Rev. J. P. Rowland, 15
Earthquakes: and Mineral Springs, B. M. Radoslavoff, 677; Deep-Focus, F. J. Scrase, 228; Rev. V. C. Stechschulte, 673; Luminous Phenomena accompanying, K. Musya, 155; Recent, 299
Earths: and Alkaline Earths, Preparation of the Cyanamides of the, Mlle. Germaine Bernheim, 315
Earth's Crust, Properties of the, 549

Earwig, Function of the Forceps of the Common, M. H. Lapidge and Dr. van der Sleen, 756; F. G. Carruthers, 440
Echinoderm Larvæ, Prof. T. Mortensen; Dr. F. A. Bather, 417
Echinostomes from Rats, A. Tubangui, 227
Eclipse Observations and the Einstein Shift, Prof. E. Freundlich, 1045
Ecological Viewpoint, The, Prof. J. W. Bews, 245
Edinburgh University: conferment of Honorary and other Doctorates, 80; Dr. C. McNeil appointed Edward Clark Professor of Child Life and Health in, 197; E. G. Dymond appointed Lecturer in Natural Philosophy; Dr. E. L. Ince, Lecturer in Mathematics; Dr. R. A. R. Gresson, Lecturer in Zoology (Cytology); Dr. P. Gray, Lecturer in Zoology (Vertebrate Embryology); and Lt.-Col. S. H. Cowan, Lecturer in Forest Engineering, 880
Educational Broadcasting, Prof. Winifred Cullis, 877
Eels and Conger Eels of the North Atlantic, Prof. J. Schmidt, 602
Egg, Development of the, Dr. G. L. Streeter, 1005
Egypt: Ancient, Hippopotamus Figures from, W. M. Crompton, 273; and the Sudan, Hand-spinning in, Mrs. Grace M. Crowfoot, 71; Cotton Growing in, N. W. Barritt, 1001; F. P. Slater, 1002; Palæolithic Man in, 287
Egyptian: Figurine, An Archaic, G. Loukianoff, 640; Sealings, Ancient, Dr. G. A. Reisner, 1079
Einnamic Aldehyde, A New Method of Synthesis of, and its Homologues substituted in the Nucleus, L. Bert and R. Annequin, 125
Einstein: Shift, Eclipse Observations and the, Prof. E. Freundlich, 1045; Universe, Static, On Thermodynamic Equilibrium in a, R. C. Tolman, 164
Eiszeitalter: Das; Grundlinien einer Geologie des Diluviums, Dr. P. Woldstedt, 394
Elastic Equilibrium, The Intrinsic Equations of, G. Andruetto, 734
Electric: and Magnetic Units, The Convention of Equidimensional, A. E. Kennelly, 164; Circuit Breaker Research, E. B. Wedmore, A. M. Cassie, and W. B. Whitney, 675; Clocks, F. Hope-Jones, 651; Field at the Summit of the Puy de Dôme, The, E. Mathias and G. Grenet, 806; Light and Power: Supply Companies, The Interconnexion of, Prof. K. Field, 297; Companies, Unification of, Capt. J. M. Donaldson, 755; Stations: Two Historic, Dr. G. A. Orrok; Col. R. E. B. Crompton, 140; Value of Linking Up, N. E. Funk, 669; Propulsion of Liners, A. D. Constable, 16; Traction Experiment in Ireland, An, 994
Electrical: Engineers, Institution of: award of Scholarships by the, 278; election of Officers of the, 147; Oscillator of Low Frequency Stabilised by a Tuning Fork, An, G. Marboux, 42; Resistance and Energy of Magnetisation, A New Relation between, Prof. W. Gerlach and E. Englert, 151; Supply, Application of, for the Provision of Labour-saving Devices, 62; System, A Self-maintained, utilising a Neon Tube, B. Decaux and P. Le Corbeiller, 978
Electricity: and Magnetism: A Connexion between, Dr. P. A. M. Dirac, 586; an Advanced Text-book for Colleges, Prof. C. A. Culver, 629; Physical Principles of, Prof. R. W. Pohl. Translated by Winifred M. Deans, 134; and the Soil, 252; for Everybody: Handbook for 1931, R. B. Matthews, 960; in the Rumanian Oilfields, Use of, H. E. Dralle, 633; Liberated, Measurement of the, during the Downgrade Reactions of Organic Compounds, J. H. Wolfenden, 69; Magnetism and, School Certificate, Dr. H. Toms, 431; Supply, Standardisation of, 16; The Mechanical Aspects of, Ll. B. Atkinson, 865
Electrification of Railways of Great Britain, The, 179
Electrochemistry, A Laboratory Manual of, Prof. E. Muller. Translated by Dr. H. J. T. Ellingham, 743
Electrodynamic Relations in Electromagnetic Machinery, The Fundamental Features of, E. Semičev, 126
Electrodynamics: Certain Fundamental Theorems of, and of the Statics of Elastic Solids (2), D. Bonvicini, 806; Gauss's Investigations on, Prof. C. Schaefer, 339
Electrokinetic Potentials, Studies on, H. B. Bull and R. A. Gortner (9), 423
Electrokinetics and the Interpretation of Surface Conductivity, McBain and Du Bois, 677
Electrolysis, Quantum Theory of, Dr. R. W. Gurney, 1044
Electrolytes in Solution, Behaviour of, Sir Harold Hartley, and others, 680
Electromagnetic Waves: Propagation of, Prof. H. Nagaoka, 120; Reflection of very Short, R. Guyot, 503
Electromagnetism, Dynamical Aspects of, Prof. V. K. F. Bjerknes, 369
Electron: Diffraction, Prof. D. R. Hartree, 47; Diffraction Patterns, A Focusing Method for Producing, Dr. A. A. Lebedeff, 491; Exchange Phenomena in the Excited Atom, Prof. R. Whiddington and J. E. Roberts, 966; -Inertia Effect, A New, Prof. Barnett, 549; Theory, A Generation of, O. U. Vonwiller, 200
Electronic Impacts in Air, The Ionising Efficiency of, J. Thomson, 81
Electrons: Diffraction of, F. L. Arnot and E. C. Bullard; H. S. W. Massey, 799; Polarisation of a Beam of, by Scattering, E. G. Dymond, 149; N. F. Mott, 454
Elektroneninterferenzen, Herausgegeben von Prof. P. Debye, 396
Elektrophorese, Elektroosmose, Elektrodialyse in Flussigkeiten, Dr. P. H. Prausnitz und Dr. J. Reitstötter, 988
Element: of Atomic Number 87, Reported Identification of the, by Dr. J. Papish, 696; 61, Investigation on, by means of the X-Rays, S. Takvorian, 82; No. 87, The Discovery of, Papish and Wainer, 789
Elks (*Alces* Gray) of the Old World, K. K. Flerov, 503
Empire: Cotton Growing Corporation, Quarterly Report of the Executive Committee, 754; Marketing Board, Report of the, 1930–31, 251; Survey Officers, Conference of, 276; *Survey Review*, pt. 1, 266; Travel for British Students, 196
Employment in Great Britain, Fluctuations in, Dr. F. C. Benham, 753
Encke's Comet, 38; H. E. Wood, 156
Endothermic Compounds, The Maximum Concentration of, at High Temperatures, E. Briner and B. Susz, 83
Engineering: Apprentices, Selection of, 463; Societies Monographs, Projected, 183
Entomological Society of London, The Transactions of the, vol. 79, part 1, 689
Entomology: Agricultural, A Textbook of, Dr. Kenneth M. Smith; Dr. A. E. Cameron, 943; A History of, Prof. E. O. Essig, 655; Applied, 655
Environment and Plant Development. Being "Klima und Boden in ihrer Wirkung auf das Pflanzenleben", Prof. H. Lundegårdh. Translated and edited by E. Ashby, 135
Enzyme-Substrate Reactions, Contraction Constants of, M. Sreenivasaya and H. B. Sreerangachar, 585
Ephedrine and related Substances, K. K. Chen und C. F. Schmidt, 629
Epidemiological Essays, Dr. F. G. Crookshank, 323
Equality, R. H. Tawney, 964
Eros, The recent Opposition of, Prof. J. Hartmann and M. Dartayet, 550
Erzmikroskopische Bestimmungstafeln: Anhang zum Lehrbuch der Erzmikroskopie, Prof. H. Schneiderhohn und Prof. P. Ramdohr, 889
Erzmikroskopie, Lehrbuch der, Prof. H. Schneiderhöhn und Prof. P. Ramdohr, Band 2, 889
Esperanto in Scientific Literature, R. M. Morris-Owen, 969
Ethane, Methane and, The Slow Combustion of, Dr. E. Mardles, 304; Prof. W. A. Bone, 188
Ethnos: or the Problem of Race considered from a New Point of View, Sir Arthur Keith, 624
Ethyl: Alcohol, Synthesis of, Prof. G. T. Morgan and R. Taylor, 38; Radical, Isolation of the, Prof. Paneth and Lautsch, 1007; Thio-aceto-acetate, Synthesis of, Sir P. C. Rây, 189
Ethylene, Oxidation of, Lenher, 912
Ethylmagnesium Bromide, Action of, on *N*-diethylmonochloracetamide, Sou Phou Ti, 199
Eugenics, Positive, in Practice, A. Dachert, 147
Eurymelinæ (Cicadelloidea, Homoptera), Biology and Morphology of the, J. W. Evans, 387
Eurytemora thompsoni, A. Willey: a New European Record, A. G. Lowndes, 967
Everest, Oxygen and, N. E. Odell, 1037; Dr. R. Greene, 893

Evolution: revealed by Palæontology, The Principles of, Prof. H. F. Osborn, 894; Some Examples of, H. Douvillé, 918; The Evidence of Palæontology with regard to, Prof. A. E. Trueman, 990
Evolutionist, A Complete, 429
Ewing's Model of the Magnetic Atom, The Specific Heat of Ferromagnetics and, Dr. J. R. Ashworth, 1003
Exanthematic Fever in Man caused by *Rhipicephalus sanguineus*, J. Troisier and R. Cattan, 422
Expansion, The Phenomena of, Presented by certain Electrolytic Deposits of Metals, C. Marie and N. Thon, 421
Experimentalphysik, Handbuch der. Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 4. Teil 1, 654
Explosion Flames, Photographic Analysis of, Prof. W. A. Bone, 589
Explosions in Closed Cylinders, Kirkby and Wheeler, 729
External Meatal Notch as a Primitive Character, The, Prof. F. Wood Jones, 458
Extinct Volcanoes of Western Scotland, 619
Extracts from Plant Tissues, Polarographic Analysis with the Dropping Mercury Cathode of, J. Babička, 1013
Eyes, Mineral Content of, H. Ramage and J. H. Sheldon, 376

Fabrician Types of Insects in the Hunterian Collection at Glasgow University, The, Coleoptera, Part 1, R. A. Staig, 1034
False Killer Whale in Ceylon Waters, Dr. J. Pearson, 839
Faraday: E. W. Ashcroft, 323; and Austria, Prof. K. Przibram, 351; and British Association Centenaries, The, 328; and Electrical Science in Russia and the U.S.S.R., W. T. Mitkewich, 359; and French Physicists, Prof. P. Brunet, 346; and his Contemporaries, Engr.-Capt. E. C. Smith, 333; and his Discoveries, A Talking Film of, 541; and Marine Boilers, 1031; and Ørsted, Mrs. Kirstine Meyer, 337; as a Botanist, Dr. R. W. Butcher, 820; Centenary: Celebration at Warsaw, 864; Commemorative Meeting, The, 520; Exhibition, 564; Festival, The, Prof. B. Brauner, 352; India's Debt to, Sir C. V. Raman, 362
Faraday's: "Chemical Manipulation", Sir Robert Robertson and B. A. Ellis, 371; Connexion with Switzerland and Swiss Industrial and Economic Development, Prof. C. E. Guye, 349; Discovery of Electromagnetic Induction, The Modern Electric Age in Relation to, Prof. A. E. Kennelly, 356; London Friends, H. G. Wayling, 482; Observations on the Interia of the Mind, Prof. Fraser Harris, 612; Researches: and the United States, Prof. W. R. Whitney, 353; Italian Physicists and, Prof. V. Volterra, 342; on Magneto-Optics and their Development, Prof. P. Zeeman, 365
Fats, Mechanism of the Synthesis of, at the Expense of Glucides, P. R. Bohn, 770
Fédération des Institutions internationales établies à Genève, The, 182
Feeding Stuffs, Home-grown, Dr. H. E. Woodman, 298
Fermentation, Acceleration of, by Algæ and Sea-water, Dr. Pirrone, 419
Ferranti Scholarship of the Institution of Electrical Engineers, award of the, to W. G. Thompson, 581
Ferro-magnetic Test Pieces, Search for Want of Symmetry and Faults in, J. Peltier, 733
Ferromagnetics, The Specific Heat of, and Ewing's Model of the Magnetic Atom, Dr. J. R. Ashworth, 1003
Ferrous Metallurgy, The Elements of, Dr. J. L. Rosenholtz, 626
Fibre Photography, X-Ray, S. Zeidenfeld, 70
Field: Museum of Natural History, Chicago, Prof. S. H. Langdon and Dr. L. Diels elected Corresponding Members of the, 756; Naturalists' Club of Victoria, Jubilee of the, 668
Fifty-two Years of Research, Observation, and Publication, 1877–1920: a Life Adventure in Breadth and Depth. Prof. H. F. Osborn. Edited by Florence Milligan, 625
Fight Against Disease, Autumn Number, 1072
Film Projection, A New System of, Dr. R. T. A. Innes, 1048
Filtration: An Electro-motive Force of, of Abnormal Value, L. Riéty and G. Salager, 1050; The Electromotive Force of, produced by the Ascent of the Sap in Plants, N. Marinesco 422
Finance, Control of, P. B. Whale, 730
Finland, Geological Map of, 728
Firedamp, Causes of Ignition of, by Permitted Explosives, Grimshaw and Payman 867
Fischer and Bulow's Pyrazole, Constitution of, P. J. Drumm, 162
Fishery Research, Advisory Committee on, Prof. G. C. Bourne appointed Chairman of the, 184
Fitzgerald Oscillators, Atoms and Molecules as, Sir C. V. Raman, 795
Flack, Group-Capt. Martin, Sir Leonard Hill, 496
Flame: Propagation in an Electric Field, Prof. W. A. Bone, R. P. Frazer, and W. H. Wheeler, 274; Temperatures, Jones, Lewis and Seaman, 1081
Flash Discharge, Experimental Investigations on the, G. Valle, 806
Flavelle Medal of the Royal Society of Canada, award of the, to Dr. F. G. Banting, 275
Flights from Chaos: a Survey of Material Systems from Atoms to Galaxies, Dr. H. Shapley, 615
Flint, The Age of, M. Burton, 32
Flood-lighting: Display, Lessons from the, P. Good, 822; in London, 439, 487
Flow at High Velocities, Application of (Optical) Interference to some Problems of, R. Tremblot, 733
Flower Anomalies, Some, and their Mode of Inheritance in Primulas, E. Tschermak, 43
Fluid Motion, 654
Fluides, Mécanique des, Prof. H. Villat, 654
Fluorescence: and Free Neutral Radicals, A Connexion between, Dr. W. A. Waters, 905; Mercury Line Spectrum in, Lord Rayleigh, 905
Fluorine: Determination of, as Calcium Fluoride, E. Carrière and Janssens, 806; The Atomic Weight of, Prof. E. Moles, 966; H. S. Patterson, Prof. R. Whytlaw-Gray, and W. Cawood, 375; The Estimation of, P. Mougnaud, 386; The Heat of Dissociation of, Manohar S. Desai, 34
Fluorite Crystals, On Different Habits of, J. Drugman, 42
Flying: as a Career, Major O. Stewart, 961; Cross-Country, Major O. Stewart, 961; -fish, W. L. Calderwood, 216; Fox in Australia, The, F. N. Ratcliffe, 122
Fœcal Pellets, The Form of, and Specific Identification, Prof. R. Macdonald, 68
Fogs of the Meuse Valley, The Poisonous Effect of the, due to Industrial Emanations, F. Bertyn, 422
Food: Investigation Board, Report of the, 1930, 551; The Preservation of, 551
Foot-and-Mouth Disease Research, Prof. J. M. Beattie, 765
Foreign Pests, Against, 85
Forest: Entomology in India, The Study of, 767; Gardens, J. MacDonald, 915; Travel in the Tropics, 1059
Forestry: Vol. 5, No. 1, 935; in the British Empire, The Inception and Development of, Sir Alexander Rodger, 833; Mycorrhiza in Relation to, Dr. M. C. Rayner, 1011; Practice and Research, A. C. Forbes, 31; Research in Great Britain, F. T. Brooks; J. Ramsbottom, 118
Forests, an Imperial Treasure, 145
Formal Logic, Dr. N. R. Campbell, 620
Forthcoming Books of Science, 631
Fortin Barometer, Casella and Co.'s New Pattern of, 732
Fossil: Plants from the Bokkeveld and Witteberg Beds of South Africa, Prof. A. C. Seward, 1012; Timber from the Sydney Harbour Colliery, R. T. Baker, 806
Fowl, Domestic, Inheritance of Body Weight in, N. F. Waters, 846
France, Le littoral du nord de la, et son évolution morphologique, suivi d'un appendice: L'Évolution du rivage du nord de la France et l'activité de l'homme, A. Briquet, 396
Freiburg im Breisgau University: conferment of honorary degrees upon Lord Rutherford, Prof. Siegbahn, and Prof. Goldschmidt, 756; New Laboratory for Physical Chemistry, 833

French Physicists, Faraday and, Prof. P. Brunet, 346
Freshwater Algæ and Phytoplankton from the Transvaal, G. Nygaard, 316
Fritz, John, Gold Medal, award of the, to Prof. M. I. Pupin, 868
Frog's Gastrocnemius, Myothermic Experiments on the, Prof. A. V. Hill, 805
Frost Injury to Plants, R. Newton and W. R. Brown, 911
Fulani of Northern Nigeria, The, G. W. Webster, 874
Fungi: Entomogenous, T. Petch, 874; Higher, Recent Advances in our Knowledge of the, Prof. A. H. R. Buller, 81; Researches on, Prof. A. H. R. Buller, Vol. 4, 944
Fungus: and Scale Insect, Symbiosis of, J. N. Couch, 119; Sexuality of a, Influence of Yeast Extracts and Concentrates of B Vitamins on the, W. H. Schopfer, 734

γ-Rays, Origin of, Lord Rutherford and Dr. C. D. Ellis, 415, 805
Galactic Rotation, Prof. P. Stroobant, 764
Galapagos Islands, Birds of the, H. S. Swarth, 762
Galaxy and the Solar Apex, Rotation of the, shown by the Radial Velocities of the Helium Stars, P. Stroobant, 846
Gallium in the Organism, Distribution of, C. Levaditi, J. Bardet, A. Tchakirian, and A. Vaisman, 466
Gallnuts as a Chemical Reagent, Dr. M. Nierenstein, 1006
Game Reserves in South Africa, New, Prof. H. B. Fantham, 992
Gamma Rays: Absorption of the Penetrating, by Lead Screens 12-30 cm. thick, A. Piccard, E. Stahel, and F. Dony, 846; Cosmic Rays and, Similarity between, Prof. R. A. Millikan and Dr. I. S. Bowen, 582
Gammarus chevreuxi Sexton, A New Locality for, F. T. K. Pentelow, 797
'Gapes' in Chickens, The Treatment of, Dr. W. R. G. Atkins, 585
Gas Reactions, Heterogeneous, Absolute Rates of, B. Topley, 115
Gaseous Explosions, Limits of, M. Neumann and A. Serbinoff, 1040
Gases, Rare, The Thermal Conductivity of the, M. Curie and A. Lepape, 1050
Gassendi and the Transit of Mercury, 787
Gasteromycetes of Australasia, The, G. H. Cunningham (11). The Phallales (pt. 2), 280
Gaster Siccata B.D.H., British Drug Houses, Ltd., 183
Gauss's Investigations on Electrodynamics, Prof. C. Schaefer, 339
Geiger: Counter, A Counting Device for use with the, Dr. J. C. Jacobsen, 674; Counters, A Method of Recording Coincidences between, Dr. J. C. Jacobsen, 185
Gelatine, Condition of sparingly Soluble Substances in, Dr. T. R. Bolam, 222; Dr. S. C. Bradford; Dr. B. N. Desai, 223
Gene, The, and the Theory of Living Structures, Dr. C. B. Bridges, 991
van Gent's Short Period Variable, H. L. Alden, 641
Géographie, La, the name of, changed to *Terre Air Mer*, 671
Geography: Modern, The Groundwork of, an Introduction to the Science of Geography, Dr. A. Wilmore. Third edition, 955
Geological Survey of India, 885
Geologie: der Steinkohlenlager, A. Dannenberg, 816; Lehrbuch der. Teil 3: Geologische Landerkunde (Regionale Geologie), Prof. F. X. Schaffer. Lief. 1, 956
Geology: A Century of, Prof. J. W. Gregory, 531, 857; Historical, Outlines of, Prof. C. Schuchert. Second edition, 513; of Ardnamurchan, North-west Mull and Coll, The, J. E. Richey and others, 619; Physical, Outlines of, Prof. C. R. Longwell, 513; Plants and, 559
Geometric Considerations for Periodal Analysis, M. Lombardini, 1050
Geometrie, Vorlesungen uber Grundlagen der, Prof. K. Reidemeister, 626
Geometry: Analytical, The Elements of, J. I. Craig. Vol. 1: Straight Line and Circle, 52; and Induction, Foundations of, J. Nicod. Translated by P. P. Wiener, 430
Geophysical: Prospecting: The Principles and Practice of, being the Report of the Imperial Geophysical Experimental Survey, edited by A. B. Broughton Edge and Prof. T. H. Laby, 427; Surveying, Modern Methods of, 634
German: Bunsen Society in Vienna, The, Prof. F. Paneth. Translated by Dr. R. W. Lawson, 94; Glaciation, 394; University System, The, 845
Germany, The Dissemination of Scientific Information in, 833
Giant Crescents: a New Stone Age Industry from South Africa, C. van Riet Lowe, 36
Glaciers, The Melting of, Dr. W. J. Humphreys, 911
Glass: Coloured, as a deterrent to House Flies, Chance Bros. and Co., Ltd., 277; -making, The History of, Sir Richard Gregory, 697; Optical, Manufacture, Recent Developments in, W. M. Hampton and W. N. Wheat, 926
Glasses: Modern, at the Science Museum, 765; The Ultra-Violet Transmission of, P. Gilard, 846
Globin with Hæmatins of various Origins, Combination of, J. Roche and A. Bendrihem, 646
Glow: Discharge, Cathode Phenomena in the, Prof. A. Guntherschulze and F. Keller, 840; -worm, Spectrum of, Dr. L. A. Ramdas and L. P. Venkiteshwaran, 726; -worms, Light of, Dr. M. Perkins, 905
Glozel alleged Antiquities, The, 60
Glucuronic Acid, The Pyranoid Structure of, and of Theophylline Arabinoside, J. Pryde and R. T. Williams, 187
Glutathione, Relation of, to Cell Respiration with special reference to Hepatic Tissue, Sir F. Gowland Hopkins and K. A. C. Elliott, 805
Glykoside: Die, Chemische Monographie der Pflanzenglykoside, Dr. J. J. L. van Rijn. Zweite Auflage von Prof. H. Dieterle, 959
Gmelins Handbuch der anorganischen Chemie: Achte Auflage. System-Nummer 59: Eisen. Teil A, Lief. 3; Teil B, Lief. 3, 657; System-Nummer 26: Beryllium. System-Nummer 58: Kobalt. Teil B: Die Ammine des Kobalts, 816
Gold: Colloidal, Magnetism of, V. I. Vaidhianathan and Balwant Singh, 302; -copper: Alloys, Transformations in the, J. L. Haughton and R. J. M. Payne, 554; Solid Solutions, Physico-Chemical Study of the, N. S. Kurnakow and N. W. Ageew, 554; Organic Compounds of, Gibson and Colles, 840; Resources of the World, Dr. W. Cullen, 4
Goldfish, Scales in, Transformation of, Yasumasa Mori, 119
Golgi Substance, Nature of, D. H. Tennant, M. S. Gardiner, and D. E. Smith, 728
Gondwana System, The, Dr. C. S. Fox, 763
Government Chemist, Report of the, 791
Graf Zeppelin, The Arctic Cruise of the, 490
Graham, George, F.R.S., 1673–1751, 435
Granulobacter pectinovorum, Influence of the Associated Bacteria on the Nitrogen Régime of, M. Korsakova and E. Nikitina, 387
Gravels in the New Forest Area, Age of Certain: N. C. Burkitt, 222; H. J. E. Peake, 377
Gravitation and Electricity, The Unitary Theory of, (3), P. Straneo, 1050
Gravity Anomalies, Major E. A. Glennie, 1004
Gray, John, Jubilee Scholarship, award of the, to G. A. Thompson, 805
Great: Britain, Distribution of Urban Population in, Prof. C. B. Fawcett, 1070; Nebula in Orion, Distance of the, Dr. R. J. Trumpler, 73
Greek Mathematics, A Manual of, Sir Thomas L. Heath, 739
Green Auroral Line, Excitation of the, Prof. J. Kaplan, 304
Greenland: Cod, The, 731; Ice-cap, Thickness of the, 296; Whale and Narwhal, Migrations of the, Dr. R. W. Gray, 798
Grid System, Subsidiary Systems in connexion with the, P. V. Hunter, 633
Grignard's Reagent, Action of, on *N*-methyl Pyrrolidon, R. Lukes, 127
Grotte d'Isturitz, La, I: Le Magdalénien de la Salle de Saint-Martin, Dr. R. de Saint-Périer, 988

Grouse, White Hen, A Protected, 102
Guano, Decomposition of, P. R. v. d. R. Copeman and F. J. Dillman, 682
Guarana, The Active Principle of, G. Bertrand and P. de Berredo Carneiro, 555
Guayra Falls of the Parana, The, E. C. Rashleigh, 549
Gun-cottons, a Method of Studying the Decomposition of, at the Ordinary Temperature, M. Lambrey, 1050
Gyroscope, Mechanics of the, Prof. R. F. Deimal, 289

Hadzapi, The, or Watindega of Tanganyika, Miss D. F. Bleek, 379
Haffkine Institute, Report of the, 1929, 220
Hail Storm, June 14, at Doncaster, N. L. Silvester, 35
Hairs: and Wools, Prof. J. Glaister, 227; So-called, in the Ampullar Organs of Fish Ears, Movements of the, R. E. Bowen, 280
Hakemite Tables of Ebn Jounis, The, J. H. Reynolds, 913
Hamilton, Sir William Rowan: Influence of the Work of, on Modern Mathematical Thought, Prof. A. W. Conway, 198; The Mathematical Papers of, Vol. 1: Geometrical Optics. Edited by Prof. A. W. Conway and Prof. J. L. Synge, 167
Hamilton's 'Characteristic Function', A. S. Ramsey, 167
Hanbury Memorial Medal of the Pharmaceutical Society, Presentation of the, to Prof. H. Thoms, 667
Hand-Spinning in Egypt and the Sudan, Mrs. Grace M. Crowfoot, 71
Hannah Dairy Research Institute, Dr. J. D. Stirling appointed to the Staff of, 81
Harrison's, John, Third Time-keeper, 381
Harvard: Museum Expedition to Australia, The, Prof. J. Stanley Gardiner, 457; University Geological Expedition in the Canadian Rockies, 1929 (3), E. Paréjas, 235
Harvester-thresher Machine Trials, Results of, 754
Haulage Accidents in Collieries, Report on, 101
Hawaii, Biological Research in, C. H. Edmundson, C. M. Cooke, jun., and H. E. Crampton, 36
Hawaiian: Lavas, Radium in, C. S. Piggot, 840; Temples, Dr. W. C. Bennett, 497; Volcano Observatory, Work at the, Prof. T. A. Jaggar, 1036
Hawksley, Thomas, Lecture, The, Ll. B. Atkinson, 865
Health: and Hygiene Charts, Dr. Winslow, with Descriptive Booklet by Prof. V. H. Mottram, 113; and Physik: Sixty Centuries of, the Progress of Ideas from Primitive Magic to Modern Medicine, S. G. B. Stubbs and E. W. Bligh, 939; Ministry of, Annual Report of the, 577; Public, To-day and To-morrow, Dr. W. G. Willoughby, 143
Heat: Engine, A New, J. F. J. Malone, 80; Insulation of Furnaces, J. B. Barnitt and R. H. Heilman, 971
Heavens, The, and the Universe, Prof. O. Thomas. Translated by B. Miall, 244
Hele-Shaw's Method, The Extension of, to Cyclic Movements, Mme. V. Popovitch-Schneider, 386
Helgoland und die Zerstorung seiner Felskuste durch das Meer, O. Pratje, 657
Heliometer, Accuracy of the, Prof. de Sitter, 274
Helium and its Properties, Lord Rutherford, 137
Helix aspersa, the Common Snail, Outgrowths from Pieces of, Prof. J. B. Gatenby, 1002
Henry, Joseph, Edith W. Stone, 542
Hermann, Otto, Medal of the Hungarian Ornithological Society, Award of the, to Dr. W. Stone, 670
Herring and Plankton, Distribution of, R. E. Savage, 1079
Herschel's Mirrors, Sir William, Capt. M. A. Ainslie, 1007
High: Frequency and very High Frequency Currents, The Comparative Biological Properties of, J. Saidman, 1013; Resistance, A Spark Method of Measuring, J. A. C. Teegan, 585; Vacua, Dr. S. Dushman, 72; Voltages, Measurement of, Prof. W. M. Thornton, 875
Hiroshima University, Journal of Science of the, Series B, Div. 1 (Zoology), part 1, 64
Hoba (South-West Africa), the Largest Known Meteorite, Dr. L. J. Spencer, 42
Homo sapiens and African Prehistory, E. J. Wayland, 1003
Hong Kong: Horticultural Society, Occasional Notes of the, No. 1, 146; *Naturalist*, May, 331
Hormones, Œstrus-producing, Dr. G. F. Marrian and A. Butenandt, 305
Horticultural Abstracts, pt. 1, 265
Housesteads National Park, A Suggested, Dr. Vaughan Cornish, 934
Huddersfield Technical College, Dr. J. Ward appointed head of the Department of Civil and Mechanical Engineering, 916
Hudson Bay: and Strait, Navigable Conditions in, 995; Region and the North-West Territories of Canada, Development of the, Dr. Brysson Cunningham, 53
Hull: Museums, Additions made to the, 113; University College, Fisheries Research at, 1032
Human: Body, The, Dr. L. Clendening. Second edition, 173; Embryology, Dr. G. Streeter, 804; Genetics, Research in, a Committee to consider, 183; Population, Discussion on, 577; Scale, From the, to the Terrestrial Scale, R. Wavre, 236; Skeleton: The Origin of the, an Introduction to Human Osteology, Dr. R. Broom, 4; Skulls and Bones from the Naga Hills, Dr. B. S. Guha and P. C. Basu, 762
Humanity: Science and, 505; under the Hammer, Lt.-Col. E. Kitson Clarke, 790
Humidity: Control and Entomological Problems, Dr. P. A. Buxton, 1079; in the Upper Air, Graphical Indication of, Dr. C. W. B. Normand, 583
Hunger and Love, L. Britton, 475
Hurricane in British Honduras, 543
Hydraulics, A New Principle of, M. Golaz, 646
Hydrazine: and Semicarbazide, The Oxidation of, by Potassium Iodate, V. Hovorka, 1013; Ultra-Violet Absorption and Raman Effect for, S. Imanishi, 64
Hydrocarbons: Slow Combustion of, Dr. R. Spence, 873; The Peroxidation of, during Combustion in Air, Dr. E. Mardles, 116
Hydro-Electric Power Development, Influence of Modern, on the British Coal Trade, Dr. Brysson Cunningham, 397
Hydrogen: Absorption of, The Critical Increment of the, on Amorphous Carbon at 400°-520° C., Dr. F. E. T. Kingman, 272; Activated Adsorption of, by Zinc and Chromium Oxides, Prof. H. S. Taylor, 636; and Oxygen, Combination of, W. L. Garstang and H. L. Hinshelwood, 1044; Influence of, on Chemical Changes in Silica Vessels, Prof. M. W. Travers, L. E. Hockin, and T. J. P. Pearce, 66; Iodide, Photochemical Decomposition of, Rollefson and Booher, 72; Ion Concentration: of Natural Waters, A New Colorimetric Method for measuring the, Daphne L. Coulston, 316; of Sea-water, Variations of the, Daphne L. Coulston, 316; The Measurement of, Dr. J. Grant, 852; -Nitrous Oxide Flame, Spectrum of the, Prof. A. Fowler and J. S. Badami, 881; Resonance Spectrum of, Prof. K. R. Rao and J. S. Badami, 585; Sulphide and Sulphur Dioxide, Reaction between, Prof. Basrur Sanjiva Rao and M. R. Aswathnarayana Rao, 413
Hydrogenating Cracking of Phenols, Mode of Action of Dehydrating Catalysts in the, A. Kling and D. Florentin, 1050
Hydrogenation, Catalysed, The Velocity of, A. Kailin and H. C. Hardt, 467
Hydrographic Surveying, Modern, The Physical Basis of, A. L. Shalowitz, 1014
Hydroxylic Compounds, Identification of, Morgan and Pettet, 37
Hygiene Exhibition, An International, at Dresden, 298
Hyperbolics: Elementary, for Technical and other Students; especially adapted to the Requirements of Beginners, M. E. J. Gheury de Bray. 2 vols., 1026
Hyperfine Structure: Isotopic Displacement in, J. H. Bartlett, Jr., 408; of Lines, Charges of Intensity in the, H. Schuler and J. E. Keyston, 911; of Thallium II, Dr. J. B. Green and J. Wulff, 409

Ice: Cooling Effects of, on the Oceans, E. H. Smith, 840; Rinks, Artificial, 489
Iceland, the Petrology of (2), G. W. Tyrrell and M. A. Peacock, 881
Identification Method, A New, Dr. T. Poole, 904
Idu (Japan) Earthquake of Nov. 26, 1930, The, Dr. C. Davison, 552

Illumination: and Tree Growth, Dr. W. R. G. Atkins and Florence A. Stanbury, 191; Congress, The International, 588, 642; Dr. A. R. Meyer elected President for 1934, 643; Device for Microscopy, A New, E. Leitz, 1010; in Factories, Dr. N. Goldstern and Dr. F. Putnoky, 1080
Immunity: Reactions, The Study of Specific Combination in, J. R. Marrack and F. Campbell Smith, 1077; Studies in, Prof. J. M. Beattie, 888
Imperial: Bureau of Soil Science, resignation of the Deputy Directorship of the, by Dr. A. F. Joseph, 220; Cancer Research Fund, Report of the, 931; Horticultural Conference, Proceedings of the, 220; Institute, Annual Report, 16; Sugar Cane Research Conference, 1931, 160
India: Archæological Service in, Proposed Changes in the, 216; Education in, in 1928–29, 197; Entomology in, The Study of, 767; Geological Survey of, 885; Irrigation in, 1928–29, 37; Lectures on the Races and Cultures of, 216; Survey of, Report of Map Publication and Office Work of the, 1929–30, 30; Zoological Survey of, 849
Indian: Archæology in Eastern Canada, W. J. Wintemberg, 1005; Butterflies, Mimicry in, Dev Raj Puri, 459; Coal, Utilisation and Conservation of, C. H. McCale, 219; Education Problem, The, J. C. Ghosh, 681; Ethnography, 50; Insects, Catalogue of, Part 18, H. E. Andrews, 867; Institute of Science: F. N. Mowdawalla appointed Professor of Electrical technology in the, 197; Extension of Service of Dr. M. O. Forster as Director; appointment of Dr. V. Subrahmanyan as Professor of Biochemistry, 1049; *Journal of Veterinary Science and Animal Husbandry*, Part 1, 299; Mosses, Census of, P. Brühl, 182; Place-names, Rai Bahadur Hira Lal, 839; Terracottas, K. de B. Codrington, 414
Indians: of Pecos Pueblo: The, a Study of their Skeletal Remains, Dr. E. A. Hooton, and others, 740; We, the Passing of a Great Race. Being the Recollections of the last of the Great Indian Chiefs, Big Chief White Horse Eagle, as told to Edgar von Schmidt-Pauli. Translated by C. Turner, 891
India's Debt to Faraday, Sir C. V. Raman, 362
Indium and Thallium, Arc Spectrum of, Fine Structure in the, Dr. A. L. Narayan, 675
Indo-China, the Tectites of, A. Lacroix, 386
Industrial: and Social Economics, 773; Problems of To-day, Some, S. Rowntree, 331
Industry: and Rationalisation, Research in, A. Y. Enstrom, 122; Creative Science and, 317; University Training in Relation to, 1017; Value of Research Methods in, Steatite and Porcelain Products, Ltd., 1033
Infection by Air, Experiment on, A. Trillat, 235
Infections: Ectromelia, The Causative Organism in, J. E. Barnard and W. J. Elford, 917; Diseases, The Problem of making Conditions unsuited to, Prof. N. J. G. Smith, 801
Infra-Red: Radiation from an Engine, An Investigation of, S. Steele, 185; Rays, Therapeutic Uses of, W. A. Troup, 953
Insect-borne Diseases, Disappearance of, from Britain, Dr. Ll. Lloyd, 798; Control in the United States and Canada, 146; Metamorphosis, Effects of Inadequate Feeding on, C. Dover, 303; Dr. Hem Singh Pruthi, 869; Relations of Plant Virus Diseases, Dr. Kenneth Smith, 915; Vectors and Virus Diseases of Plants, Dr. K. M. Smith, 379
Insects: and Climate, 689; specially Injurious to Cultivation in French Switzerland, J. and L. Deshusses, 467
Instinct and Intuition: a Study in Mental Duality, G. B. Dibblee, 51
Instituts Nationaux à l'Étranger, The Organisation and Activities of, 63
Insulin: Molecular Weight of, Sjogren and Svedberg, 380; Therapy, British Drug Houses, Ltd.; Allen and Hanburys, Ltd., 461
Intelligence, Environment, and Heredity, Prof. R. W. Wilcocks, 801
Interferential Level, An, without an Air Bubble, C. Fabry, 466, Internal: Combustion Engine: Power and the, Prof. W. E. Dalby, 886; The, and its Performance, W. A. Tookey, 634; The High-speed, H. R. Ricardo. New Edition, 886; Secretion, The Physiology of, Sir E. Sharpey-Schafer, 437, 441
International: Aspects of Agriculture, 597; Astronomical Union (Union Astronomique Internationale) Report of Commission 3: Atlas céleste, E. Delporte, 690; Bibliographical Guide, Forthcoming, 936; Congress for the Testing of Materials, 643; Dr. W. Rosenhain elected President for 1935, 644; Congress of Pure and Allied Chemistry, the Forthcoming, 901; Congress of the History of Science and Technology, The, Dr. T. Greenwood, 77; Council of Scientific Unions, Dr. G. Hale elected President of the, 111; Dairy Congress, The Ninth, 145; Geological Congress, Postponement of the, till 1933, 61, 698; Illumination Congress, The, 588, 642; Dr. A. R. Meyer elected President for 1934, 643; Institute of African Languages and Cultures, Grant to the, by the Rockefeller Foundation, 265; Agriculture, The, Dr. A. Hobson, 737; Polar Year, A Second, 754; Union for Geodesy and Geophysics. Section of Terrestrial Magnetism and Electricity. Comptes rendus de l'Assemblée de Stockholm, 1035; Union of Physics, Brussels Meeting, 1931, 485; Standards of Lighting, 1083
Intestinal Juice and of the Pancreatic Juice, The Proteolytic Ferments of the, E. Le Breton, F. Mocoroa, and E. Stulz, 422
Intrammon and Locron, Two New Reagents, 1035
Iodide, The Oxidation of, by Persulphate, King and Jacobs, 121
Ionised Gases and the Working of Valves with Positive Grid, and V. Ionescu, 882
Ions, Negative: Prof. H. D. Smyth, 677; Photoelectrons and, Dr. J. L. Hamshere, 871
Irish Radium Committee, Report for 1930, 756
Iron and Steel, Non-Metallic Inclusions in, Dr. C. Benedicks and H. Lofquist, 856; Compounds in Yeast Complex, Oxidation Reduction Potential of, T. B. Coolidge, 223; Dipped into Aerated Saline Solutions, the Protection by Cathode Polarisation, E. Herzog and G. Chandron, 882; Nitride, Atomic Hydrogen occluded in, Shun-ichi Satoh, 457; The Passivity of, U. R. Evans, 1062
Islam, Sociology of, An Introduction to the, R. Levy, 951
Isotope Effect in the Band Spectrum of Lithium Hydride, Prof. G. Nakamura, 759
Isotopes: of Lead: Nuclear Moments of the, Relative Values of the $g(L)$ Factors of Pb(207) and Tl, Prof. J. C. McLennan, M. F. Crawford, and L. B. Leppard, 301; of Lithium, Sodium, and Potassium, K. T. Bainbridge, 876
Isotopes, Prediction of, H. L. Johnston; H. C. Urey, 498
Italian: Physicists and Faraday's Researches, Prof. V. Volterra, 342; Royal Geographical Society, Gold Medal and Diploma of the, Presentation of, to Sir Hubert Wilkins, 184
Ives, Frederick, Medal of the Optical Society of America, award of the, to Prof. T. Lyman, 834

Janssen, Jules, 1824–1907, 239
Japan, Larval Freshwater Shrimps from, Dr. Zu Yokoya, 874
Japanese: Earthquake of 1923, The, Dr. C. Davison, 989; Morning Glory, Genetics of, Yoshitaka Imai, 497; Nematodes, Dr. Shigemoto Imamura, 586
Jaws and Teeth, Evolutionary Tendencies in the, Prof. G. Elliot Smith, 501
Jeanne d'Arc, The Trial of, a Complete Translation of the Text of the Original Documents, with an Introduction, by W. P. Barrett, 284
Jet-wave Rectifier, The, J. Hartmann, 156
Jewels, Pivots and, V. Stott, 273
Joan of Arc, The Psychological Problem of, 284
Jolliffe and Banks, Contractors, The Work of, H. W. Dickinson, 698
Joshua: Judges, Prof. J. Garstang, 938
Jumping Negative Glow, The, W. A. Leyshon, 795
Jungfraujoch Scientific Station, The, 817
Jungle-fowl at the Zoological Society's Gardens, 180

Jupiter: Rapid Current on, B. Peek, 192; The Faint Outer Satellites of, Prof. M. Wolf, 912
Jupiter's Satellites, Mutual Eclipses of, 876

Kansas Permian Insects, Dr. R. J. Tillyard, 414
Kaolin Minerals, C. S. Ross and P. F. Kerr, 875
Karité Butter, Composition of, J. Bougault and G. Schuster, 682
Katwe Crater-lake, The, Uganda, E. J. Wayland, 977
Kelvin Lecture, Prof. W. L. Bragg, 210, 248
Kelvin's "On the Clustering of Gravitational Matter in any Part of the Universe", Dr. M. C. Grabham, 793
Kenya: Colony, The Stone Age Cultures of, Dr. L. S. B. Leakey. With Appendices by J. D. Solomon, C. E. P. Brooks, A. T. Hopwood, H. C. Beck, and M. Connolly, 1019; Early Man in, 1019
Keratin Molecule, Constitution of the, J. B. Speakman and Mercia C. Hirst, 1073
Kew, Royal Botanic Gardens, J. S. L. Gilmour appointed assistant director of the, 756
Kidney, Work of the, in the Production of Urine, H. Borsook and H. M. Winegarden, 83
Kikuyu Girls, The Marriage of, Dr. L. S. B. Leakey, 696
Kilimandjaro: Der, sein Land und seine Menschen, Dr. W. Geilinger, 956
Kish, Human Remains from, Dr. L. H. Dudley Buxton and D. T. Rice, 798
Knowledge: A New Summary of, Prof. F. S. Marvin, 937; Modern, An Outline of, edited by Dr. W. Rose, 937
Kohle: Der Chemie der, Dr. W. Fuchs, 1024; Entstehung, Veredlung und Verwertung der, W. Petrascheck and others. Herausgegeben von Prof. K. A. Redlich, Prof. J. C. Breine und H. Tropsch, 1024
Krypton and Xenon, F. J. Allen and R. B. Moore, 380

Labrador, Coast of, Uncharted State of Part of the, Sir Wilfred Grenfell, 635
Lake: Baikal, Some New Marine Infusoria Symbiotic in Molluscs of, E. Cheisin, 163; Gusinœ, Transbaikalia, Periodic Variations in the Level and in the Chemical Composition of the Water of, A. Zachvatkin, 422
Lancashire and Cheshire Coal Research Association, opening of New Laboratories of the, 580
Lange (Prof. J.), translated by Charlotte Haldane, Crime as Destiny: a Study of Criminal Twins, 630
Lankester, late Sir Ray, Work of the, Prof. E. S. Goodrich, 64
'Lapides palmati', The, mentioned in the "Historia Naturalis" of the Elder Pliny, Dr. K. C. Bailey, 672
La Tène Spear-head from the Thames, A late, T. D. Kendrick, 586
Lavoisier, Priestley and, Sir Philip Hartog, 797
Law, Oriental and Tropical, The Study of, 265
Lead: Alloys: Effects of Cold-rolling and of Heat-treatment of some, H. Waterhouse and R. Willows, 502; The Spectrographic Assay of some, D. M. Smith, 554; and Iron, Penetrating Corpuscular Radiation in, Absorption and Diffusion of the, B. Rossi, 806; Isotopes of, Nuclear Moments of the, Relative Values of the $g(I)$ Factors of Pb(207) and Tl, Prof. J. C. McLennan, M. F. Crawford, and L. B. Leppard, 301; The Spectrographic Assay of some Alloys of, D. M. Smith, 802
Leaf Fall in the Tropics, R. E. Holtum, 798
Leather Crafts Manual, Ivy Evelyn Norman and P. I. Smith, 1060
Leathers, Examination of Dyed, in Cases of alleged Dermatitis, T. Callan and N. Strafford, 733
Leeds University: Additional Grant by the West Yorkshire Coal Owners' Association, 41; conferment of Honorary Doctorates, 80; institution of a Diploma in Public Administration, 278
Leibniz: The Monadology of, with an Introduction, Commentary, and Supplementary Essays, Dr. H. Wildon Carr, 136
Leicester Museum and Art Gallery, Extension of the, 936
Lemna: Chemical Composition of, as a Specific Character, V. Vernadskij and A. Vinogradov, 770; The Chemical Composition of, as Characteristic of the Species, V. Vernadskij and A. Vinogradov, 882
Lens, The Calculation of a, G. Vitali, 1050
Lepidocyclina, *L. hamiltonensis*, and *L. howchini*, New Species of, F. Chapman and Irene Crespin, 683
Lepidosiren, The Double Lateral Line of, J. T. Cunningham, 377
Lepomis, Relative Effectiveness of Spectral Radiation for the Vision of the Sun-fish, H. Grundfest, 555
Let's Help! a Collection of Good Causes, Sir Charles Bright, 989
Levigator with a Motionless Liquid Medium, A. E. Joukowsky, 734
Liapounov, A. M., 1857–1918, A. J. Pressland, 138
Lichenin, Prof. J. Reilly, M. Hayes, and P. J. Drumm, 162
Life: and Matter, Sir Peter Chalmers Mitchell, 723; Outlines of General Biology, Sir J. Arthur Thomson and Prof. P. Geddes. 2 vols., 1056; Science and Philosophy of, Prof. J. Ritchie, 1056; The Origin of, G. Rumbold. Second impression, 243
Light: Intensities, The Translation of, into Sound Intensities, G. Fournier, 234; Intensity in Two Common Vegetation Types in Tropical Africa, Photochemical Measurements of, J. Philip, J. D. Scott, and J. Y. Moggridge, 162; Quanta, Spin of, Sir C. V. Raman and S. Bhagavantam, 727; Scattered by Liquids, The Fine Structure of Spectral Lines of, S. Rafałowski, 495; -scattering: Doppler Effect in, Sir C. V. Raman, 636; in Liquids, S. Venkateswaran, 870; Spin of, Experimental Demonstration of, Sir C. V. Raman and S. Bhagavantam, 576; The Angular Momentum of, Sir C. V. Raman, 545; The Deflection of, in the Sun's Gravitational Field, Prof. E. Freundlich, 993; The Penetration of, through Successive Layers of Tissue Paper, Dr. W. R. G. Atkins, 545; Transmission through Fog, H. G. Houghton, 1043; Velocity of: Dr. V. S. Vrkljan, 269; from the Spiral Nebulæ, G. Strömberg, 587
Lighting: International Standards of, 1083; Units, Testing of Combinations of, D. C. Rose, 1034
Lightning: Ball, Charged Aerosols and, W. C. Reynolds, 584; Branching of, Dr. B. F. J. Schonland and Dr. T. E. Allibone, 794; Major J. L. P. Macnair, 969; Correlations between the Field Changes due to, and the Appearance of the Flashes, E. L. Halliday, 200; Discharge, Duration and Magnitude of a, R. S. J. Spilsbury, 872; Phenomena, Dr. B. F. J. Schonland, 799; Unusual, H. E. Beckett and A. F. Dufton, 189; Capt. C. J. P. Cave, 378
Liming and Fertility, 1080
Limnological Laboratory, Reports from the, (2), R. Southern and A. C. Gardiner, 1013
Limonites, Artificial Magnetisation of, F. Loewinson-Lessing, V. Mitkevitch, amd A. Turcev, 127
Linear Partial Differential Equations, An Operational Method for the Solution of, W. O. Kermack and W. H. McCrea, 882
Linnæus, The Influence of, upon Gilbert White, Dr. K. Hagberg, 332
Linseed Oil, Composition of, N. E. Cocchinaras, 1086
Lion Farm, A, at El Monte, U.S.A., 578
Lipetsk Area, The Origin of the Ferrous Deposits in the, A. Archangelskii and D. Perkin, 163
Lipoid Nephrosis: Blood Serum in, Some Physical Properties of the, C. Achard and A. Boutaric, 315; The Physical Properties of the Serum Proteins and of the Hydropic Serosities in, C. Achard, A. Boutaric, and A. Arcand, 646
Liquation Phenomena in a Coinage Bronze, A. Borloz, 734
Liquid: Drops in Electric Fields, Dr. W. A. Macky, 799; Mixtures, Diamagnetism of, V. C. G. Trew and Prof. J. F. Spencer, 152; Dr. H. Buchner, 301; Prof. E. van Aubel, 455; S. Ramachandra Rao and G. Sivaramakrishnan, 872
Liquids, Viscosity of, Prof. G. W. Stewart, 727; Prof. E. N. da C. Andrade, 835
Lister Institute: Dr. T. F. Macrae appointed a Research Student in Biochemistry at the, 197; Report for 1931, 1009
Lithium: Constitution of, Dr. F. W. Aston, 149; Hydride, Isotope Effect in the Band Spectrum of, Prof. G. Nakamura, 759; Metallic, The Excitation Potentials of, Dr. H. W. B. Skinner, 114

Lithothamnion in the South Indian Cretaceous, Occurrence of, Prof. L. Rama Rao, 225, 873
" Live and let Live ", 329
Liverwort, A, as Pioneer on Burnt Forest Land, 37
Load-gauge, A remote Electrically Recording, for Wheel-impact Measurements, Dr F. Aughtie, 918
Lobatsi-Linokana Area, The Herpetological Fauna of the, J. H. Power, 126
Locomotive Laboratory, A, 63
Locomotives, Articulated, Prof. L. Wiener, 289
Locron, Intrammon and, two new Reagents, 1035
Logarithmic Potential, Certain Problems on the Limits of the Theory of, E. Okhlopkova, 43
Logarithms, Addition-Subtraction, to Five Decimal Places, L. M. Berkeley, 91
Logaritmer of Antilogaritmer, Femcifrede, A. K. Erlang, Udgivet ved R. E. H. Rasmussen, 91
Logic: Formal: A Treatise of, its Evolution and Main Branches, with its Relations to Mathematics and Philosophy, Prof. Jørgen-Jørgensen. 3 vols., 1021; The Development of, Dr. T. Greenwood, 1021; Textbook of, Prof. A. Wolf, 6
L'Ologénèse: nouvelle théorie de l'évolution et de la distribution géographique des êtres vivants, Prof. D. Rosa. Adapté de l'italien par l'auteur, 429
London: and the Advancement of Science, 687; and the British Association, 687; City of, Science in the, Engr.-Capt. E. C. Smith, 515; Mathematical Society, election of officers, 868; Skull, The, C. N. Bromehead, 118; University: Bequest by J. F. H. Knight, 80; Conferment of a Doctorate, 124; Prof. C. Burt appointed Professor of Psychology at University College; renewal of the Sir George Jessel Studentship in Mathematics to T. E. Garstang; and award of the same Studentship to H. Kestelman, 161; conferment of Doctorates, 313; Dr. F. C. Benham appointed University Reader in Commerce, 804; R. J. V. Pulverstaft appointed University Reader in Pathology; conferment of Title of Reader on Dr. Nora Edkins, 805; conferment of Title of Professor on F. W. Twort, Dr. H. A. Harris, and Dr. F. A. P. Aveling, and that of Reader in Eugenics on Miss E. M. Elderton, 975; conferment of Honorary Doctorates, 1011
Longshaw Estate, Acquisition of the, by the National Trust, 29
Lord Mayor's Show, Progress of Industry aided by Science illustrated in the, 824
Loudspeaker Frequency Response Curves, Subjective Interpretation of, in terms of Loudness, D. A. Oliver, 268
Loud Speakers, Lanchester's, 669
Low Temperature Carbonisation Test, 841
Lubricating Layers, Adhesion of, to Metals, A. Boutaric and R. Amiot, 882
Ludicrous, The Paradox of the, Prof. S. S. Seward, 988
Lunar Circles, 416

d-Mannitol and *d*-Mannose, An X-ray Examination of, G. W. McCrea, 882
d-Mannose, The Oxidation Products of, by Ammoniacal Copper Oxide in the presence of Air, at the Ordinary Temperature, J. Parrod and Mlle. Y. Garreau, 1050
Macdonnell Ranges, The, C. T. Madigan, 1006
Machine Drawing and Design: a Textbook of Intermediate Standard for Engineering Students, W. Abbott, 962
Magdalenian Deposits near Frangy (Haute Savoie), Discovery of, A. Jayet and G. Amoudruz, 1087
Magical Belief and Practice, 204
Magnesium: Alloys, Protection of, against Corrosion, H. Sutton and L. F. Le Brocq, 502; Pure, Preparation of, by Sublimation, J. Hérenguel and G. Chaudron, 1043
Magnetic: Birefringence, A New Type of, Sir C. V. Raman and S. W. Chinchalkar, 758; Field, Alternating High-Frequency, A Method of Measuring an, F. Esclangon, 882; Phenomena: an Elementary Treatise, Prof. S. R. Williams, 623; Polarisation, Rotatory, Prof. E. van Aubel, 1004; Poles, Isolated Quantised, Prof. O. W. Richardson, 582
Magnetisation, Energy of, A New Relation between Electrical Resistance and, Prof. W. Gerlach and E. Englert, 151
Magnetism: and Electricity: School Certificate, Dr. H. Toms, 431; E. Nightingale, 959; Electricity and, A Connexion between, Dr. P. A. M. Dirac, 586; Modern Views on, Prof. W. Peddie, 623
Magneto: -Electric Saturation Effect, The, Dr. O. E. Frivold and S. Koch, 675; -Optics and their Development, Faraday's Researches on, Prof. P. Zeeman, 365
Maize: in South Africa, A. R. Saunders, 1060; Supernumerary Cell Divisions in, G. W. Beadle, 191
Maladies, L'Esprit et ses, Dr. M. Nathan, 6
Malaria in South Africa, Prof. N. H. Swellengrebel, 497
Malarial Infection in Human Beings, The Prevention of, Col. S. P. James, W. D. Nicol, and P. G. Shute, 404
Malaya, Rubber Research Institute of, Report of the, 880
Malayan *Aleurites Montana*, Oil from, and the Properties of Hong Kong oil, T. H. Barry, 1086
Maleic Acid into Fumaric Acid, A Possible Transformation of, H. Saini and J. Weiglé, 235
Mallard, Eclipse Plumage in the, Violet K. Tallent, 672
Mammals: Certain Extinct, The Auditory Region in, Dr. van der Klaauw, 910; of an Island Group (Pityusa), Dr. O. Koller, 414
Mammoth Remains, Fossilised, near Nottingham, 993
Man: and the Primates, Prof. A. H. Schultz, 1043; and the Stars, Prof. H. T. Stetson, 615; Early, His Origin, Development, and Culture, Prof. G. Elliot Smith, Sir Arthur Keith, Dr. F. G. Parsons, M. C. Burkitt, H. J. E. Peake, Dr. J. L. Myres, 951
Manchester University, conferment of honorary degree on Prof. E. Fiddes and Prof. F. E. Weiss, 916
Manganese, An Electro-Colorimetric Method for the Determination of Small Quantities of, K. Nenadkevic, 770
Mann und Weib: Die Beschneidung bei, ihre Geschichte, Psychologie und Ethnologie, F. Bryk, 91
Manoa, Social Organisation in, Miss Margaret Mead, 414
Man's: Family Tree, The Construction of, Sir Arthur Keith, 590; Remote Ancestry, Prof. G. Elliot Smith, 4
Manured or Artificially Fertilised Soil, Biological Value of the Products of, G. Tallarico, 595
Marine: Algæ from the Pacific, W. A. Setchell and N. L. Gardner, 191; Biology: and the Problems of the Fishing Industry, The Correlation between, Dr. C. von Bonde, 801; Contributions to, 172; Boiler Design: Charts and Data on, a Summary of the Standard Formulæ in Chart Form with Tables and Notes, H. C. Walker, 962; Boilers, Faraday and, 1031; Engineers, Institute of, *Transactions* of the, 63; Fauna of the Plymouth District. Second edition, 936
Marugin Warfare, W. L. Warner, 910
Mason and Dixon's Line, Col. T. T. P. Luguer, 995
Massachusetts Institute of Technology, Research Work at the, 384
Mass Production, Sir Eric Geddes, 182
Materials: and Structures: a Text-book for Engineering Students, Dr. E. H. Salmon. Vol. 1: The Elasticity and Strength of Materials, 617; Strength of, Prof. S. Timoshenko. 2 parts, 617
Mathematical: Analysis, Numerical, Prof. J. B. Scarborough, 962; Ancestry, Our, Prof. H. W. Turnbull, 739
Mathematics: Actuarial, An Elementary Treatise on, H. Freeman, 286; Elementary, Craftsmanship in the Teaching of, F. W. Westaway, 950; for Actuaries and Others, Dr. J. Wishart, 286; The Foundations of, and other Logical Essays, F. P. Ramsey. Edited by R. B. Braithwaite, 620; The Teaching of, 950
Mathématique, Leçons sur la théorie, de la lutte pour la vie, Prof. V. Volterra. Rédigées par M. Brelot, 963
Mathematischen Physik und Technik, Angenäherte und symbolische Lösung der Differentialgleichungen der, Prof. N. M. Kryloff, 963
Matriarchy in the Malay Peninsula and Neighbouring Countries, G. A. de C. de Moubray, 624
Matter: and Radiation, Prof. F. G. Donnan, 290; Life: Mind: A. Eagle; W. W. L., 906; Dr. W. D. Lighthall, 907; Dr. M. Copisarow, 1042; The Annihilation of, Sir James Jeans, 100, 103; The Properties of, W. H. Spikes, 396

Maxillo Facial Correlations, A. L. Perier, 734
Maxwell: James Clerk, Centenary of the birth of, 487, 604; a Commemorative Volume, 1831–1931. Essays by Sir J. J. Thomson and others, 607; and Modern Theoretical Physics, Prof. Niels Bohr, 691
Measurement: Standards of, their History and Development (Guthrie Lecture), Sir Richard Glazebrook, 17
Mécanique, Exercices de, H. Beghin and Prof. G. Julia. Tome 1, Fasc. 2, 514
Mechanics, Intermediate, D. Humphrey. Vol. 2: Statics and Hydrostatics, 244
Medical: Pioneers in Science, Dr. D. F. Fraser-Harris, 864; Research Council: appointment of a Therapeutic Trials Committee, 217; Lord Dawson of Penn and Prof. E. Mellanby appointed members of the, 184; Tables of the Registrar-General's Statistical Review, 1930, 936
Medicinal Ions, The Elective Fixation of, by the Electro-Magnet, D. la Tour du Pin, 199
Medicine: Curative, Science and (Stephen Paget Memorial Lecture), Dr. H. H. Dale, 499; History of, 939; in Massachusetts, A Brief History of, Dr. H. R. Viets, 135
Mediums, Some Modern, T. Besterman, 92
Medizin des Rinascimento, aus der, An der Hand des "Leben von Benvenuto Cellini" nach der Übersetzung Goethes, Prof. P. Strassmann, 173
Megascolides australis, the Largest Known Earthworm, C. Barrett, 669
Melanism in Moths, Inheritance of, A. W. McKenny Hughes, 496
Mellon Institute, The, 418
Membrane Behaviour, Studies in, (1), W. L. Francis, 1049
Mendelian Factor for Flower Colour, Chemical Effect of a, Hon. Mrs. M. W. Onslow, 373
Mental: Defective: The, a Problem in Social Inefficiency, Dr. R. J. A. Berry and Dr. R. G. Gordon, 954; Deficiency, Sterilisation and, 129; Diseases, Joint Board of Research for, Birmingham, Report of the Laboratory of the, 407; Nursing (Simplified), Dr. O. P. N. Pearn, 892
Mercury: Band Spectrum in Fluorescence, Lord Rayleigh, 724; Cadmium, and Zinc, The Forbidden Lines in the High Frequency Discharge of, J. Okubo and E. Matuyama, 224; Derivatives of Divalent Bromo-Phenols, M. Amadori, 647; in Vegetable Tissues, A Method for detecting, D. Petri, 647; Large Drop of, Measurements of the Height of a, R. S. Burdon, 456
Mercury: Motion of the Perihelion of, Dr. J. K. Fotheringham, 841; Photographs of, Mme. G. Camille Flammarion, 82; Transit of, Gassendi and the, 787
Metacresol, The Direct Bromination of, G. Darzens and A. Lévy, 555
Metallurgical Spectrum Analysis, A. A. Fitch, 802
Metals: Dissolved, Estimation of, F. Twyman and C. S. Hitchen, 587; Electrical Conductivity and Optical Absorption in, E. H. Hall, 555; Impurities in, their Influence on Structure and Properties, Dr. C. J. Smithells. Second edition, 627; Institute of, Journal of the. Vol. 44, 514; Microscopic Examination of, by Polarised Light, Dr. M. v. Schwarz, 800; of the Hydrogen Sulphide Group, Separation of the Earth Acids from, E. F. Waterhouse and W. R. Schoeller, 845; Overstrain of, and its Application to the Auto-Frettage Process of Cylinder and Gun Construction, Major A. E. Macrae, 49; The Spectra of, obtained by Explosive Reactions, T. Tucholski, 126
Meteor, A Daylight, 461
Meteoric: Hypothesis for the Origin of the Solar System, Abbé Moreux, 729; Stone from Suwahib, Arabia, A New, W. Campbell Smith, 977
Meteorite Craters: at Henbury, Central Australia, The, A. R. Alderman, 977; in Central Australia, Contents of, 994
Meteorological: Developments important to Agricultural Research, E. G. Bilham, 667; Instruments, Negretti and Zambra's, 670; Office, Annual Report of the Director of the, 753
Meteorology, A Century of, Sir Napier Shaw, 925
Meteors, The Leonid, 841, 912, 972, 1007
Methane and Ethane, The Slow Combustion of, Prof. W. A. Bone, 188; Dr. E. Mardles, 304
Methyl: Alcohol, Heat of Combustion of, F. D. Rossini, 555; -Guanido-Oxalic Acid (Creaton) as a Constituent Part of Muscles, V. Gulevitch, 127
Methylene Blue: in Gelatin, Diffusion and Cataphoresis of, Mlle. Suzanne Veil, 1013; Stain for Yeast Cells, Fink and Weinfurtner, 306
Mexican: Hairless Swine, E. Roberts and W. E. Carroll, 866; Jacana, Incubation of the, A. H. Miller, 306
Mexico, Ancient, Pottery of, E. Noguera, 459
Micelle, Determination of the Charge of the, Mlle. Sabine Filitti, 386
Michelson-Morley Experiment, Repetition of the, Prof. G. Joos, 729
Microcalorimeter: Adiabatic, Application of the, to the Determination of the Heat of Adsorption and of Vaporisation, W. Swietolawski and Mlle. E. Bartoszewiczowna, 126; An Adiabatic, adapted to the Measurement of the Specific Heat of Solid and Liquid Substances, W. Swietolawski, Mme. M. Rybicka, and Mme. W. Solodkowska, 126
Micro-organisms: Formation of New Stable Races of, under the Influence of X-Rays, G. A. Nadson and G. Filippov (2), 422; (3), 467
Microscopy: A New Illumination Device for, E. Leitz, 1010; Some Recent Developments in, Prof. L. C. Martin, 833
Mikrokosmos, October, 756
Milk Diet for Rats, 306
Milky Way, Beyond the, Sir James Jeans, 592, 821, 825
Mind, On the Nature of, Dr. C. S. Myers, 744
Mineral: Frequencies, Heavy, Accuracy in Percentage Representation of, A. L. Dryden, Jr., 422; Industry, Problems of the, Dr. E. F. Armstrong, 508; Names, New, Dr. L. J. Spencer, 42
Mineralogical Society, election of Officers, 834
Minerals in Modern Industry, Dr. W. H. Voskuil, 508
Mira Ceti, The Theory of the Variability of the Family of, G. Armellini, 646
Mitogenetic Radiation acting on the Multiplication of Bacteria, The Hypothesis of, Mlle. Choucroun, 316
Moissan, Henri, A Monument to, 679
Molecular: Spectrum and the Structure of the Molecule: Simple Relations between the, Dr. H. Deslandres, 199, 315; Weight Determinations, Le Fèvre and Webb, 38
Molecules: Atoms and, as Fitzgerald Oscillators, Sir C. V. Raman, 795; Constitution et thermochimie des, A. et M. Gosselin, 92; Organic, and Surfaces, Collision between, F. O. Rice and H. T. Byck, 228
Molybdenum Trioxide, Crystal Structure of: a Correction, Nora Wooster, 35
Molybdo-octocyanides, G. A. Barbieri, 647
Mongolian Wild Horses at the Zoological Society's Gardens, 792
Moniezia expansa, Life-Cycle of, D. F. Sinitsin, 676
Monohydric Phenols, Application of the Simonis Reaction to, A. Robertson, 908
Monsters: The Mystery and Lore of, with Accounts of Some Giants, Dwarfs, and Prodigies, C. J. S. Thompson, 90
Moon: Eclipsed, The Spectrum of the, J. Dufay, 978; Total Eclipse of the: on April 2, 1931, Observation of the, M. Dehalu, 846; on Sept. 26, 550; Observation of the, of Sept. 26, 1931, made in Haute-Provence, E. Esclangon, 806
Moose-Wapiti Hybrid in Montana, An Alleged, 676
Mordellidæ, New (Coleoptera) in the Collections of the Zoological Museum of the Academy of Sciences, T. Sčegoleva-Barovskaja, 387
Moroccan Anti-Atlas, Presence of the Ordovician in the, A. Bigot and J. Dubois, 555
Moths, Melanism in, Inheritance of, A. W. McKenny Hughes, 496
Mouse, The Laboratory: its Origin, Heredity, and Culture, Dr. C. E. Keeler, 431
Mousterian (Levalloisian) Implements, Derived Early, in the Melt-water Gravels of the Coombe Rock Glaciation, J. P. T. Burchell, 909
Multiple Ionisation and Secondary X-Ray Absorption Edges, A. Sandstrom, 759
Muscovy Ducks at the Dairy Show, 791

Museums: Association, Annual Conference of the, 159; in Great Britain, Progress of, Sir Henry Miers, 330
Musical Sounds, Propagation of, Velocity of, R. de la Boulaye and G. Balme, 646
Mycobacterium cœliacum Gray and Thornton, The Systematic Position of, H. L. Jensen, 280
Mycorrhiza in Relation to Forestry, Dr. M. C. Rayner, 1011
Mysore Tribes and Castes, The, late H. V. Nanjundayya and Rao Bahadur L. K. Ananthakrishna Iyer. Vol. 3, 50

Naga Hills, Human Skulls and Bones from the, Dr. B. S. Guha and P. C. Basu, 762
Nagata's Comet, 1931 *b*, 229, 274, 912
Nansen's Last Journey, 319
Naphthalene Bisulphite Compounds, Researches on the, P. Lantz and G. Mingasson, 315
National: Expenditure, Committee on, Recommendations of the, 215; Ministries of Education, 732; Needs, 809; L. A. Fenn, 909; Needs (II.), 1053; Physical Laboratory: appeal for support of the Froude Laboratory and National Experimental Tank at the, 824; Inspection by the General Board, 74; Opening of new physics building, 14; new physics building at the, Dr. G. W. C. Kaye, 311; Radio Exhibition, The, 553
Nationalism and Science in China, 469, 1035
Native Administration: Anthropology and, 86; in Africa, 685
Natural Scenery, The Poetic Impression of, Dr. Vaughan Cornish, 656
Nature, One Touch of, a Literary Nature Study Reader for Boys and Girls, arranged by Dr. F. W. Tickner, 624
Nautilus, Progress of the, Sir Hubert Wilkins, 439
Naval Architects, Institution of: award of Scholarships, 161; award of the Elgar Scholarship to H. Lackenby and of the Earl of Durham prize to J. A. Price, 420; awards of the, to L. Redshaw and J. Irwin, 768
Neanthropic Man, Relation of, to the Ice Age, J. P. T. Burchell, 879
Nebulæ: Distant, The Velocities of, Hubble and Humason, 1007; Faint, A New Cluster of, Dr. W. Baade, 641
Necturus, Reactions of Dermal Melanophores in, to Heat and to Cold, Elsie H. Field, 163
Negative Images, Preparation of Fine Grain, by Development, A. Lumière and A. Seyewetz, 1086
Nematode Parasite of a Lucanid Beetle, A, J. R. Christie and B. G. Chitwood, 910
Nemertean, A New and Peculiar Marine, from the Australian Coast, Prof. W. J. Dakin and Mahalah G. C. Fordham, 796
Neon-Helium Bands, Dr. M. J. Druyvesteyn, 1076
Neujmin's Comet, 1913 III., Detection of, 587
New: Guinea, Expedition to, Dr. Margaret Mead, 823; South Wales, Mineralogy and Origin of the Natural Beach Sand Concentrate of, H. F. W. Whitworth, 316; Zealand, Science and Agriculture in, 981
Newcomen Society, Report for 1930–31, 932
ng and *np* Ultra-Violet Spectra Refracted by a Doubly Refracting Prism, The Separation of the, A. Brun, 1086
Nickel: -Chromium Alloys, Melting, in Hydrogen, Dr. C. J. Smithells, S. V. Williams, and E. J. Grimwood, 595; -Copper Alloys of High Elastic Limit, D. G. Jones, L. B. Pfeil, and W. T. Griffiths, 502; Ion in Solutions of its Chloride, The various Magnetic States of the, G. Foëx and Mlle. B. Kessler, 315
Nicotine, Excretion of, from the Aerial Parts of the Tobacco Plant, J. Chaze, 82
Nigeria, Anthropology in, P. Amaury Talbot, 285
Nitrate Deposits of California, L. F. Noble, 155
Nitrates: Mechanism of the Reduction of, M. P. Korsakova (3), 387; of Lime, Commercial, C. Matignon, 646
Nitrobenzene: and of Benzene, Melting Points of, Prof. I. Masson, 726; Change of Dielectric Polarisation of, with Temperature, Prof. M. Wolfke and Dr. J. Mazur, 584
Nitrogen: Compounds contained in Primary Tar, Hydrogenation of the, G. Roberti, 735; in Gases, The Direct Determination of, H. R. Ambler, 845; Pentoxide, The Thermal Decomposition of, J. H. Hodges and E. F. Linhorst, 83
Nitrogenous Excretion in Invertebrates, Prof. H. Delaunay, 306
Nitrosodithiocarbamates, L. Cambi and A. Cagnasso, 595
Nitrosyl Chloride, The Hydrolysis of, and of Nitrogen Peroxide by Caustic Potash, A. Perret and R. Perrot, 1086
Nobel Prize: for Chemistry, 1931, award of the, to Dr. C. Bosch and Dr. F. Bergius, 863; for Medicine for 1931, award of the, to Prof. O. Warburg, 789
Noise and its Measurement, Dr. G. W. C. Kaye, 251, 253
Non-ferrous: Metals and Alloys, Application of the Spectrograph to the Analysis of, H. W. Brownsdon and E. H. S. van Someren, 554, 802; Wires, The Drawing of, E. L. Francis and Prof. F. C. Thompson, 554
Nordsudetische Dyas: Die, eine stratigraphisch-palaographische Untersuchung, Prof. H. Scupin, 892
North: -East Coast: Institution of Engineers and Shipbuilders, Annual Report of the, 1070; institution of a Laing Memorial Lectureship, 670; Sea Earthquake, The, Rev. J. P. Rowland, 147; Floor, Deep Trench on the, Prof. J. W. Gregory, 37, 792; -West Australia, Rock-Paintings in, A. P. Elkin, 419; -West India, Eocene Mollusca of, L. R. Cox, 460
Northern Polytechnic, Dr. T. J. Drakeley appointed Principal of the, 124
Nottingham University College, Dr. H. L. Brose appointed Professor of Physics, 81
Nova Pictoris, The Distance of, Dr. Spencer Jones, 121
Novius Organum: Essays in a New Metaphysic, J. C. McKerrow, 562
Nuclear Moments, Prof. R. de L. Kronig and S. Frisch, 228
Nucleus, Quantum-Mechanical Models of a, R. H. Fowler, 453
Nudibranch, A Supposed Primitive Gill-less, Kikutaro Baba, 728
Nuer Customs and Folk-Lore, R. Huffman, 989
Nursery, Health and Education in the, Victoria E. M. Bennett and Dr. Susan Isaacs, 690
Nutrition: and Food Chemistry, B. S. Bronson, 856; *Journal of*, 306; Studies of, The Physique and Health of Two African Tribes, J. B. Orr and J. L. Gilks, 327

Occluded Gases, Influence of, on the Mechanical Properties of Metallurgical Products, L. Guillet, A. Roux, and J. Cournot, 978
Oceanic Bird Wanderers to Ceylon, W. E. Wait, 728
Œnothera, Chromosome Linkage in a Triploid, D. G. Catcheside, 460
Œnothera, Origin of Chromosome Linkage in, Prof. R. R. Gates and D. G. Catcheside, 637
Œuvres scientifiques, J. Janssen. Recueillies et publiées par H. Dehérain. Tomes 1 et 2, 239
"Of Composts shall the Muse disdain to Sing?" Prof. F. L. Engledow, 854
Official Statistics of the United Kingdom, Guide to Current, 266
Ogilvie, Sir Francis, The late, J. C. Smail, 118
Oil: and Petrol from Coal, Dr. C. H. Lander, 900; -Well Drilling, Deep, 93
Oils, Essential, Researches on, Prof. J. Read, 864
Oldoway: Bone Beds, Tanganyika Territory: Age of the, Dr. L. S. B. Leakey, A. T. Hopwood, and Prof. H. Reck, 724; New Yields from the, Dr. L. S. B. Leakey, A. T. Hopwood, and Prof. H. Reck, 1075; Further Discoveries in the, 995; Human Skeleton, The, J. Reid Moir, 797
Ondes et des corpuscles, La Synthèse des, K. K. Darrow, 629
Optical: Glass Manufacture, Recent Developments in, W. M. Hampton and W. N. Wheat, 926; Rotation and Atomic Dimension, D. H. Brauns, 876; Sensitisation, W. D. Bancroft, J. W. Ackerman, and Catharine Gallagher, 846

Orange and Allied Fruits, The Culture of the, Prof. H. C. Powell, 955
Oranges and Arsenates, P. v. d. R. Copeman, 120
Orchids of the South Maitland Coalfields, with description of a New *Dendrobium* from Bullahdelah, H. M. R. Rupp, 279
Ordnance Survey: Report for Year ending March 31, 1931, 867; The Small-Scale Maps of the, Brig. H. S. L. Winterbotham, 997
Ore-Minerals and the Microscope, 889
Organic: Acids in Plants, Nelson and Mottern, 415; and Mineral Compounds, Reactions between, R. de Fazi and A. Hemmeler, 43; Compounds, Downgrade Reactions of, Measurement of the Electricity Liberated during the, J. H. Wolfenden, 69; Gold Compounds, Kharasch and Isbell, 415; Oxides: Dissociable, a Dimethoxyrubrene, C. Dufraisse and R. Buret, 163; The Dissociable, C. Dufraisse and M. Badoche, 503; Syntheses, Vol. 11, 856
Orientator, The, Cooke, Troughton and Simms, Ltd., 102
Oriole, American, Song of an, A. H. Miller, 970
Orpheus: a History of Religions, S. Reinach. Revised and partly rewritten. Translated by Florence Simmonds, 628
Ørsted, Faraday and, Mrs. Kirstine Meyer, 337
Orthoptera Celebica Sarasiniana I., 671
Oscillators with very Short Waves, C. Gutton and G. Beauvais, 1013
Ostrich, A Fossil, from Transbaicalia, A. Tugarinov, 127
Ostwald-Luther Hand- und Hilfsbuch zur Ausfuhrung physiko-chemischer Messungen. Fünfte Auflage, 814
Overhead Transmission Cables, Insulation of, H. O. Austin, 416
Oxford University: the Savilian Chair of Astronomy, Dr. H. Dudden, 681; Dr. H. H. E. Craster elected Bodley's Librarian, 768; Prof. H. H. Plaskett appointed Savilian Professor of Astronomy, 930; gifts from Prof. J. M. Baldwin and the Royal Astronomical Society, 975
Oxidation: by Living Cells, Prof. J. B. S. Haldane, 175; -Reduction Potentials in Bacteriology, L. F. Hewitt, 73
Oxlip, Wild, Segregation of Floral Characters in the, Prof. F. E. Weiss, 305
Oxygen: and Everest: Dr. R. Greene, 893; N. E. Odell, 1037; Consumption, Oscillation in, during the Day and during the whole Life of Invertebrates, K. Michael, 1013; Elementary, An Experimental Study on the Estimation of Traces of, F. Novotny and F. Toul, 1013; Hydrogen and, Combination of, W. L. Garstang and H. L. Hinshelwood, 1044; The Absorption Spectrum of, at High Temperatures, D. Malan, 386
Oyster, Sex-change in the, Prof. J. H. Orton and C. Amirthalingam, 273
Ozone: Photosensitised Decomposition of, by Bromine, J. W. T. Spinks, 548; Ultra-Violet Spectrum of, O. R. Wulf and E. H. Melvin, 763

Pacific Science Congress, the fourth, 1033
Paget, Stephen, Memorial Lecture, Dr. H. H. Dale, 499
Palæolithic: Flint Implements, J. Reid Moir, 767; Man: and the Nile-Faiyum Divide: a Study of the Region during Pliocene and Pleistocene Times, Dr. K. S. Sandford and Dr. W. J. Arkell, 287; in Egypt, 287
Palæontology: Outlines of, Prof. H. H. Swinnerton. Second edition, 173; The Evidence of, with regard to Evolution, Prof. A. E. Trueman, 990
Paläoklimatologie, Dr. F. Kerner-Marilaun, 1025
Palo Alto Tree, The, Miss A. I. Weymouth, 904
Pancreatic Juice, Number and Nature of the Proteolytic Ferments of the, Mlle. E. Lebreton and F. Mocoroa, 199
Pancreatin, Action of, upon different Types of Wool, C. Fromageot and A. Porcherel, 1013
Paper Making: Dr. E. F. Armstrong, 949; The Digestion of Grasses and Bamboo for, W. Raitt, 949
Paracentrotus lividus, Action of Sea Water, in which Carotene has remained, on the Experimental Development of, J. A. Thomas, 978
Paraffin Oil, The Oxidation of, G. Arditti, 882
'Paragutta', A. R. Kemp, 218
Paramagnetic Salts in Aqueous Solutions, The Magnetic Double Refraction of, C. Haenny, 1086
Parasitology, Human, Introduction to, Prof. A. C. Chandler. Fourth edition, 323
Paris: Observatory, Report for 1930, 1081; University, conferment of Honorary Doctorates on Prof. W. B. Cannon and Prof. H. F. Osborn, 936
Parsons, Sir Charles, The Life and Work of the late, Sir Alfred Ewing, 932
Parthénogénèse, La, Prof. A. Vandel, 941
Parthenogenesis, Problems in, Prof. A. D. Peacock, 941
Patent: Litigation, The Cost of, W. H. Ballantyne and H. A. Gill, 790; System, British; Reform of the, 165
Paths, Systems of, A Characteristic Property of, C. H. Rowe, 1086
Peabody Museums of Natural History, 'Special Guides' to the, 113
Peat Fuel Power Station in Russia, A, F. C. Wigham, 406
Peking Man and Stone Implements, 823
Penetrating: Corpuscular Rays coming from Inclined Directions, Measurements on the Absorption of the, Prof. B. Rossi, 408; Rays, Origin of, Prof. Gianfranceschi, 581
Peppermint Oil, Evaluation of the Menthone Content of, Prof. J. Reilly, N. Noonan, and P. J. Drumm, 845
Pereira Medal of the Pharmaceutical Society, Presentation of the, to H. G. Rolfe, 667
Peridote, The Apparent Dispersion of the Optical Axes in, and the Measurement of $2V$, A. Brun, 1086
Periodic Physico-Chemical Phenomena, Dr. E. S. Hedges, 398
Periodicals, The Subject Index to, 1929, 562
Peroxides in the Gases from Internal Combustion Motors, Dumanois, Mondain-Monval, and Quanquin, 43
Perseid Meteors observed in America, 550
Peru: Balsam, The Dry Distillation of, J. Dupont and J. J. Guerlain, 646; from the Air, Lieut. G. R. Johnson. With Text and Notes by R. R. Platt, 172
Petrol-Alcohol-Benzene Mixtures, C. Baron, C. Boulanger, and R. Le Grain, 163
Petunias, Tetraploid and Triploid, Dr. D. Kostoff and J. Kendall, 227
Pflanzenmikrochemie: ein Hilfsbuch beim mikrochemischen Studium pflanzlicher Objekte, Dr. A. Tunmann. Zweite Auflage bearbeitet von Prof. L. Rosenthaler, 953
Pharmacy, School of, of the Pharmaceutical Society, Address to Students of the, Prof. G. E. Gask, 667
Phenological Observations in the British Isles from Dec. 1929 to Nov. 1930, J. E. Clark, I. D. Margary, R. Marshall, Capt. C. J. P. Cave, and L. C. W. Bonacina, 917
Philippines, The Tectites of the, A. Lacroix, 554
Philosophy, A Defence of, Prof. R. B. Perry, 964
Phosphate of Trivalent Manganese and of Aluminium, A. Yakimach, 315
Phosphorescence of the Sea, 843
Phosphoric Acid, The Electrometric Titration of, A. Sanfourche, 82
Phosphorus, Green Flame of, Band Spectrum of the, Dr. E. B. Ludlam, 271
Photoconductance in the Photovoltaic Effect, Rôle of the Phenomena of, R. Audubert and J. Roulleau, 555
Photoelectric: Cells: Gas-filled, Accuracy obtainable with, Dr. W. R. G. Atkins, 550; New Facts ascertainable by means of ordinary, Q. Majorana, 734; Effect, The, R. H. Fowler, 415; Investigations, New, Q. Majorana, 647; Relay, A, Dr. L. Bergmann, 677
Photoelectrons and Negative Ions, Prof. E. M. Wellish, 547; Dr. J. L. Hamshere, 871
Photography, International Congress of, 543
Photon: Evidence for the Spin of the, from Light-Scattering, Sir C. V. Raman and S. Bhagavantam, 114; Dr. G. Placzek, 410; The Spin of the, Prof. M. N. Saha and Y. Bhargava, 870
Photovoltaic Cells, The Rôle of Water in, R. Audubert, 466

Physical Metallurgy Laboratory Manual, Dr. N. E. Woldman, 779
Physico-Chemical Phenomena, The Lower Limit of, Ç. E. Guye, 279
Physics: A Survey of, Prof. F. A. Saunders, 628; Critique of, L. L. Whyte, 964; for College Students, A Survey of, Prof. F. A. Saunders, 134; General, Prof. W. S. Franklin and Prof. G. E. Grantham, 134; in Sound Recording, A. Whitaker, 933; Institute of, Dr. H. R. Lang appointed Secretary of the, and Editor of the *Journal of Scientific Instruments*, 1036; Intermediate, Dr. R. A. Houston, 134; International Union of, Brussels Meeting, 1931, 485; Theoretical, Lectures on, delivered at the University of Leiden, Prof. H. A. Lorentz. Translation by Dr. L. Silberstein and A. P. H. Trivelli. Vol. 3: Maxwell's Theory, Edited by Dr. H. Bremekamp; The Principle of Relativity for Uniform Translations, Edited by Dr. A. D. Fokker, 959
Physiology: General, An Elementary Course in, Part 1: Principles and Theory, Prof. G. W. Scarth. Part 2: Laboratory Exercises, Prof. F. E. Lloyd and Prof. G. W. Scarth, 563; Human Experimental, An Introduction to, Dr. F. W. Lamb, 475
Physique mathématique, Les méthodes de solution approchée des problèmes de la, Prof. N. Kryloff, 963
Phytoplankton from South African Pans and Vleis, F. Rich, 316
Pierce, Lorne, Medal of the Royal Society of Canada, award of the, to Adjutor Rivard, 275
Piezoelectric Quartz Frequency Meter with Synchronous Modulation, A, B. Decoux, 386
Pigafetta, New Gyro-stabiliser for the, 934
Pigeon, Homing, Remarkable Flight of a, 668
Pigment Migration in the Chromatophores of Crustaceans, Control of, E. B. Perkins and T. Snook, 423
Pigmy Right Whale (*Neobalæna*), The, H. M. Hale, 910
Pinnipedia from the Neogene Deposits in Western Siberia, Remains of a Primitive Representative of, J. Orlov, 503
Pit-Dwellings at Kiatuthlanna, Eastern Arizona, F. H. H. Roberts, Jr., 154
Pittsburgh, Air Pollution at, H. B. Meller, 307
Pituitrin: Injected in the Ventricle, The Counteractive Effect of Tribromethanol (Avertin) on the Stimulating Response to, H. Cushing, 422; introduced into the Ventricle, Method of Action of, H. Cushing, 422
Pivots and Jewels, V. Stott, 273
Planet, New Minor, An interesting, 641
Planetary System, Birth of the, Theories of the, Prof. W. de Sitter, 972
Planets, Minor, The numbering of, 800
Plant: Biochemistry: Prof. A. R. Ling, 621; The Principles of, Hon. Mrs. Muriel Wheldale Onslow, Part 1, 621; Breeding in Germany, Dr. Baur, 975; Contents, Adobe Brick Analysis for, G. W. Hendry, 1006; Genetics: Abstracts of Papers on, 65; for Herbage Plants, Imperial Bureau of, *Bulletin* of the, 407; Life through the Ages: a Geological and Botanical Retrospect, Prof. A. C. Seward, 559; Patent, the first, granted by the U.S. Patent Office, 994; Physiology: with reference to the Green Plant, Prof. E. C. Miller, 952; Processes, Physical Attributes in, 240; Virus Diseases: Dr. J. Henderson Smith, 635; Insect Relations of, Dr. Kenneth Smith, 915
Plants: and Geology, 559; Exploring for, D. Fairchild, 52; Life Movements in, edited by Sir Jagadis Chunder Bose, 240; Mortality among, and its bearing on Natural Selection, R. Wetherall, 23; The Phosphorus Compounds of, E. Mnich (6), 279
Platinum, Influence of the Field on the Magnetic States of, Mlle. Paule Collet and G. Foex, 82
Pleistocene Period, Duration of the, G. F. Kay, 586
Pleurodictyum megastomum, The Development of the Tabulate Coral, R. B. Withers, 127
Pluto, Orbit and Mass of, Dr. E. C. Bower, 1047
Poincaré, Henri, Annales de l'Institut, Fasc. 2, Vol. 1, 243; recueil de conférences et mémoires de calcul des probabilités et physique théorique. Vol. 1, fasc. 3, 657
Polar: *Record*, The, July, 581; Year 1932–1933, arrangements for the, Dr. G. C. Simpson, 793
Polarising Microscope, Use of the, in the Determination of Organic Substances, E. Galopin, 734
Polarity and Vapour Pressure, Dr. A. R. Martin, 456
Polonium: A New Gaseous Compound of, Mme. Irène Curie and M. Lecoin, 199; A New Reaction of, M. Haissinsky, 315; in Tartaric Acid Solution, The Electrochemical and Chemical Behaviour of, M. Haissinsky, 199; The Centrifugation of Solutions of, in the Presence of Various Electrolytes, Mlles. C. Chamié and A. Korvezee, 82; The Separation of, and of Protactinium fixed on Tantalum Oxide, F. Reymond and Tcheng da tchang, 386
Polyhedra, Embryology and the Theory of, Prof. D'Arcy W. Thompson, 31
Population: and Production, Prof. E. Cannan, 534, 658; Density and the Optimum for Life, relation between the, and of this to the Sex Ratio, in some Invertebrates, K. Michal, 1013; Problems, 10; Some Problems of, Sir Leonard Hill, 488; Theories of, from Raleigh to Arthur Young: Lectures delivered in the Galtonian Laboratory, University of London, under the Newmarch Foundation, February 11 to March 18, 1929, with two additional Lectures and with References to Authorities, Dr. J. Bonar, 940
Porcelain, A New, without Silica, based on Pure Fluorspar, R. Damiens, 82
Porphyro-quartz of Samshvildo, The Regular Formation of Twins in, G. Laemmlein, 387
Position: in High Latitudes, Determination of, with Particular Reference to Aircraft Observation, C. J. Stewart, 212; Physiological Perception of, 815
Positivismus und reale Aussenwelt, Prof. Max Planck, 289
Posterior: Lobe Extract (Pituitrin), Similarity in the response to, and to Pilocarpine when injected into the Cerebral Ventricles, H. Cushing, 280; Pituitary Extract (Pituitrin), Reaction to, when introduced into the Cerebral Ventricles, H. Cushing, 280
Potassium: β-Radiation of, A Hard Component of the, D. Bocciarelli, 374; Permanganate, Influence of Fluoride Ions upon the Reduction of, W. Pugh, 682; Salts, The Physiological Characteristics of, D. Prianischnikov and V. V. Butkevitch, 163
Potato: Plants affected with Certain Virus Diseases, Cytological Studies of, Phyllis Clinch, 198; Productivity of the, Influence of a Period in the Mountains on the, J. Costantin, P. Lebard, and J. Magrou, 1086
Potatoes, Healthy and Leaf Roll, Respiration of, Dr. T. Whitehead, 967
Potential, The Theory of, R. Wavre (i), 682
Potentilla, *Chrysanthemum* and, Chromosome Multiples in, N. Shimotomai, 72
Potters' Stamps on Terra Sigillata "Samian Ware", Index of, Dr. F. Oswald. With a Supplement, 951
Pottery with Flint Implements of Upper Palæolithic Facies from Swanscombe, Kent, J. P. T. Burchell, 548
Poultry, Size-Inheritance in, W. T. Waters, 1005
Power: Sir Alfred Ewing, 567; Engineering, Origins of, H. P. Vowles, 800
Praseodymium and Thallous Sulphates, F. Zambonini and S. Restaino, 1014
Pre: -Cambrian Tillite in South-West Africa, Dr. T. W. Gevers, 191; -Chellean Age in the Gravels of Stanstead, Upper Caterham, apparently Site and New Culture of, L. MacLellan Mann, 144
Precipitation, Periodic, in the Absence of Colloids, Prof. J. W. McBain, 1042
Pregl's Method for Determining Nitrogen, Modification of, J. J. Rutgers, 421
Prehistoric: Colonists of Yorkshire, The, and their Economics, Prof. V. Gordon Childe, 776; Society of East Anglia, 879
Prehistory: An International Congress of, 389; Association and Chronology in, A. J. H. Goodwin, 801
Prejudice: A Plea for, 473; in Modern Civilization (Prejudice and Politics), The Place of, Sir Arthur Keith, 473
Prickly-Pear, Control of, by the Cochineal Insect, C. T. Jacob, 117; T. V. Ramakrishna Ayyar, 837; W. B. Alexander, 226

Priestley: and Lavoisier, Sir Philip Hartog, 797; as a Pioneer, 464; Joseph: A Life of, Anne Holt, 625; and his place in the History of Science, Sir Philip Hartog, 464
Primates, Cerebral Evolution of the, with special reference to the Hominidæ, Prof. C. Fraipont, 61
Probabilités et statistiques, Dr. R. de Montessus de Ballore, 286
Probability Theorems connected with the discovery of Variable Stars by a Photographic Method, B. Gerasimovic, 682
Production, Population and, Prof. E. Cannan, 534, 658
Prophylaxis, Experiments in, Sir Flinders Petrie, 35
Protactinium, Purification of the, fixed on Tantalum Oxide, Tcheng Datchang, 466
Proteins: Hydration of, The Volume Contraction produced by the, C. Marie and N. Marinesco, 978; in their Native State, Molecular Weights of the, Prof. The Svedberg, 999
Proton: On the Mass of the, Sir Arthur Eddington, 1049; Waves, The Diffraction of, Y. Sugiura, 1006
Protons, Collision Properties of, C. Ramsauer, R. Kollath, and D. Lilienthal, 911
Protoplasm: Extensibility of, Prof. W. Seifriz and Janet Plowe, 1045; The Permeability of, to Water, B. Huber, 497
Protozoölogy, Problems and Methods of Research in, J. Andrews and others. Edited by Prof. R. Hegner and J. Andrews, 395
Psychology: and Organised Religion, Prof. R. Pearl; J. R. Miner, 1047; Integrative, a Study of Unit Response, Dr. W. M. Marston and C. D. King and Elizabeth H. Marston, 1025
Psycho: -neurotics, The Concentric Method in the Diagnosis of, Prof. M. Laignel-Lavastine, 690; -physical Law, The Fundamental, A. Tsvetkov, 503
Public Health: Pioneers of, the Story of some Benefactors of the Human Race, M. E. M. Walker, 6
Puccinia: *graminis tritici*, Effect of Light on Urediniospores of Black Stem Rust of Wheat, W. A. R. Dillon Weston, 67; *pygmæa* Erikss. on *Berberis*, An Æcidium of, W. Tranzschel, 467
Pueblo and related Indian Races, Skulls of the, Dr. A. Hrdlička, 1079
Pulp-Wood Market in the United States, The, 313
Purkinje's Phenomenon, Nature of, P. Rossier, 235
Pyrethrins in the Pyrethrum Flower, Distribution of the, L. and J. Deshusses, 126
Pyruvic Acid in Lactic Fermentation, Formation of, S. P. Kostychev, V. Gvaladze, and P. S. Eliasberg, 127

Qualitative: Analysis by 'Spot' Tests, 987; Analyse mit Hilfe von Tupfelreaktionen: theoretische Grundlagen und praktische Ausfuhrung, Dr. F. Feigl, 987
Quantitative Analysis, Textbook of, Prof. W. T. Hall, 323
Quantum: Mechanical Motion of Free Electrons in Electromagnetic Fields, E. H. Kennard, 83; Theory, An Introduction to, Dr. G. Temple, 960
Quartz: Anomalous Variation of the Electrical Conductivity of, with Temperature at the Transformation Point, Prof. H. Saegusa and S. Shimizu, 835; Crystallised, and Fused Quartz, Comparison of the Magnetic Rotations of, A. Cotton, 81; Resonators and Oscillators, P. Vigoureux, 961
Quaternary Ice Margins (North Sea), Prof. J. K. Charlesworth, 498
Quebec, Pre-Cambrian Rocks of, H. C. Cooke, W. F. James, and J. B. Mawdsley, 1006
Quekett Microscopical Club, Recollections of the, J. M. Offord, 29
Quinine Sulphate, The Radiation accompanying the Hydration of, M. Curie and M. Prost, 386

Rabbit: Breeding, The Scientific Aspects of, J. N. Pickard and Prof. F. A. E. Crew, 512; Industry, Science in the, 512
Rabbits, Some Diseases of, 219
Race and Progress, Prof. F. Boas, 557
Racemic Aldehydes, Optical Resolution of, (2), M. Betti and P. Pratesi, 1014
Racial Prejudice, 557
Radicals, Free Neutral, Fluorescence and, A Connexion between, Dr. W. A. Waters, 905
Radiation: and Life, Dr. W. R. G. Atkins, 199; Matter and, Prof. F. G. Donnan, 290; Ultra-Violet, Measurement of, A. F. Dufton and H. E. Beckett, 223
Radiations from Radioactive Substances, Sir Ernest Rutherford [Lord Rutherford], Dr. J. Chadwick, and Dr. C. D. Ellis, 3
Radioactive Constants, The, 1006
Radioactivity: and Earth Movements, Prof. A. Holmes, 419, 496; and the Atomic Nucleus, Prof. A. H. Compton, 3; of the Atmosphere in Czechoslovakia, 903
Radio: Beacon Stations of the Rotating Type, 252; Broadcasting Stations in Europe, Increase of, 903; Communication, Modern, J. H. Reyner. Third edition, 1057; -electric Waves, The Propagation of, R. Jouaust and N. Stoyko, 82; -elements and Isotopes: Chemical Forces and Optical Properties of Substances, Prof. K. Fajans, 948; Frequency Measurements, The Theory and Practice of, E. B. Moullin. Second edition, 1057; Observations during a Solar Eclipse, Dr. M. A. F. Barnett, 381; Research: Board, Report of the, for the year ended 31st Dec. 1930, 861; in Great Britain, 861; in the British Empire, R. A. Watson Watt and O. F. Brown, 755; Signal across the Atlantic, Thirtieth Anniversary of the First, 1031; Signals passing through High Latitudes, Abnormality of, S. Namba, 1044; -telegraphy, Second Thoughts on, 1057; -telephone System, Demonstration of a, in Italy, 902; -therapy, Ultra-Violet, Dr. W. K. Russell, 953
Radium: Commission, Second Annual Report of the, 803; Concentration of, by Plants, V. Vernadskii, 127; in Hawaiian Lavas, C. S. Piggot, 840
Raffety Bands, The, and the Spectra of Comets, F. Baldet, 234
Railway Electrification: in India, 406; in Italy, 146
Rainfall: as Carbohydrates, Conservation of, Prof. W. A. Osborne, 378; in a given place, Usefulness of long Periods of Observation of the, E. Mathias, 918; Eighty Years', at North Craig Reservoir, Kilmarnock, W. Dunbar, 917
Raman: Band in Water, Structure of the, S. Rafałowski; Dr. G. Bolla, 546; Bands in Water, S. Rafałowski, 978; Effect: Enlargement of Diffused Lines without change of Frequency in the, Mlle. M. Ney, 126; Prof. K. W. F. Kohlrausch, 155; in Chemistry, The, R. Lespieau, M. Bourguel, and R. L. Wakeman, 503; Lines: due to Co-ordination Bond, Prof. D. M. Bose and S. Datta, 725; in Liquids, Fine Structure of, Dr. A. Langseth, 225; Scattering: in Gases, Intensity of, S. Bhagavantam, 272; Polarisation of, by Hydrogen Gas, S. Bhagavantam, 70; Spectra: Effect of Pressure on, S. Bhagavantam, 188; in the Ultra-violet, The Monochromatic Stimulation of, Horia Hulubei and Mlle. Yvette Cauchois, 315; of Benzene and Toluene, L. E. Howlett, 796; of Crystals, Lines of Large Frequency Shift in the, Prof. R. Tomaschek, 495; of Liquid Mixtures, P. Krishnamurti, 639; Spectrum: and Chemical Constitution of certain Chloroethylenes, G. B. Bonino and L. Brull, 595; of CO_2, Rotational, W. V. Houston and C. M. Lewis, 280; of Dichlorobromomethane, G. B. Bonino and L. Brüll, 1051; of Hydrogenated Derivatives of Naphthalene, G. B. Bonino and P. Cella, 1051
Ramsay: Fellowships, award of, 313; Memorial Laboratory of Chemical Engineering at University College: opening of the, by Prince George, 932; The, 1046
Rare: Earths, Sulphates of the, A Physico-chemical Study of the, Prof. B. Brauner and E. Švagr, 1013; Gas Spectra, Intensity Anomalies in, E. Rasmussen and H. Swenson, 188
Rat, The Local Effects in the, due to Electric Fields of very High Frequency, J. Saidman, J. Meyer, and R. Cahen, 387
Rationalisation, The International Discussion Conference and, 405
Rationalization, Dr. J. A. Bowie, 92
Rats and Mice as Enemies of Mankind, M. A. C. Hinton. Third edition, 1036
Rayons de courbure des surfaces sphériques employées en optique, La mesure des, A. Arnulf, 323

Red Algæ, Resistance Experiments on, A. Zeller, 467
Reflector, Another large, in America, 381
Registrar-General's Statistical Review, 1930; Tables, Part 2, Civil, 997
Relativistic Opacity Coefficient, The, R. C. Majumdar and D. S. Kothari, 908
Religion, Organised, Psychology and, Prof. R. Pearl; J. R. Miner, 1047
Repton School Science Society, Conversazione of the, 15
Research in Industry and Rationalisation, A. Y. Enström, 122
Resonator, Bottle-Pipe, The, A. E. Bate, 270
Reticulo-endothelial Blocking, Variations of the Blood Serum Albumins under the Influence of, A. H. Du Bois, 279
Reversible Coagulation in Living Tissue, W. D. Bancroft and G. H. Richter, (3), 423; (4), 846; 1014

REVIEWS AND SHORT REVIEWS.

Agriculture, Forestry, and Horticulture:

Gill (T.), Tropical Forests of the Caribbean, 1059
Howard (A.), and Yeshwant D. Wad, The Waste Products of Agriculture: their Utilization as Humus, 854
Keen (Dr. B. A.), The Physical Properties of the Soil, 391
Mann (G. E.), [Dr. H. A. Tempany and], Principles of Tropical Agriculture, 954
Powell (Prof. H. C.), The Culture of the Orange and Allied Fruits, 955
Saunders (A. R.), Maize in South Africa, 1060
Tempany (Dr. H. A.), and G. E. Mann, Principles of Tropical Agriculture, 954
Wad (Yeshwant D.), [A. Howard and], The Waste Products of Agriculture: their Utilization as Humus, 854

Anthropology and Archæology:

Askell (Dr. W. J.), [Dr. K. S. Sandford and], Paleolithic Man and the Nile-Faiyum Divide; a Study of the Region during Pliocene and Pleistocene Times, 287
Bowman (W. D.), The Story of Surnames, 743
Broom (Dr. R.), The Origin of the Human Skeleton: an Introduction to Human Osteology, 4
Budge (Sir E. A. Wallis), Amulets and Superstitions, 204
Cardinall (A. W.), Tales Told in Togoland, to which is added the Mythical and Traditional History of Dagomba, 1026
Charlot (J.), [E. H. Morris, Ann Axtell Morris, and], The Temple of the Warriors at Chichen Itza, Yucatan. 2 Vols., 694
Elgee (F.), Early Man in North-east Yorkshire, 776
Ewen (C. L'Estrange), A History of Surnames of the British Isles: a Concise Account of their Origin, Evolution, Etymology, and Legal Status, 891
Garstang (Prof. J.), Joshua: Judges, 938
Goodland (R.), A Bibliography of Sex Rites and Customs: an Annotated Record of Books, Articles, and Illustrations in all Languages, 892
Griaule (M.), Le livre de recettes d'un dabtara abyssin, 204
Hall (Dr. H. R.), A Season's Work at Ur: al-'Ubaid, Abu Shahrain (Eridu), and Elsewhere; being an Unofficial Account of the British Museum Archæological Mission to Babylonia, 1919, 131
Hooton (Dr. E. A.), and others, The Indians of Pecos Pueblo: a Study of their Skeletal Remains, 740
Huffman (Ray), Nuer Customs and Folk-Lore, 989
Indians: We, the Passing of a Great Race. Being the Recollections of the last of the Great Indian Chiefs, Big Chief White Horse Eagle, as told to Edgar von Schmidt-Pauli. Translated by C. Turner, 891
Iyer (Rao Bahadur L. K. Ananthakrishna), [the late H. V. Nanjundayya and], The Mysore Tribes and Castes. Vol. 3, 50
Keith (Sir Arthur), Ethnos: or the Problem of Race considered from a New Point of View, 624
Leakey (Dr. L. S. B.), with Appendices by J. D. Solomon, C. E. P. Brooks, A. T. Hopwood, H. C. Reck, and M. Connolly, The Stone Age Cultures of Kenya Colony, 1019
Levy (R.), An Introduction to the Sociology of Islam. Vol. 1, 951
McInerny (A. J.), Deserts and the Birth of Civilizations, 475
Meek (C. K.), A Sudanese Kingdom: an Ethnographical Study of the Jukun-speaking Peoples of Nigeria, 285; Tribal Studies in Northern Nigeria. Vol. 1, 285
Morris (Ann Axtell), [E. H. Morris, J. Charlot, and], The Temple of the Warriors at Chichen Itza, Yucatan. 2 Vols., 694
Morris (E. H.), J. Charlot, and Ann Axtell Morris, The Temple of the Warriors at Chichen Itza, Yucatan. 2 Vols., 694
de Moubray (G. A.), Matriarchy in the Malay Peninsula and Neighbouring Countries, 624
Nanjundayya (the late H. V.), and Rao Bahadur L. K. Ananthakrishna Iyer, The Mysore Tribes and Castes. Vol. 3, 50
Oswald (Dr. F.), Index of Potters' Stamps on Terra Sigillata "Samian Ware", 951
Prejudice in Modern Civilization, The Place of (Prejudice and Politics), Sir Arthur Keith, 473
de Saint-Périer (Dr. R.), La Grotte d'Isturitz. 1: Le Magdalénien de la Salle de Saint-Martin, 988
Saller (Dr. K.), Leitfaden der Anthropologie, 624
Sandford (Dr. K. S.), and Dr. W. J. Arkell, Paleolithic Man and the Nile-Faiyum Divide; a Study of the Region during Pliocene and Pleistocene Times, 287
Smith (Prof. G. Elliot), and others, Early Man: his Origin, Development and Culture, 951
Stayt (Dr. H. A.), The Bavenda, 614
Thompson (C. J. S.), The Mystery and Lore of Monsters: with Accounts of some Giants, Dwarfs, and Prodigies, 90

Biology:

Allee (Prof. W. C.), Animal Aggregations: a Study in General Sociology, 940
Alston (A. H. G.), Supplement 6 to Trimen's 'A Hand-Book to the Flora of Ceylon,' 891
Andrews (J.), and others, edited by Prof. R. Hegner and J. Andrews, Problems and Methods of Research in Protozoölogy, 395
Bergey (D. H.), and others, Bergey's Manual of Determinative Bacteriology: a Key for the Identification of Organisms of the Class Schizomycetes. Third edition, 6
Biden (C. L.), Sea-Angling Fishes of the Cape (South Africa), 209
Biologischen Arbeitsmethoden, Handbuch der, Herausgegeben von Prof. E. Abderhalden. Lief. 331. Abt. 9: Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 4, Heft 4 (Schluss). Methoden und Technik der vergleichenden Stoffwechselphysiologie bei Wirbellosen, von H. P. Wolvekamp, 396. Lief. 346. Abt. 9: Methoden der Erforschung der Leistungen des tierischen Organismus, Teil 7, Heft 1. Methoden der Tierhaltung und Tierzuchtung, 431
Botanical Congress, Fifth International, Cambridge, 16-23 August, 1930. Report of Proceedings. Edited by F. T. Brooks and Dr. T. F. Chipp, 778
Buchner (Dr. P.), Tier und Pflanze in Symbiose, 558
Buller (Prof. A. H. R.), Researches on Fungi. Vol. 4, 944
Crawshay (R.), The Spore Ornamentation of the Russulas, 801
Crew (Prof. F. A. E.), [J. N. Pickard and], The Scientific Aspects of Rabbit Breeding, 512
Dalziel (Dr. J. M.), [J. Hutchinson and], Flora of West Tropical Africa: the British West African Colonies, British Cameroons, the French and Portuguese Colonies south of the Tropic of Cancer to Lake Chad, and Fernando Po. Vol. 2, Part 1, 952
Elliott (Charlotte), Manual of Bacterial Plant Pathogens, 953
Elton (C.), Animal Ecology and Evolution, 243
Entomological Society of London, Transactions of the. Vol. 79, Part 1, 689
Essig (Prof. E. O.), A History of Entomology, 655
Fairchild (D.), Exploring for Plants 52

Gardiner (Prof. J. Stanley), Coral Reefs and Atolls: being a Course of Lectures delivered at the Lowell Institute at Boston, February 1930, 206
Geddes (Prof. P.), [Sir J. Arthur Thomson and], Life: Outlines of General Biology. 2 Vols., 1056
Gideon (P. W.), An Introduction to Zoology, 952
d'Herelle (Prof. F.), translated by Prof. G. H. Smith, The Bacteriophage and its Clinical Applications, 431
Hogben (Prof. L.), Principles of Animal Biology, 242
Hutchinson (J.), and Dr. J. M. Dalziel, Flora of West Tropical Africa: the British West African Colonies, British Cameroons, the French and Portuguese Colonies south of the Tropic of Cancer to Lake Chad, and Fernando Po. Vol. 2, Part 1, 952
Keeler (Dr. C. E.), The Laboratory Mouse: its Origin, Heredity and Culture, 431
Levine (Prof. M.), and H. W. Schoenlein, A Compilation of Culture Media for the Cultivation of Micro-organisms, 244
Lundegårdh (Prof. H.), translated and edited by E. Ashby, Environment and Plant Development. Being "Klima und Boden in ihrer Wirkung auf das Pflanzenleben", 135
Marine Biology: Contributions to, Lectures and Symposia given at the Hopkins Marine Station, Dec. 20-21, 1929, at the Midwinter Meeting of the Western Society of Naturalists, 172
Miller (Prof. E. C.), Plant Physiology: with reference to the Green Plant, 952
Nature: One Touch of, a Literary Nature Study Reader for Boys and Girls, arranged by Dr. F. W. Tickner, 624
Osborn (Prof. H. F.), edited by Florence Milligan, Fifty-two Years of Research, Observation and Publication, 1877–1920: a Life Adventure in Breadth and Depth, 625
Pickard (J. N.), and Prof. F. A. E. Crew, The Scientific Aspects of Rabbit Breeding, 512
Plants, Life Movements in, edited by Sir Jagadis Chunder Bose, 240
Rosa (Prof. D.), adapté de l'italien par l'auteur, L'Ologénèse: nouvelle théorie de l'évolution et de la distribution géographique des êtres vivants, 429
Rumbold (G.), The Origin of Life. Second impression, 243
Schoenlein (H. W.), [Prof. M. Levine and], A Compilation of Culture Media for the Cultivation of Micro-organisms, 244
Seward (Prof. A. C.), Plant Life through the Ages: a Geological and Botanical Retrospect, 559
Singer (Dr. C.), A Short History of Biology: a General Introduction to the Study of Living Things, 132
Smith (Dr. Kenneth M.), A Textbook of Agricultural Entomology, 943
Thomson (Sir J. Arthur), and Prof. P. Geddes, Life: Outlines of General Biology. 2 Vols., 1056
Trimen (H.), A Hand-Book to the Flora of Ceylon. Part 6: Supplement, A. H. G. Alston, 891
Tunmann (Dr. A.), Pflanzenmikrochemie: ein Hilfsbuch beim mikrochemischen Studium pflanzlicher Objekte. Zweite Auflage, Prof. L. Rosenthaler, 953
Vandel (Prof. A.), La parthénogénèse, 941
Weygandt (Prof. C.), The Wissahickon Hills: Memories of Leisure Hours out of doors in an Old Countryside, 208
White, Gilbert, Journals of, edited by W. Johnson, 952

Chemistry:

Alchemist: The Travels of an, the Journey of the Taoist Ch'ang-ch'un from China to the Hindukush at the Summons of Chingiz Khan. Recorded by Li Chih-Ch'ang. Translated with an introduction by A. Waley, 509
van Arkel (A. E.), und J. H. de Boer; Deutsche, von den Verfassern autorisierte Ausgabe von L. Klemm und W. Klemm, Chemische Bindung als elektrostatische Erscheinung, 816
Badger (Prof. W. L.), and Prof. W. L. McCabe, Elements of Chemical Engineering, 622
Bailey (Dr. G. H.), and H. W. Bausor, Chemistry for Matriculation. Third edition, 173
Barr (Dr. G.), A Monograph of Viscometry, 947
Bausor (H. W.), [Dr. G. H. Bailey and], Chemistry for Matriculation. Third edition, 173
Blanchard (Prof. A. A.), and Prof. J. W. Phelan, Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. Fourth edition, 92
de Boer (J. H.), [A. E. van Arkel und], Deutsche, von den Verfassern autorisierte Ausgabe von L. Klemm und W. Klemm, Chemische Bindung als elektrostatische Erscheinung, 816
Bronson (B. S.), Nutrition and Food Chemistry, 856
Caven (Dr. R. M.), and Dr. G. D. Lander, Systematic Inorganic Chemistry from the Standpoint of the Periodic Law. New edition, 209
Chemie, anorganischen, Handbuch der, Herausgegeben von Prof. R. Abegg and others. Band 4, Abt. 3, Teil 2: A Lief., 1, 625
Chemistry, Analytical, Recent Advances in, Vol. 1: Organic Chemistry. Editor: Dr. C. Ainsworth Mitchell, 208
Chemistry, Physical, A Treatise on, a Co-operative Effort by a Group of Physical Chemists. Edited by Prof. H. S. Taylor. Second edition. In 2 vols., 429
Chimie, l'Union Internationale de, Dixième Conférence de, Liége, 14-20 septembre 1930. Rapports sur les hydrates de carbone (glucides), 656
Chittenden (Prof. R. A.), The Development of Physiological Chemistry in the United States, 90
Du Mez (Prof. A. G.), [Prof. G. L. Jenkins and], Quantitative Pharmaceutical Chemistry: containing Theory and Practice of Quantitative Analysis applied to Pharmacy, 958
Durrans (Dr. T. H.), Solvents, second edition, 958
Ewald (P. P.), und C. Hermann, Strukturbericht, 1913–1928, 511
Fajans (Prof. K.): Radioelements and Isotopes: Chemical Forces and Optical Properties of Substances, 948; and K. Wust, translated by B. Topley, A Textbook of Practical Physical Chemistry, 852
Feigl (Dr. F.), Qualitative Analyse mit Hilfe von Tüpfelreaktionen: theoretische Grundlagen und praktische Ausführung, 987
Findlay (Prof. A.), Practical Physical Chemistry. Fifth edition, 959
Fuchs (Dr. W.), Die Chemie der Kohle, 1024
Gessner (Dr. H.), Die Schlämmanalyse, 1061
Gmelins Handbuch der anorganischen Chemie. Achte Auflage. System-Nummer 59: Eisen. Teil A, Lief. 3; Teil B, Lief. 3, 657; Bearbeitet von R. J. Meyer. System-Nummer 26: Beryllium. System-Nummer 58: Kobalt. Teil B: Die Ammine des Kobalts, 816
Goard (Dr. A. K.), Chemical Composition: an Account of the Methods by which Atomic Weights and Molecular Formulæ have been determined, 958
Gosselin (A.), et M. Gosselin, Constitution et thermochimie des molécules: les constituants moléculaires, les liaisons intramoléculaires, la valeur énergétique des liaisons, 92
Gosselin (M.), [A. Gosselin et], Constitution et thermochimie des molécules: les constituants moléculaires, les liaisons intramoléculaires, la valeur énergétique des liaisons, 92
Grant (Dr. J.), The Measurement of Hydrogen Ion Concentration, 852
Hall (Prof. W. T.), Textbook of Quantitative Analysis, 323
Hermann (C.), [P. P. Ewald und], Strukturbericht, 1913–1928, 511
Holmyard (Dr. E. J.), Makers of Chemistry, 321
Holt (Anne), A Life of Joseph Priestley, 625
Huntress (Prof. E. H.), A Brief Introduction to the use of Beilstein's Handbuch der organischen Chemie, 136
Jager (F. M.), Spatial Arrangements of Atomic Systems and Optical Activity; Methods, Results and Problems of Precise Measurements at High Temperatures; The Constitution and Structure of Ultramarines, 852
Jellinek (Prof. K.), Lehrbuch der physikalischen Chemie. Funf Bande. Band 3: Die Lehre von der Statik chemischer Reaktionen in verdunnten Mischungen (Lösungen). Erste und zweite Auflage. Lief. 9, 852;

Lief. 10 (Band 4): Die Lehre von der Statik chemischer Reaktionen (Schlussteil) und die Lehre von der chemischen Kinetik. Erste und zweite Auflage, 958
Jenkins (Prof. G. L.), and Prof. A. G. Du Mez, Quantitative Pharmaceutical Chemistry: containing Theory and Practice of Quantitative Analysis applied to Pharmacy, 958
Kopaczewski (W.), Traité de biocolloidologie. Tome 1: Pratique des colloides. Deux. édition. Fasc. 3: Mésures capillaires et électriques, 852
Kruyt (Prof. H. R.), translated by Prof. H. S. van Klooster. Colloids: a Textbook. Second edition, 852
Lander (Dr. G. D.), [Dr. R. M. Caven and], Systematic Inorganic Chemistry from the Standpoint of the Periodic Law. New edition, 209
Lewis (Prof. H. F.), Fundamentals of Organic Chemistry, 957
von Lippmann (Prof. E. O.), Entstehung und Ausbreitung der Alchemie. Band 2: Ein Lese- und Nachschlage-Buch, 774
Macbeth (Prof. A. K.), Organic Chemistry for Medical, Intermediate Science and Pharmaceutical Students. Second edition, 657
McCabe (Prof. W. L.), [Prof. W. L. Badger and], Elements of Chemical Engineering, 622
Martin (Dr. G.), The Modern Soap and Detergent Industry. Second edition. 2 vols., 625
Mellor (Dr. J. W.), A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. 11, 957
Müller (Prof. E.), translated by Dr. H. J. T. Ellingham, A Laboratory Manual of Electro-chemistry, 743
Miall (Dr. S.), A History of the British Chemical Industry, 46
Onslow (Hon. Muriel Wheldale), The Principles of Plant Biochemistry, Part 1, 621
Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 11, 856
Ostwald-Luther Hand- und Hilfsbuch zur Ausfuhrung physiko-chemischer Messungen, Herausgegeben von C. Drucker. Funfte Auflage, 814
Phelan (Prof. J. W.), [Prof. A. A. Blanchard and], Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. Fourth edition, 92
Prausnitz (Dr. P. H.), und Dr. J. Reitstotter, Elektrophorese, Elektroosmose, Elektrodialyse in Flüssigkeiten, 988
Rakshit (Jitendra Nath), Association Theory of Solution and Inadequacy of Dissociation Theory, 852
Read (Prof. J.), An Introduction to Organic Chemistry, 742
Reitstötter (Dr. J.), [Dr. P. H. Prausnitz und], Elektrophorese, Elektroosmose, Elektrodialyse in Flussigkeiten, 988
van Rijn (Dr. J. J. L.), Die Glykoside: Chemische Monographie der Pflanzenglykoside. Zweite Auflage von Prof. H. Dieterle, 959
Scheele, Carl Wilhelm, The Collected Papers of, translated by Dr. L. Dobbin, 1023
Sherman (Prof. H. C.), and S. L. Smith, The Vitamins, 743
Smith (S. L.), [Prof. H. C. Sherman and], The Vitamins, 743
Ulich (Prof. H.), Chemische Thermodynamik: Einführung in die Lehre von den chemischen Affinitäten und Gleichgewichten, 52
Wüst (K.), [Prof. K. Fajans and], translated by B. Topley, A Textbook of Practical Physical Chemistry, 852

Engineering:
Abbott (W.), Machine Drawing and Design: a Textbook of Intermediate Standard for Engineering Students, 962
Bradbrooke (F. D.), The Light Aeroplane Manual, 961
Brown (F. J.), The Cable and Wireless Communications of the World. Second edition, 1057
Camichel (Prof. C.), Leçons sur les conduites, 209
Dalby (Prof. W. E.), Power and the Internal Combustion Engine, 886
Deimel (Prof. A. F.), Mechanics of the Gyroscope, 289
Fordham (A. A.), Civil Engineering Design, 962
Garratt (Prof. G. A.), The Mechanical Properties of Wood: including a Discussion of the Factors affecting the Mechanical Properties, Working Stresses for Structural Timber, and Methods of Timber Testing, 961
Macrae (Major A. E.), Overstrain of Metals: and its Application to the Auto-Frettage Process of Cylinder and Gun Construction, 49
Moullin (E. B.), The Theory and Practice of Radio Frequency Measurements. Second edition, 1057
Reyner (J. H.), Modern Radio Communication. Third edition, 1057
Ricardo (H. R.), The High-Speed Internal-Combustion Engine. New edition, 886
Salmon (Dr. E. H.), Materials and Structures: a Textbook for Engineering Students. Vol. 1: The Elasticity and Strength of Materials, 617
Stewart (Major O.), Cross-Country Flying; Flying as a Career, 961
Timoshenko (Prof. S.), Strength of Materials. Parts 1 and 2, 617
Walker (H. C.), Charts and Data on Marine Boiler Design: a Summary of the Standard Formulæ in Chart Form with Tables and Notes, 962
Wiener (Prof. L.), Articulated Locomotives, 289

Geography and Travel:
Briquet (A.), Le littoral du nord de la France et son évolution morphologique, suivi d'un appendice: L'Évolution du rivage du nord de la France et l'activité de l'homme, 396
Curnow (Dr. I. J.), The World Mapped: being a Short History of attempts to Map the World from Antiquity to the Twentieth Century, 289
Geilinger (Dr. W.), Der Kilimandjaro: sein Land und seine Menschen, 956
Huxley (Prof. J.), Africa View, 87
Johnson (Lieut. G. R.), with text and notes by R. R. Platt, Peru from the Air, 172
Nansen (Dr. F.), translated by G. C. Wheeler, Through the Caucasus to the Volga, 319
Siam: Nature and Industry, 209
Thomas (B.), Alarms and Excursions in Arabia, 956
Wilmore (Dr. A.), The Groundwork of Modern Geography: an Introduction to the Science of Geography. Third edition, 955

Geology, Mineralogy, and Mining:
Barrett (B. H.), [Prof. J. W. Gregory and], General Stratigraphy, 945
Dannenberg (Prof. A.), Geologie der Steinkohlenlager. Band 2, Teil 2, 816
Davison (E. H.), Handbook of Cornish Geology. Second edition, 779
Gold Resources of the World, The, with a Summary by A. C. Sutherland, 4
Grabau (Prof. A. W.), Central Asiatic Expeditions. The Permian of Mongolia: a Report on the Permian Fauna of the Jisu Honguer Limestone of Mongolia and its relations to the Permian of other parts of the World. With a Chapter on the Relations of the Jisu Honguer Formation to the General Geology of Mongolia, by Dr. C. P. Berkey and F. K. Morris, 956
Gregory (Prof. J. W.), and B. H. Barrett, General Stratigraphy, 945
Longwell (Prof. C. R.), Outlines of Physical Geology, 513
Pratje (O.), Helgoland und die Zerstorung seiner Felskuste durch das Meer, 657
Ramdohr (Prof. P.), [Prof. H. Schneiderhöhn und], Lehrbuch der Erzmikroskopie. Band 2; Erzmikroskopische Bestimmungstafeln: Anhang zum Lehrbuch der Erzmikroskopie, 889
Richey (J. E.), and others, The Geology of Ardnamurchan, North-west Mull and Coll, 619
Schaffer (Prof. F. X.), Lehrbuch der Geologie. Teil 3: Geologische Landerkunde (Regionale Geologie), Lief. 1, 956

Schneiderhöhn (Prof. H.), und Prof P. Ramdohr, Lehrbuch der Erzmikroskopie. Band 2; Erzmikroskopische Bestimmungstafeln: Anhang zum Lehrbuch der Erzmikroskopie, 889
Schuchert (Prof. C.), Outlines of Historical Geology. Second edition, 513
Scupin (Prof. H.), Die Nordsudetische Dyas: eine stratigraphisch-paläogeographische Untersuchung, 892
Stratigraphie Deutschlands. Handbuch der vergleichenden. Herausgegeben von der Preussischen Geologischen Landesanstalt. *Alluvium.* Schriftleitung, J. Stoller. Unter Mitwirkung von K. von Bülow und W. Dienemann, 1025
Swinnerton (Prof. H. H.), Outlines of Palæontology. Second edition, 173
Voskuil (Dr. W. H.), Minerals in Modern Industry, 508
Willis (Prof. B.), Living Africa: a Geologist's Wanderings through the Rift Valleys, 87
Woldstedt (Dr. P.), Das Eiszeitalter: Grundlinien einer Geologie des Diluviums, 394

Mathematical and Physical Science:
Arnulf (A.), La mesure des rayons de courbure des surfaces sphériques employées en optique, 323
Ashcroft (E. W.), Faraday, 323
Baker (Prof. R. H.), Astronomy: an Introduction, 563
Beghin (H.), and Prof. G. Julia, Exercices de mécanique. Tome 1, fasc. 2, 514
Berkeley (L. M.), Addition-Subtraction Logarithms to Five Decimal Places, 91
Bozman (A. M.), A School Algebra: as far as the Advanced Course in the School Certificate Stage, 1061
Chadwick (Dr. J.), [Sir Ernest Rutherford (Lord Rutherford), Dr. C. D. Ellis, and], Radiations from Radioactive Substances, 3
Craig (J. I.), The Elements of Analytical Geometry. Vol. 1.: Straight Line and Circle, 52
Culver (Prof. C. A.), Electricity and Magnetism: an Advanced Text-book for Colleges, 629
Darrow (K. K.), La synthèse des ondes et des corpuscules, 629
Davison (Dr. C.), The Japanese Earthquake of 1923, 989
Delporte (E.), Atlas céleste, 690
Durell (C. V.), and A. Robson, Advanced Trigonometry, 92
Earth: Physics of the; Volcanology; The Figure of the Earth; Meteorology; The Age of the Earth, 984
Eason (A. B.), Flow and Measurement of Air and Gases. Second edition, 654
Edge (W. L.), The Theory of Ruled Surfaces, 856
Elektroneninterferenzen, Herausgegeben von Prof. P. Debye, 396
Ellis (Dr. C. D.), [Sir Ernest Rutherford (Lord Rutherford), Dr. J. Chadwick, and], Radiations from Radioactive Substances, 3
Erlang (A. K.), Udgivet ved R. E. H. Rasmussen, Femcifrede Logaritmer og Antilogaritmer, 91
Experimentalphysik, Handbuch der, Herausgegeben von W. Wien und F. Harms. Band 4. Teil 1, 654
Franklin (Prof. W. S.), and Prof. G. E. Grantham, General Physics, 134
Freeman (H.), An Elementary Treatise on Acturial Mathematics, 286
Geophysical Prospecting. The Principles and Practice of, being the Report of the Imperial Geophysical Experimental Survey. Edited by A. B. Broughton Edge and Prof. T. H. Laby, 427
Gheury de Bray (M. E. J.), Elementary Hyperbolics: for Technical and other Students; specially adapted to the Requirements of Beginners. Vol. 1: Hyperbolic Functions of Real and Unreal Angles. Vol. 2: The Applications of Hyperbolic Functions, 1026
Gibson (late Prof. G. A.), Advanced Calculus: a Sequel to an Elementary Treatise on the Calculus, 851
Glasser (Dr. O.), Wilhelm Conrad Röntgen und die Geschichte der Röntgenstrahlen. Mit einem Beitrag: Persönliches über W. C. Röntgen, mit Margret Boveri, 629
Grantham (Prof. G. E.), [Prof. W. S. Franklin and], General Physics, 134
Hamilton, Sir William Rowan, The Mathematical Papers of. Vol. 1: Geometrical Optics. Edited by Prof. A. W. Conway and Prof. J. L. Synge, 167
Heath (Sir Thomas L.), A Manual of Greek Mathematics, 739
Hotine (Capt. M.), Surveying from Air Photographs, 946
Houstoun (Dr. R. A.), Intermediate Physics, 134
Humphrey (D.), Intermediate Mechanics. Vol. 2: Statics and Hydrostatics, 244
International Astronomical Union (Union Astronomique Internationale). Report of Commission 3: Atlas céleste, E. Delporte, 690
Janssen (J.), Œuvres scientifiques. Recueillies et publiées par H. Dehérain. Tomes 1 et 2, 239
Jeans (Sir James), The Stars in their Courses, 615
Julia (Prof. G.), [H. Beghin and], Exercices de mécanique. Tome 1, fasc. 2, 514
Kayser (Prof. H.), und Prof. H. Konen, Handbuch der Spektroscopie. Band 7, Lief. 2, 1061
Kohlrausch (Prof. K. W. F.), Der Smekal-Raman-Effekt, 1026
Konen (Prof. H.), [Prof. H. Kayser und], Handbuch der Spektroscopie. Band 7, Lief. 2, 1061
Kryloff (Prof. N. M.), Angenaherte und symbolische Lösung der Differentialgleichungen der mathematischen Physik und Technik, 963
Kryloff (Prof. N.), Les méthodes de solution approchée des problèmes de la physique mathématique, 963
Leavenworth (Prof. F. P.). Measures of Double Stars, with the Measures by Prof. W. O. Beal, 743
Lindsay (Prof. R. B.), [Prof. G. W. Stewart, and], Acoustics: a Text on Theory and Applications, 779
Lorentz (Prof. H. A.), Lectures on Theoretical Physics delivered at the University of Leiden. Authorised translation by Dr. L. Silberstein and A. P. H. Trivelli. Vol. 3: Maxwell's Theory, edited by Dr. H. Bremekamp; The Principle of Relativity for Uniform Translations, edited by Dr. A. D. Fokker, 959
Mackaye (Prof. J.), The Dynamic Universe, 288
Matthews (R. B.), Electricity for Everybody: Handbook for 1931, 960
Maxwell: James Clerk, a Commemoration Volume, 1831–1931. Essays by Sir J. J. Thomson, and others, 607
Montessus de Ballore (Dr. R. de), Probabilités et statistiques, 286
Nicod (J.), Foundations of Geometry and Induction. Containing Geometry in the Sensible World, and The Logical Problem of Induction. Translated by P. P. Wiener, 430
Nightingale (E.), Magnetism and Electricity, 959
Payne (Cecilia H.), The Stars of High Luminosity, 615
Pohl (Prof. R. W.), translated by Winifred M. Deans, Physical Principles of Electricity and Magnetism, 134
Poincaré, Henri, Annales de l'Institut, Fasc. 2, Vol. 1, 243; recueil de conférences et mémoires de calcul des probabilités et physique théorique. Vol. 1, Fasc. 3, 657
Reidemeister (Prof. K.), Vorlesungen über Grundlagen der Geometrie, 626
Robson (A.), [C. V. Durell and], Advanced Trigonometry, 92
Rosseland (Prof. S.), Astrophysik auf atomtheoretischer Grundlage, 615
Rutherford (Sir Ernest) [Lord Rutherford], Dr. J. Chadwick, and Dr. C. D. Ellis, Radiations from Radioactive Substances, 3
Saunders (Prof. F. A.), A Survey of Physics for College Students, 134; A Survey of Physics, 628
Scarborough (Prof. J. B.), Numerical Mathematical Analysis, 962
Shapley (Dr. H.), Flights from Chaos: a Survey of Material Systems from Atoms to Galaxies, 615
Shearcroft (W. F. F.), Post-Primary Science. Book 1: First Year's Course, 960
Shorter (L. R.), Introduction to Vector Analysis: with many fully worked examples and some applications to Dynamics and Physics, 626
Smart (Prof. W. M.), Text-Book on Spherical Astronomy, 207
Spikes (W. H.), The Properties of Matter, 396

Steffensen (Prof. J. F.), Some Recent Researches in the Theory of Statistics and Actuarial Science, 286
Stetson (Prof. H. T.), Man and the Stars, 615
Stewart (Prof. G. W.) and Prof. R. B. Lindsay, Acoustics: a Text on Theory and Applications, 779
Temple (Dr. G.), An Introduction to Quantum Theory, 960
Thomas (Prof. O.), translated by B. Miall, The Heavens and the Universe, 244
Thomas (Prof. T. Y.), The Elementary Theory of Tensors: with Applications to Geometry and Mechanics, 626
Thompson (J. E.), A Manual of the Slide Rule: its History, Principle and Operation. Second printing, 563
Thomson (Prof. G. P.), The Wave Mechanics of Free Electrons, 47
Toms (Dr. H.), School Certificate Magnetism and Electricity, 431
Vigoureux (P.). Quartz Resonators and Oscillators, 961
Villat (Prof. H.), Mécanique der fluides, 654
Volterra (Prof. V.), Rédigées par M. Brelot. Leçons sur la théorie mathématique de la lutte pour la vie, 963
Watts (late Dr. W. Marshall), Index of Spectra. Appendix Z: Iron and Iron Oxide, 1060
Westaway (F. W.), Craftmanship in the Teaching of Elementary Mathematics, 950
Whitlock (T. G.), Elementary Applied Aerodynamics, 654
Whyte (L. L.), Critique of Physics, 964
Williams (Prof. S. R.), Magnetic Phenomena: an Elementary Treatise, 623
Zinner (Prof. E.), Die Geschichte der Sternkunde: von den ersten Anfangen bis zur Gegenwart, 986

Medical Science and Physiology:

Arkwright (J. A.), and others, A System of Bacteriology in relation to Medicine. Vol. 6, 888
Bennett (Victoria E. M.), and Dr. Susan Isaacs, Health and Education in the Nursery, 690
Bligh (E. W.), [S. G. B. Stubbs and], Sixty Centuries of Health and Physick: the Progress of Ideas from Primitive Magic to Modern Medicine, 939
Camis (Prof. M.), translated and annotated by Dr. R. S. Creed, The Physiology of the Vestibular Apparatus, 815
Cathcart (Dr. G. C.), The Treatment of Chronic Deafness by the Electrophonoide Method of Zund-Burguet. Second edition, 563
Chandler (Prof. A. C.), Introduction to Human Parasitology. Fourth edition, 323
Chen (K. K.), and C. F. Schmidt, Ephedrine and related Substances, 629
Clendening (Dr. L.), The Human Body. Second edition, 173
Crookshank (Dr. F. G.), Epidemiological Essays, 323
Hollander (Dr. B.), Brain, Mind and the External Signs of Intelligence, 815
Holmes (Dr. Barbara), Cancer and Scientific Research, 136
Isaacs (Dr. Susan), [Victoria E. M. Bennett, and], Health and Education in the Nursery, 690
Lamb (Dr. F. W.), An Introduction to Human Experimental Physiology, 475
Nathan (Dr. M.), L'esprit et ses maladies, 6
Pearn (Dr. O. P. N.), Mental Nursing (Simplified), 892
Russell (Dr. W. K.), Ultra-Violet Radiotherapy, 953
Scarth (Prof. G. W.), An Elementary Course in General Physiology. Part 1: Principles and Theory, Prof. G. W. Scarth. Part 2: Laboratory Exercises, Prof. F. E. Lloyd and Prof. G. W. Scarth, 563
Strassmann (Prof. P.), Aus der Medizin des Rinascimento. An der Hand des "Leben von Benvenuto Cellini" nach der Übersetzung Goethes, 173
Stubbs (S. G. B.), and E. W. Bligh, Sixty Centuries of Health and Physick: the Progress of Ideas from Primitive Magic to Modern Medicine, 939
Troup (W. A.), Therapeutic Uses of Infra-Red Rays, 953
Tumours, The Metabolism of, edited by O. Warburg, translated by Dr. F. Dickens, 630
Viets (Dr. H. R.), A Brief History of Medicine in Massachusetts, 135
Walker (M. E. M.), Pioneers of Public Health: the Story of some Benefactors of the Human Race, 6
Wilson (Dr. Isabel), How You Work: an Introduction to the Human Body, 136

Metallurgy:

Benedicks (Dr. C.), and H. Löfquist, Non-Metallic Inclusions in Iron and Steel, 856
Dews (H. C.), The Metallurgy of Bronze, 627
Johnson (C. M.), Rapid Methods for the Chemical Analysis of Special Steels, Steel-making Alloys, their Ores, Graphites, and Bearing Metals. Fourth edition, 288
Löfquist (H.), [Dr. C. Benedicks and], Non-Metallic Inclusions in Iron and Steel, 856
Metals, Institute of, Journal of the, Vol. 44, edited by G. Shaw Scott, 514
Rosenholtz (Dr. J. L.), The Elements of Ferrous Metallurgy, 626
Smithells (Dr. C. J.), Impurities in Metals: their Influence on Structure and Properties. Second edition, 627
Woldman (Dr. N. E.), Physical Metallurgy Laboratory Manual, 779

Meteorology:

Kerner-Marilaun (Dr. F.), Paläoklimatologie, 1025
Miller (A. A.), Climatology, 514

Miscellaneous:

Aristotle, The Works of, translated into English. Physica. By R. P. Hardie and R. K. Gaye, 396
Besterman (T.), Some Modern Mediums, 92
Bonar (Dr. J.), Theories of Population from Raleigh to Arthur Young: Lectures delivered in the Galtonian Laboratory, University of London, under the Newmarch Foundation, February 11 to March 18, 1929, with two additional Lectures and with References to Authorities, 940
Bowie (Dr. J. A.), Rationalization, 92
Bright (Sir Charles), Let's Help! a Collection of Good Causes, 989
Britton (L.), Hunger and Love, 475
Bryk (F.), Die Beschneidung bei Mann und Weib: ihre Geschichte, Psychologie und Ethnologie, 91
Carpenter, Edward, in Appreciation, edited by G. Beith, 892
Cornish (Dr. Vaughan), The Poetic Impression of Natural Scenery, 656
Crowther (J. G.), An Outline of the Universe, 627
Dingwall (Dr. E. J.), The Girdle of Chastity: a Medico-Historical Study, 628
Earle (F. M.), and other members of the staff of the National Institute of Industrial Psychology, edited with a Preface by Dr. Charles S. Myers, Methods of Choosing a Career: a Description of an Experiment in Vocational Guidance conducted on Twelve Hundred London Elementary School Children, 393
Fay (C. R.), Youth and Power: the Diversions of an Economist, 955
Flexner (Dr. A.), Universities: American, English, German, 811
Howarth (O. J. R.), The British Association for the Advancement of Science: a Retrospect, 1831–1931. Centenary (second) edition, 687
Jeanne d'Arc, The Trial of. A complete translation of the Text of the Original Documents, with an Introduction, by W. P. Barrett, 284
Lodge (Sir Oliver), Advancing Science: being Personal Reminiscences of the British Association in the Nineteenth Century, 982
London and the Advancement of Science. Various Authors, 687
Loveday (A.), Britain and World Trade: Quo Vadimus and other Economic Essays, 955
Modern Knowledge, An Outline of, edited by Dr. W. Rose, 937

Murphy (P.), Armadas of the Sky: the Problem of Armaments, 963
Periodicals, The Subject Index to, 1929, 562
Royal College of Science, Scientific Journal of the, Vol. 1, 627
Science at the Cross Roads. Papers presented to the International Congress of the History of Science and Technology held in London from June 20 to July 3, 1931, by the Delegates of the U.S.S.R., 170
Tannery, Paul, Mémoires scientifiques de, Publiés par L.-L. Heiberg et H.-G. Zeuthen. Tome 10 (Supplément au Tome 6): Sciences modernes, généralités historiques, 1892–1930. Édité avec la collaboration de Joseph Pérès, 613
Tawney (R. H.), Equality, 964
Upasaka (E.), A Heathen's Thoughts on Christianity, 892
Wickens (C. H.), Editor: J. Stonham, Commonwealth Bureau of Census and Statistics, Canberra. Official Year Book of the Commonwealth of Australia. No. 23, 1930, 514
Wolf (Prof. A.), Textbook of Logic, 6

Philosophy and Psychology:

Badley (J. H.), The Will to Live: an Outline of Evolutionary Psychology, 954
Berry (Dr. R. J. A.), and Dr. R. G. Gordon, The Mental Defective: a Problem in Social Inefficiency, 954
Carr (Dr. H. Wildon), The Monadology of Leibniz: with an Introduction, Commentary and Supplementary Essays, 136
Dibblee (G. B.), Instinct and Intuition: a Study in Mental Duality, 51
Gordon (Dr. R. G.), [Dr. R. J. A. Berry and], The Mental Defective: a Problem in Social Inefficiency, 954
Isaacs (Dr. Susan), Intellectual Growth in Young Children. With an Appendix on Children's "Why" Questions, by Nathan Isaacs, 777
Jørgensen (Prof. J.), A Treatise on Formal Logic: its Evolution and Main Branches, with its Relations to Mathematics and Philosophy. 3 Vols., 1021
King (C. D.), [W. M. Marston, Elizabeth H. Marston, and], Integrative Psychology: a Study of Unit Response, 1025
Laignel-Lowastine (Prof. M.), The Concentric Method in the Diagnosis of Psychoneurotics, 690
Lange (Prof. J.), translated by Charlotte Haldane, Crime as Destiny: a Study of Criminal Twins, 630
Lynch (A.), Brain and Mind, 954
Mackenzie (Prof. J. S.), Cosmic Problems: an Essay on Speculative Philosophy, 628
McKerrow (J. C.), Novius Organum: Essays in a New Metaphysic, 562
Marston (Elizabeth H.), [W. M. Marston, C. D. King, and], Integrative Psychology: a Study of Unit Response, 1025
Marston (W. M.), C. D. King, and Elizabeth H. Marston, Integrative Psychology: a Study of Unit Response, 1025
Pear (Prof. T. H.), Voice and Personality, 657
Perry (Prof. R. B.), A Defence of Philosophy, 964
Planck (Prof. Max), Positivismus und reale Aussenwelt, 289
Ramsey (F. P.), edited by R. B. Braithwaite, The Foundations of Mathematics: and other Logical Essays, 620
Reinach (S.), Orpheus: a History of Religions, Revised. Translated by Florence Simmonds, 628
Seward (Prof. S. S.), The Paradox of the Ludicrous, 988
Smith (Prof. Sydney), Alcohol and Behaviour, 630

Technology:

Capey (R.), The Printing of Textiles, 855
Gabillion (R.), Soies artificielles et matières plastiques, 855
Hope-Jones (F.), Electric Clocks, 651
Kershaw (S.), Worsted Open Drawing, 1060
Kohle, Entstehung, Veredlung und Verwertung der, Vortrage von W. Petrascheck, H. Apfelbeck, H. Tropsch, R. Heinze, A. Czermak, E. Kothny, H. Löffler, A. Rozinek, J. C. Breinl. Herausgegeben von Prof. K. A. Redlich, Prof. J. C. Breinl und H. Tropsch, 1024
Norman (Ivy Evelyn), and P. I. Smith, Leather Crafts Manual, 1060
Practical Dry Cleaner, Scourer and Garment Dyer, edited by W. T. Brannt and J. B. Gray. Sixth edition, 1060
Raitt (W.), The Digestion of Grasses and Bamboo for Paper-making, 949
Smith (P. I.), [Ivy Evelyn Norman and], Leather Crafts Manual, 1060
Snyder (H.), with biographical sketch by A. L. Winton, Bread: a Collection of Popular Papers on Wheat, Flour and Bread, 953
Williams (J. G.), Textiles on Test: a Study for Distributor and Consumer of the Wearing and Washing Properties of Fabrics and Garments, 855

Revista del Consejo Oceanografico Ibero-Americano, 868
Rhenium: Compounds, Briscoe, Robinson, and Stoddart, 192, 729; Magnetic Resolution of Nuclear Moment of, Prof. P. Zeeman, J. H. Gisolf, and T. L. de Bruin, 637
Rhodesia, Southern, Archæology and Surveying in, 500
Rhodium Compounds, G. A. Barbieri, 683
Rhodopes and the Balkans, The Central, G. Ladame, 83
Rice Research in India, Grant towards, by the Empire Marketing Board, 148
Rift Valleys, the Origin of, African Settlement and, Prof. J. W. Gregory, 87
Ringed Plover and its Eggs, G. Marples, 154
"River Flow Records", Reports of, Capt. W. N. McClean, 867
Rockefeller: Fellowships, award of, 81; Institute for Medical Research, The, 792
Rock-Paintings in North-West Australia, A. P. Elkin, 419
Rocks, Lead Content of, Prof. G. Hevesy and Dr. A. Hobbie, 1038; Prof. A. Holmes, 1039
Roman: Buildings in Britain, Discovery of, 252; Neanderthal Skull, The, Prof. S. Sergi, 306
Rontgen, Wilhelm Conrad, und die Geschichte der Rontgenstrahlen, Dr. O. Glasser. Mit einem Beitrag: Personliches uber W. C. Rontgen, von Margret Boveri, 629
Roosevelt Medal, award of the, to Dr. C. Hart Merriam, 147
Roses, A Virus Disease of, in Australia, B. J. Grieve, 839
Rotatoria from the Ussuri Region, Two New Species of, N. S. Smirnov, 467
Rotary Polarisation, The Natural and Magnetic, of some Organic Compounds studied in the Liquid State, C. Salceanu, 82
Rotifers influenced by Feeding, Polymorphic Characters in, Kenzo Kikuchi, 227
Royal: Anthropological Institute, Foundation of a Gold Medal by, Dr. H. S. Wellcome, 904; College of Science, Scientific Journal of the, Vol. 1, 627; College of Surgeons of England, Lord Moynihan re-elected president of the, 101; Commission on the Civil Service, The, 201; Institution: Rumford and the, a Retrospect, T. E. James, 476; Meteorological Society, Phenological Report for 1930, 633; Microscopical Society, Prof. V. Grégoire and Prof. O. Rosenberg elected Honorary Fellows, 834; Photographic Society, Exhibition of the, 543, 822; Society: Prof. C. Fabry, Dr. E. de Margerie, and Prof. H. Wieland elected Foreign Members of the, 64; Anniversary Meeting of the, presentation of Medals, 973; award of Medals, 821; recommendations for election as Officers and Council of the, 864; award of Royal Medals to Sir Richard Glazebrook and Prof. W. H. Lang, 973; award of the Copley Medal to Sir Arthur Schuster, 973; award of the Davy Medal to Prof. A. Lapworth, 973; award of the Hughes Medal to Prof. W. L. Bragg, 974; award of the Sylvester Medal to Prof. E. T. Whittaker, 974; of Canada: Annual Meeting in Toronto, 275; Sir Robert Falconer elected President of the, 276;

of Edinburgh, election of Officers, 793; for the Protection of Birds, Report of the, 633; Swedish Academy of Science, Sir Sidney Harmer elected a Foreign Member of the, 723
Rubber: Artificial, E. I. du Pont de Nemours, 1044; Research Institute of Malaya, Report of the, 880
Rubidium Spectrum, Hyperfine Structure in the, D. A. Jackson, 34
Ruled Surfaces, The Theory of, W. L. Edge, 856
Rumford and the Royal Institution: a Retrospect, T. E. James, 476
Rural Electrification, E. W. Dickinson and H. W. Grimmitt, 902
Russia: and the U.S.S.R., Faraday and Electrical Science in, W. T. Mitkewich, 359; Industrialisation in, Wigham, 544
Russulas, The Spore Ornamentation of the, R. Crawshay, 891
Rust Diseases of Cereal Crops, Sir R. H. Biffen, 728
Ruwenzori, Uganda, Petrology of the Volcanic Fields east and south-east of, Prof. A. Holmes and H. F. Harwood, 977

Sacred Bull, Cult of the, in Ancient Egypt, O. H. Myers, 119
Safety: in Mines Research Board, Annual Report, 698; Work in Chemical Industries, 1
Sahara, Magnetic and Electrical Observations in the, C. Le Camus and F. de Saint-Just, 882
St. Andrews University: Dr. F. L. Arnot appointed Lecturer in Natural Philosophy, and Dr. G. L. Montgomery Lecturer in Clinical Pathology, 81; Fire Outbreak at, 822; Genl. J. C. Smuts elected Rector, 916
St. Kilda, Change of owner of, 182
Sâl, Seeds and Seedlings of, H. G. Champion and B. D. Pant, 1080
Salix, The Biochemical Study of the genus, C. Charaux and J. Rabaté, 199
Salt Hydrate, Dissociation of a, Function of Water Vapour in the, B. Topley and M. L. Smith, 302
Salters' Institute, award of fellowships of the, 313
Salts: Complex, Absorption Spectra of, Dr. R. Samuel, 729; Dehydration of, Dr. M. Copisarow, 838; of the Iron Group, Gyromagnetic Effect for, W. Sucksmith, 640
Saluda Hydro-Electric Station near Columbia, Completion of the, 330
Santonine, The Mechanism of the Antiglycosuric Action of, A. Leulier and Mme. Andrée Roche, 422
Saturated Hydrocarbons in the Gaseous State, The Thermal Conductivities of, W. B. Mann and B. G. Dickens, 881
Saturn's Ring, The Mass of, H. Slouka, 972
Save the Children International Union of Geneva, Section of Preventive Pædiatrics, Congress of the, 544
Scheele: Carl Wilhelm, The Collected Papers of, Translated by Dr. L. Dobbin, 1023; The Works of, 1023
Schistosomiasis (Bilharziasis), Zoological, Clinical, and Prophylactic, The Bibliography of, Prof. Mohamed Bey Khalil, 65
Schlammanalyse, Die, Dr. H. Gessner, 1061
School Life, January, 197
Schwarzschild Relation, The Validity of the, as applied to the Use of the Logarithmic Sector, F. Twyman and A. Harvey, 770
Sciara, Differences between Chromosome Groups of Soma and Germ-line in, C. W. Metz and M. Louise Schmuck, 423
Science: Advancement of, London and the, 687; Advancing, being Personal Reminiscences of the British Association in the Nineteenth Century, Sir Oliver Lodge, 982; and Agriculture in New Zealand, 981; and Curative Medicine (Stephen Paget Memorial Lecture), Dr. H. H. Dale, 499; and Humanity, 505; and Industry, Creative, 317; and Service, 921; and Technology, The International Congress of the History of, Dr. T. Greenwood, 77; at a New Angle, 562; at the Cross Roads. Papers presented to the International Congress of the History of Science and Technology . . . by the Delegates of the U.S.S.R., 170; Bibliography of, Classification for, Dr. S. C. Bradford, 268; in the City of London, Engr.-Capt. E. C. Smith, 515; Man of, The Faith of a, Sir Daniel Hall, 1069; Museum: A New Children's Gallery at the, 994; Sir Richard Glazebrook appointed Chairman of the Advisory Council of the, 184; National Teaching of, Problems in the (Pedler Lecture), Prof. I. Masson, 753; Post-Primary, W. F. F. Shearcroft. Book 1: First Year's Course, 960; The Beginnings of, Dr. C. Singer, 7; The Recorded Data of, 662; The Social Function of, Prof. C. H. Desch, 824
Scientific: Abstracting Services, Organisation of, A. A. Eldridge, 1004; and Industrial Research, Department of, Dr. F. S. Sinnatt appointed Director of Fuel Research, 1072; and Technical Books, Recent: July 25, v; Aug. 22, v; Oct. 31, v; Nov. 28, v; Dec. 26, v; Management Problems, 1008; Men as Administrators, 237; Research and Invention, The Value of, Prince of Wales, 60; World-Picture of To-day, The, Genl. J. C. Smuts, 521
Scorodite from Kiura Mine, Bungo, Kiushiu, Japan, T. Ito and T. Shiga, 977
Scottish Marine Fauna, Studies in the, R. Elmhirst, 42
Scylliorhinus Canicula, The Physiological Nature of the Diastase, secreted by the Eclosion Gland in, Ouang Te Yio, 846
Sea: -Angling Fishes of the Cape (South Africa), C. L. Biden, 209; -elephant, A, at Cape Point, 634; -lion Census, A, P. Bonnet, 640; Phosphorescence of the, 843; Stars, South American, W. K. Fisher, 154; -urchin, Larvæ of the, Influence of Metallic Silver on the Calcification of the, G. Bohn and Mme. Anna Drzewina, 806; Water, Irradiation of, by Ultra-Violet Rays, etc., L. Sanzo and F. Pirrone, 806
Seed Analysis, Commercial, British Association of, Annual Meeting of the, 265
Seedlings in some Grasses, Latency of, H. G. Chippindale, 1075
Seeds, Damaged, Germination of, 307
Seismological: Committee of the British Association, Report of the, 580; Messages, a Provisional Code for, 994; Stations, New, 181
Seminal Vesicle, Regulation of the Secretory Activity of the, H. Burchardt, 468
Serpent Worship, W. D. Hambly, 1043
Serum Albumin, Temperature Stability and Denaturation of, Dr. K. O. Pedersen, 150
Service, Science and, 921
Sex Rites and Customs: A Bibliography of, an Annotated Record of Books, Articles, and Illustrations in all Languages, R. Goodland, 892
Sheep, A Naked, E. T. Popova-Wassina, 866
Sheffield University: appointment of B. H. Bentley as Professor of Botany, of Dr. R. N. Rudmose Brown as Professor of Geography, of L. E. S. Eastham as Professor of Zoology, of Dr. J. Florey as Professor of Pathology, and Dr. J. W. Edington as Professor of Bacteriology, 1048; Prof. J. H. Andrew appointed Professor of Metallurgy, 975
Shells, Industrial, of the Philippines, F. Talavera and L. A. Faustino, 676
Shipping, Engineering, and Machinery Exhibition, The, 488
Ship-waves, Rhythmic Breaking of, Prof. Kerr Grant, 838
Shoalhaven River Valley, Physiography of the, F. A. Craft (1), 279; (2), (3), 387
Short Wave Reception and Ultra-Radiation, Dr. W. M. H. Schulze, 837
Shoshonean Linguistics, Dr. E. Sapir, 379
Shrikes, The Impaling Instinct of, A. H. Miller, 1005
Siam: Nature and Industry, 209
Siderolite from Bencubbin, Western Australia, A New, E. S. Simpson and D. G. Murray, 977
Sigma Scorpii, B. H. Dawson, 1081
Silica: remaining after attacking Leucite with Acids, Certain Properties of the, G. A. Blanc, 647; Vessels, Influence of Hydrogen on Chemical Changes in, Prof. M. W. Travers, L. E. Hockin, and T. J. P. Pearce, 66
Silkworms, Starch Digestion in, Osamu Shinoda, 497
Silver: Bivalent, Paramagnetism of, Prof. G. T. Morgan and Dr. S. Sugden, 31; and Mercury, Alloys of, Constitution of the, Dr. A. J. Murphy, 554, 1082

Simonis Reaction, Application of the, to Monohydric Phenols, A. Robertson, 908
Slate, X-Ray Analysis of, H. V. Anderson, and K. C. Chesley, 1043
Sleep, Bodily Position in Restful, Dr. H. M. Johnson, 190
Slide Rule: A Manual of the, its History, Principle, and Operation. Second edition, 563
Smallpox Prevention, Review of certain Aspects of, 148
Smekal-Raman-Effekt, Der, Prof. K. W. F. Kohlrausch, 1026
Smithsonian Institution: Explorations and Field-work, 1930, 147
Smoke Abatement Handbook, 1034
Smooth Surfaces, On the Contact of, S. H. Bastow and F. P. Bowden, 881
Snakes: Attraction of, to Dead Ones, 329; Insectivorous, Prof. F. J. Meggitt, 413
Soap and Detergent Industry, The Modern, Dr. G. Martin. Second edition. 2 vols., 625
Social Economics, Industrial and, 773
Société: française des Électriciens, title of Honorary Member of the, conferred on P. F. Rowell, 834; Zoologique de France, Sir Sidney F. Harmer elected an Honorary Member of the, 29
Society Islands, Class Distinction in the, Dr. E. S. C. Handy, 459
Soda, The Reduction of, P. Villard, 978
Soies artificielles et matières plastiques, R. Gabillion, 855
Soil: *Bulletin*, The, 298; Classification, L. L. Lee, 677; Science, The Aims and Objects of, Prof. I. de V. Malherbe, 801; The Physical Properties of the, Dr. B. A. Keen, 391
Soils, The Interchange of, L. I. Jones, 668
Solar: Corona, Forms of the, and their Origin, Dr. W. J. S. Lockyer, 784; Radiations, Influence of the, on the Temperature of the Bodies of Insects, J. D. Strelnikov, 125; System, The Origin of the, Sir James Jeans, 432
Solid State, The Architecture of the, Prof. W. L. Bragg (Kelvin Lecture), 210, 248
Solution, Association Theory of, and Inadequacy of Dissociation Theory, Jitendra Nath Rakshit, Rai Sheheb, 852
Solutions, Constitution of, deduced from Absorption Measurements, P. Vaillant, 918
Solvents, Dr. T. H. Durrans, 958
Sonora, Mexico, Land Birds of, A. J. van Rossem, 190
Soral (Canton of Geneva), The Phreatic Sheet of, E. Joukowsky, 235
Sound: in Tubes: Velocity of, Ultrasonic Method, G. S. Field, 117; Production, The Effective Mass of Flexible Discs and Conical Diaphragms used for, Dr. N. W. McLachlan, 733
Sounds, Isolated, Articulation of, C. E. Parmenter, S. N. Trevino, and C. A. Bevans, 380
South: Africa: medal of the South African Association, award of the, to Prof. H. B. Fantham, 29; New Game Reserves in, Prof. H. B. Fantham, 992; African: Association: 1932, election of Prof. P. J. du Toit as President, 802; Grahamstown Meeting. Presentation of South Africa Medal and grant to Prof. H. B. Fantham, 801; Museum, Progress of the, 265; Tribe, Ethnological Survey of a, 614; Australia, The Rift Valleys of, Dr. C. Fenner, 155; London: Botanical Institute, Twenty-first Anniversary of the, 697; Entomological and Natural History Society, *Proceedings* for 1931–32, 635; Russian Steppe Graves, Prof. V. Gordon Childe, 190
Southampton, University College of: Wing Comdr. T. R. Cave-Browne-Cave appointed Professor of Engineering and H. Leech Experimental Engineer, 681; S. Weintroub appointed an Assistant Lecturer in Physics at, 278
Southern: Equatorial Africa, Proposed Compilation of a Geological Map of, 438; Rhodesian Geology, R. Tyndall-Biscoe, 971; Whaling, Sir Sidney F. Harmer, 292
Soviet Science, Prof. F. S. Marvin, 170
Space Lattice? A Two-Dimensional: Dr. R. C. Menzies, 907; W. Baker, 1078
Spark, Formation of a, F. G. Dunnington, 1081
Sparrows, London, Degeneracy in, 180
Spatial Distance in General Relativity, On the Definition of, H. S. Ruse, 882
Special Libraries and Information Bureaux, Association of, 644
Spectra, Index of, late Dr. W. Marshall Watts. Appendix Z: Iron and Iron Oxide, 1060
Spectrum: Se III., The Structure of the, J. S. Badami and Dr. K. R. Rao, 496; Sensibility of Photoelectric Cells, Extension of the, under the Action of Oxygen, G. Dejardin, 83
Speech and Music, Reproduction of, Modern Apparatus for the, Dr. N. W. McLachlan, 517
'Spekker' Photometer, The, for Ultra-Violet Spectrophotometry, F. Twyman, 770
Spektroscopie, Handbuch der, Prof. H. Kayser und Prof. H. Konen. Band 7, Lief. 2, 1061
Spherical Astronomy, Text-Book on, Prof. W. M. Smart, 207
Sp. hispanicum var. *marocanum*, The Jackal and Hedgehog Reservoirs of, P. Delanoë, 770
Spiral Nebulæ, The Apparent Recession of the, M. L. Humason, 461
Spiriferidæ, The British Carboniferous Reticulate, T. N. George, 1012
Squilla, Anal Gland of, T. Komai and Y. M. Tung, 762
Stainless Metals, Sir Harold Carpenter, 382
Star: Apparent Diameter of a, Calculation of the, P. Rossier, 734; Density in Different Galactic Latitudes, P. J. Melotte, 192
Stars: Collapsed, and Novæ, Prof. E. A. Milne, 587; Double: Catalogue of, 1045; Measures of, Prof. F. P. Leavenworth. With which are included the Measures by W. O. Beal, 743; in their Courses, The, Sir James Jeans, 615, of High Luminosity, The, Cecilia H. Payne, 615; White Dwarf: Constitution of, Seitarô Suzuki, 838; The Internal Temperature of, Prof. E. A. Milne, 999; with Nebulæ, Impact of, K. Hirayama, 156
Statistics and Actuarial Science, Some Recent Researches in the Theory of, Prof. J. F. Steffensen, 286
Steel: Industry, the British Heavy, Prof. H. Stanley Jevons, 678; Mild, in Hot-galvanising, Attack on, E. J. Daniels, 594
Stellar: Energy, Atomic Synthesis and, Dr. R. d'E. Atkinson, 194; Photometry, A. S. Fairley, 461; Rotation, Dr. E. A. Kreiken, 308; Velocities, Measurement of, Absorption Spectra of Crystals at Low Temperatures as References in the, S. Freed, 33
Stereoisomerism of Derivatives of 1:1′-dinaphthyl, A. Corbellini, 1014
Sterilisation: and Mental Deficiency, 129; Human, pamphlet on, 111
Sternkunde: Die Geschichte der, von den ersten Anfangen bis zur Gegenwart, Prof. E. Zinner, 986
Stipa nitida, The Autecology of, T. G. B. Osborn, J. G. Wood, and T. B. Paltridge, 918
Stocks, Ever-sporting, A Satellite missing from, Dr. J. Philp and Prof. C. L. Huskins, 970
Storm of July 24, 1930, in the Treviso-Udine District: A. Puppo, 199; A. Puppo and P. Longo, 466
Strangeways Research Laboratory, Cambridge, Report of the, 792
Stratified Clouds: Electrical Conditions in, Dr. M. Graham, 969; The Forms of, Part 1: Experimental; Part 2: Discussion, Sir Gilbert Walker and A. C. Phillips, 917
Stratigraphy, General, Prof. J. W. Gregory and B. H. Barrett, 945
Streaks in Chemical Studies, E. Schally (4), 468
Street: Lighting: Tests on, 996; The British Standard Specification for, C. C. Paterson, 488; Traffic: Control by Visual Signals, 180; Engineering, Dr. M. McClintock, 1033
Stresses: in Welded and Riveted Connexions, Distribution of, W. Hovgaard, 555; in Wheels, Prof. E. G. Coker, 174
Stretta, The Struggle of Cereals against, R. Perotti, 735
Strontium and Barium, New Isotopes of, Dr. F. W. Aston, 221
Strukturbericht, 1913–1928, P. P. Ewald und C. Hermann, 511

Strychnos henningsii, The Alkaloids of the Bark of, M. Rindl, 200
'Sub-genes', A Hypothesis of, Sturtevant and Schultz, 273
Sudanese Kingdom: A, an Ethnographical Study of the Jukun-speaking Peoples of Nigeria, C. K. Meek, 285
Sugar Cane: -Breeding Stations, proposed, 181; Mosaic, Immunity to, acquired by the Host, E. M. East, 555; Research Conference, Imperial, 1931, 160
Sugars from Human Milk, Two New, Gyrolactose and Allolactose, M. Polonovski and A. Lespagnol, 125
Sulphides of the Rare Earths, Study of some, Picon and Cogné, 882
Sulphur: and Growth, L. Binet and J. Magrou, 466; The Photochemical Oxidation of, R. Dubrisay and R. Pallu, 646
Sulphuric Acid, The Comparative Hydration of, and of the Alkaline Bisulphates, J. B. Senderens, 199
Sun, The horizontal Diameter of the, in 1929 and 1930, G. Armellini, 1014
Sunshine, Bright, A Method of recording, W. A. Thomson, 15
Superconductivity: a Polarisation Phenomenon, Prof. J. C. McLennan, 373; at High Frequencies, Prof. J. C. McLennan, A. C. Burton, A. Pitt, and J. O. Wilhelm, 1004
Surface: Conductivity, Electrokinetics and the Interpretation of, McBain and Du Bois, 677; Films, A Method of Studying, Prof. E. Gorter and W. A. Seeder, 413
Surnames: of the British Isles: A History of a Concise Account of their Origin, Evolution, Etymology, and Legal Status, C. L'Estrange Ewen, 891; The Story of, W. D. Bowman, 743
Surveying: from Air Photographs, Capt. M. Hotine, 946; The New, 946
Swanley Horticultural College, Dr. Catherine C. Steele appointed Lecturer in Agricultural Chemistry and Physics in, 197
Swedish: Ironfields, 384; Turnip (*Brassica napus* L. var. *napobrassica* (L.) Reichb.), On a Method of Distinguishing the Seedlings of, from those of Broad-leaved Rape (*Brassica napus* L. var. *biennis* (Schubl at Mart) Reichb.), M. J. Gorman and H. A. Lafferty, 162
Switzerland and Swiss Industrial and Economic Development, Faraday's Connexion with, Prof. C. E. Guye, 349
Symbiose, Tier und Pflanze in, Dr. P. Buchner, 558
Symbiosis, 558
Symons Gold Medal of the Royal Meteorological Society, award of the, to Prof. V. F. K. Bjerknes, 931
Syphilis, Detection of, Dr. L. V. Blina, 459

Tadpoles, The Splenectomy of, Daphne L. Coulston, 316
Tanning and Unexposed Skin Colour, Correlation between, as recorded by the Colour Top, F. Clements, 423
Tannery, Paul: and the History of Science, Prof. F. S. Marvin, 613; Mémoires scientifiques de, Publiés par L.-L. Heiberg et H.-G. Zeuthen. Tome 10 (Suppt. au Tome 6): Sciences modernes, généralités, historiques, 1892–1930. Édité avec la collaboration de J. Pérès, 613
Tartaric Acid and Copper, Spectrographic Study of the Compounds of, J. Giuntini, 646
Taste and Chemical Constitution, A. L. Fox, 124
Tchistaya-Gora Deposits in the Southern Ural, The Pyrophyllite from the, S. Kurbatov, 770
Technical: Colleges, Applied Chemistry in, 678; Man, The Faith of a, O. Bloch, 901
Telegraph and Radio Telegraphic Transmissions, Secrecy of, E. Belin, 421
Telephony in Large Cities, Progress of, 330
Telescope Mirrors, Silvering, G. Tiercy, 236
Television: and Atmospherics, T. Bray, 439; Progress of, 670
Temple of the Warriors at Chichen Itzá, Yucatan, The, E. H. Morris, J. Charlot, Ann Axtell Morris. 2 vols., 694
Tensors: The Elementary Theory of, with Applications to Geometry and Mechanics, Prof. T. Y. Thomas, 626
Ternary Heteroazeotrope formed of Carbon Disulphide, Acetone, and Water, The, W. Swietoslawski and Mlle. L. Wajcenblit, 918
Terrestrial Vertebrates, Combination of Factors to which the Origin and the Development of, is due, M. A. Menzbier, 127
Tertiary Foraminifera, Dr. W. A. Macfadyen; Dr. J. A. Cushman and J. D. Barksdale, 1080
Testing of Materials, International Congress for the, 643; Dr. W. Rosenhain elected President for 1935, 644
Tetanus and Tonus Substratum, Histology and Chemistry of, P. Kruger and F. Furlinger, 468
Tetraethylammonium and Ammonium Salts, Conductivity of, Sir Harold Hartley, and others, 461
Textile Research, 193
Textiles: on Test: a Study for Distributor and Consumer of the Wearing and Washing Properties of Fabrics and Garments, J. G. Williams, 855; The Printing of, R. Capey, 855
Thallium: and Uranium, Constitution of, Dr. F. W. Aston, 725; Indium and, Arc Spectrum of, Fine Structure in the, Dr. A. L. Narayan, 675; Pharmacology of, J. C. Munch and J. Silver, 383; The Atomic Weight of, Prof. H. V. A. Briscoe, and others, 763; II., Hyperfine Structure of, Dr. J. B. Green and J. Wulff; Dr. H. Schuler and J. E. Keyston, 409
Thames, The Tidal, Sir Cyril Kirkpatrick, 789
Theophylline Arabinoside, The Pyranoid Structure of Glucuronic Acid and of, J. Pryde and R. T. Williams, 187
Thermionic Valves with Fall of Potential across the Grid, A. Lo Surdo, 734
Thermocouples in a Vacuum, Some Properties of, J. Jaffray, 1086
Thermodynamics, Generalised, Prof. G. N. Lewis, 498
Thermometers, Distance, Negretti and Zambra, 972
Thrips tabaci as a Vector of Plant Virus Disease, G. Samuel and J. G. Bald, 494
Thunderstorms, Point Discharge Measurements below, J. Schonland and C. A. Coppens, 200
Thyratrons, An Application of, Dr. Wynn-Williams, 307
Ticks, The Spermatogenesis of, Prof. E. Warren, 454
Tide-gauge Measurements at Height Differences, D. la Cour, 875
Tigroid, Chemical Nature of the, Prof. A. Szent-Gyorgyi, 761
Time-Recording, Improvement in, A. L. Loomis, 38
Titanium: A Reliable Method for the Quantitative Separation of, from Tantalum and Niobium, W. R. Schoeller and C. Jahn, 845; in the Tetrachloride, Valency, and Diamagnetism of, Dr. V. I. Vaidhianathan, 189
Toad, Anterior Abdominal Vein in the, Prof. Ekendranath Ghosh and Birendrakumar Mitra, 273
Tobacco Plant, A New Virus Disease of the, Dr. H. H. Storey, 187
Togoland, Tales told in, A. W. Cardinall. To which is added the Mythical and Traditional History of Dagomba, by E. F. Tamakloe, 1026
Toluene: Benzene and, Raman Spectra of, L. E. Howlett, 796; The Transformation of, and of Xylene into Methane, A. Mailhe and Creusot, 466
Tomlinson, The late Mr. Herbert, F.R.S., J. J. Abraham, 153
Topography and Tradition, Prof. J. L. Myres, 938
Tortoises, Giant, of Galapagos, Age of the, C. H. Townsend, 227
Tragulidæ (Mammalia, Artidactyla), The Generic Characters in the Family, K. K. Flerov, 503
Transbaikalia, Northern, The Chemical Composition of the Water in the Hot Springs in, A. Frank-Kamenetskii and V. Koncevich, 422
Translations, International Bibliography of, Proposed Formation of an, 405
Transit Instrument, Systematic Use of the Rotation of the, G. Tiercy, 734
Tree: Growth: and Weather, Hirokichi Nakashima, 840; Illumination and, Dr. W. R. G. Atkins and Florence A. Stanbury, 191; -Kangaroos at the London Zoological Gardens, 996; -Rings and the Sunspot Cycle, Dr. A. E. Douglass, 121

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Of Nature trusts the mind that builds for aye."—WORDSWORTH.

SATURDAY, JULY 4, 1931.

CONTENTS.

PAGE
Safety Work in Chemical Industries 1
Radioactivity and the Atomic Nucleus. By Prof. Arthur H. Compton 3
Man's Remote Ancestry. By Prof. G Elliot Smith, F.R.S. . 4
Gold Resources of the World. By Dr. William Cullen . . 4
Short Reviews 6
The Beginnings of Science. By Dr. Charles Singer . . 7
Population Problems 10
Obituary:
Mr. W. P. Denning. By H. P. H. 12
News and Views 14
Letters to the Editor:
Embryology and the Theory of Polyhedra.—Prof. D'Arcy W. Thompson, C.B., F.R.S. 31
Effect of Certain Substances and of Heat on Cells of *Abraxas*.—Prof. J. Brontë Gatenby and Joyce C. Hill . . . 31
Paramagnetism of Bivalent Silver.—Prof. G. T. Morgan, O.B.E., F.R.S., and Dr. S. Sugden 31
Forestry Practice and Research.—A. C. Forbes . . . 31
The Age of Flint.—Maurice Burton 32
Absorption Spectra of Crystals at Low Temperature as References in the Measurement of Stellar Velocities.—Simon Freed 33
Mortality among Plants and its Bearing on Natural Selection.—R. Weatherall 33
The Heat of Dissociation of Fluorine —Manohar S. Desai . 34
Hyperfine Structure in the Rubidium Spectrum.—D A. Jackson 34
Hail Storm, June 14, at Doncaster.—N. L. Silvester . . 35
An Apparatus for Recording the Ultra-Violet Light of the Sky. —Dr. P. W. Cunliffe 35
Records of Actinic Value of Daylight.—Geo. J. Gibbs . . 35
Experiments in Prophylaxis.—Sir Flinders Petrie, F.R.S. . 35
Crystal Structure of Molybdenum Trioxide : A Correction.—Nora Wooster 35
Research Items 36
Astronomical Topics 38
Recent Advances in the Chemistry of the Vitamins . . 39
University and Educational Intelligence 41
Birthdays and Research Centres 41
Societies and Academies 42
Official Publications Received 43
Diary of Societies 44
SUPPLEMENT.
Standards of Measurement: Their History and Development. By Sir Richard Glazebrook, K.C.B., F.R.S. . . . 17

Safety Work in Chemical Industries.

THE common impression that chemical industry is exceptionally dangerous is largely derived from such disasters as the serious explosion at the Royal Naval Cordite Factory, Holton Heath, on June 23, in which ten men were killed and three seriously injured. Like the Castleford disaster of last year, the explosion originated in the nitrating house, and indicates the devastating effects of chemical processes which are allowed to get out of control.

In spite of the poisonous and dangerous materials and the high temperatures and pressures which are frequently used, the accident rate in chemical industry compares very favourably with that of other industries, in a number of which both the frequency rate and the severity rate of accidents are considerably higher. This position is the result not only of experience but also of accurate and scientific control of the manufacturing processes. Chemical manufacturers are now well aware of the dangers connected with their industry, and take every possible step to reduce the number of accidents in chemical industry and develop adequate safety measures.

It is, indeed, significant that even in processes which to the ordinary person appear to involve the greatest risks, the accident rate, as a result of exceptionally strict control, is even lower than normal. The price of safety is unceasing vigilance, and the characteristic of chemical industry is not a high accident rate, but the appalling consequences which may attend the single slip or oversight on the part of the human element, which is responsible for 90 per cent of industrial accidents. The Castleford disaster may apparently be traced to the neglect to sample the waste acid storage tanks in the ordinary way, the Home Office inspectors observing that proper sampling might have led to detection of the presence of the nitro-compound in the acid mixer and allowed suitable precautions to be taken.

Even the strictest control may, however, at times be thwarted by some abnormal conditions, and if, as at Holton Heath, responsible officials such as the chemist in charge perish in the explosion, or, as at Chatterley, Stoke-on-Trent, on June 3, lose their lives in attempts at its control, it is difficult to detect the abnormal circumstances responsible and devise precautions to prevent its recurrence. This emphasises both the need for research into the causes of accidents and the importance of correlating, by publication, abstracting, and indexing, the information obtained by research or other means.

As noted in a recent article in NATURE (May 30, p. 805), to this formidable problem scientific workers have as yet given inadequate attention. Much valuable work has already been done, especially in chemical industry, which compares very favourably with other industries. In Germany, the work of the Berufsgenossenschaft der chemische Industrie is well known, and its publication in *Die chemische Industrie* of illustrated notes on accidents, safety precautions, and devices compiled by the technical inspectors receives a wide circulation. In Great Britain, the efforts of the Association of British Chemical Manufacturers, which in the last two years has undertaken the task of abstracting, indexing, and publishing safety information pertaining to chemical industry, are by no means so well known as they should be. The Association has published quarterly, since January 1930, a classified summary of safety information, derived not only from published literature but also from the records of the Association. The latter include information supplied privately by members of the Association, and this adds very considerably to their value. The wider the membership of the Association, and the more fully its members co-operate in this work by pooling their information on safety matters, the more effective and invaluable its Safety Summary will become.

In addition to the Safety Summary, the Association of British Chemical Manufacturers has for several years published what are termed " Safety Circulars ". These are single sheets dealing with accidents which either present some unusual feature or indicate some useful precaution. The circular usually describes briefly the accident and its cause, and gives the views of the Works Technical Committee of the Association as to the precautions necessary to avoid repetition of the accident. Recent circulars have dealt with the escape of sulphuric acid in transfer by air pressure from a tank waggon to a raised storage tank, fires at a tar distillation plant and benzole plant, the bursting of a drum of phenol by compressed air, and fires at cellulose spraying plants. Such circulars are obviously of an interest which is not confined to chemical industry in the narrower sense. This is recognised by the Association, which holds the view that safety information, like medical science, should receive the widest possible publication. Accordingly, not only has a system of co-operation been arranged for the pooling of information with French and German colleagues, but also the benefits of its safety service are available to non-members on payment of a suitable fee.

A further feature of the safety work of the Association of British Chemical Manufacturers is the " Model Safety Rules for Chemical Works ", of which Part 1 and a first section of Part 2 have already been issued to its members. These rules, as indicated by Mr. J. Davidson Pratt in his recent address on " The Cleaning and Repair of Plant and Vessels containing Dangerous Materials " at the Chemical Session in the National Safety First Week at Leeds, in some respects go beyond the Chemical Works Regulations issued by the Home Office. The addition to which Mr. Pratt particularly referred was intended to prevent misunderstanding where the full implications of the regulations regarding the thorough removal of dangerous material might conceivably be overlooked.

In his paper, Mr. Pratt outlines the main types of risk attached to the cleaning of containers and the chief precautions to be taken. While the details to be followed may vary widely with different materials and classes of vessel, certain general principles can be enunciated. For these the widest publicity is desirable, especially since volatile and dangerous solvents are now widely used in industries where the scientific knowledge and control is by no means so prominent as in chemical industry. In such industries the design of plant to facilitate safe cleaning may be completely overlooked and the question of responsibility assumes great importance.

Even in chemical industry the term ' responsible person ' does not always receive an interpretation consistent with its use in the Chemical Works Regulations. Many serious accidents have occurred because the testing of stills or containers prior to repair work or entry by workmen has been entrusted to persons without adequate scientific knowledge. Under modern conditions, industrial safety requires the employment in industry generally of larger numbers of chemists and other responsible scientific workers. Under-staffing on the scientific side definitely increases the risks of operatives, and while it is probable that some delegation of responsibility is unavoidable under industrial conditions, the scientific and technical staff should be adequate to ensure thorough training of, and personal contact with, those to whom such responsibility is at any time delegated. It was a public-spirited policy which led the organisers of the British Association of Chemists to include in its programme the endeavour to secure legislation providing that certain prescribed operations should be under the direct control and supervision of a qualified chemist. While in practice such operations can frequently be carried out by well-trained assistants, their efficiency, especially from the safety point of view, depends upon uninterrupted personal contact with a responsible chemist upon whose experience and knowledge they can draw at once in emergency.

Radioactivity and the Atomic Nucleus.

Radiations from Radioactive Substances. By Sir Ernest Rutherford, Dr. James Chadwick, and Dr. C. D. Ellis. Pp. xii + 588. (Cambridge: At the University Press, 1930.) 25*s.* net.

THE appearance of a new book on radioactivity by Lord Rutherford and his associates is a noteworthy event in the world of physics. Rather than prepare a new edition of his standard treatise on "Radioactive Substances and their Radiations", the senior author has chosen to devote his present discussion primarily to the significant developments in radioactivity which have occurred since that treatise appeared. These developments deal primarily with the characteristics of the radiations from radioactive materials and the effects which they produce. In view of the present state of physics, and the fundamental questions associated with the outer part of the atom apparently well understood, and the atomic nucleus offering perhaps the most vital problem with which physics is now faced, we are fortunate to be presented with this clear and comprehensive account of the information regarding the nucleus which is afforded by studies in radioactivity. Nothing could be more timely.

One is impressed by the extent of the important information that has come from recent studies in radioactivity. Thus, among other things, discussions are found of the disintegration of atoms by alpha ray bombardment; the studies of nuclear charge and nuclear size by the scattering of alpha rays; the discovery of rare alpha, beta, and gamma particles of extraordinarily large energy, revealing hitherto unsuspected types of disintegration; the quantum mechanics theory which describes how radioactive disintegration is possible; magnetic beta ray spectra, and their associated gamma ray spectra, revealing nuclear energy levels and evidence that electrons as discrete entities may not exist within the nucleus; crystal measurements of gamma ray wave-lengths, and the precise confirmation of Einstein's photoelectric equation at very high frequencies; recent quantum theories of gamma ray scattering; experiments with cosmic rays and their significance regarding the origin of the rays. Many of these developments have resulted from the labours of the authors themselves, and none could be found better qualified to describe them.

Gradually our knowledge regarding the atomic nucleus becomes more precise. Experiments with scattered alpha rays have shown its minute size and its relative large mass. They have enabled us to measure its charge, and even to estimate the field of electric force in its neighbourhood. Further information on the latter point is given by the speed with which the alpha particles are ejected from the radioactive nucleus. Combining the evidence from these alpha ray experiments, it becomes evident that surrounding the nucleus there is a 'potential wall', which prevents alpha particles that are outside from entering the nucleus and those on the inside from escaping. We are thus afforded a basis for developing a quantum theory of radioactive disintegration according to which the probability of an alpha particle jumping this wall is greater if it has large energy, and a qualitative explanation of one of the fundamental laws of radioactivity is obtained. Studies of the sharpness of gamma ray lines suggest a nucleus in which planetary alpha particles correspond to the electrons of the outer atom; though how these particles are held together remains unknown. Similarly, the condition of the electrons in the nucleus remains unsolved. There is no gamma radiation that can be traced to these electrons, and when they appear as beta particles their energies are distributed over broad bands. Though much new light is shed by these studies in radioactivity, the nucleus of the atom, with its hoard of energy, thus continues to present us with a fascinating mystery.

It is inevitable that in an undertaking of this magnitude not all parts of the treatment can be kept strictly up to date. Thus, for example, in discussing the spectra of gamma rays from crystals, though the important work of Thibaud (1925) and Frilley (1928) is mentioned, that of Steadman (1929), which reveals gamma rays of frequency much higher even than those observed with the magnetic spectrometer, is not referred to. The impression is, nevertheless, that the authors have covered the field with great thoroughness, and have made careful selection of the material that is included.

For those who are familiar with Rutherford's style from his earlier writings, it is superfluous to mention the clarity and succinctness of his portion of the present book. Dr. Chadwick and Dr. Ellis are, however, to be congratulated in having caught something of the senior author's lucidity of expression. The result is a well-balanced discussion which the novitiate will find readable, and those working in the same field will find a mine of suggestive ideas and authoritative information.

ARTHUR H. COMPTON.

Man's Remote Ancestry.

The Origin of the Human Skeleton: an Introduction to Human Osteology. By Dr. Robert Broom. Pp. 164. (London: H. F. and G. Witherby, 1930.) 10*s.* 6*d.* net.

WHEN, nearly forty years ago, Dr. Broom went to Australia to study the most primitive mammals now surviving, very little that was more than conjecture was known of the origin of mammals. As the result of his researches on the comparative anatomy of the Australian monotremes and marsupials and the examination of the rich harvest of fossils that has rewarded his thirty-four years of searching in South Africa, he has recovered so many links between the most primitive reptiles and mammals as to be justified in claiming, as he does in this book, that the essential problem of the origin of mammals is now definitely solved. Incidentally also, the question of the origin of lizards and crocodiles has been answered, and new light has been thrown upon the ancestry of dinosaurs and birds.

It is not surprising that the man who has contributed so largely to these great achievements, and himself recovered in the field most of the material which made them possible, should be able to write with freshness and originality, with a disregard for traditional views and pedantry, on the subject of his lifework. In this small book, Dr. Broom gives a concise and wonderfully simple and convincing account of the information afforded by the comparative anatomy of the skeleton in vertebrates to demonstrate the line of evolution leading to reptiles, the derivation of mammals from one of the reptilian groups (Ictidosauria) at the close of the Triassic, and the origin of the Primates from a primitive Menotyphlous mammal before the end of the Cretaceous.

In the process of building up his argument, Dr. Broom examines in turn the comparative anatomy of the skull, the vertebræ and sternum, and the limbs, and thus incidentally has written in bold outline a most fascinating story of "the origin of the human skeleton", which is the descriptive label he has given his book. His wise selection, no less than his boldness and courage, eliminates most of the puzzling complexities of a difficult subject, and has enabled him to write with full mastery and lucidity a surprisingly easy and stimulating narrative. Whether or not this drastic re-interpretation of our knowledge will stand the test of critical analysis is, at the moment, of less importance than the consideration that a mass of new information is skilfully woven into the fabric of an easily comprehended hypothesis, which will provide the student with a clear-cut scheme wherewith to test the evidence, as well as the scheme itself, the brilliant hypothesis which Dr. Broom has constructed in tentative interpretation of the facts. This masterly synthesis is a conspicuous contribution to the study of the origin of mammals and of the evolution of man, which every student of human and comparative anatomy should assimilate.

G. ELLIOT SMITH.

Gold Resources of the World.

The Gold Resources of the World: an Inquiry made upon the Initiation of the Organising Committee of the XV International Geological Congress, South Africa, 1929. With a Summary by A. C. Sutherland. Pp. xiv + 457 + 38 plates. (Pretoria: Wallach's, Ltd., 1930.) 25*s.*

IN 1929 the fifteenth International Geological Congress met in South Africa—synchronising as to time with the meeting of the British Association. The organising committee of the Congress had decided beforehand to initiate an inquiry into the gold resources of the world, as it was felt that such a subject was singularly appropriate. Previous congresses had dealt with the world's resources of iron ore, coal, and pyrites, and these reports are still looked upon as standard works of reference. The Prime Minister of the Union, General Hertzog—who was honorary president of the Congress—issued a circular letter on Oct. 31, 1927, asking for the assistance and co-operation of those countries which have ever been known producers, and the reports are set out in this volume. There are also innumerable maps and useful statistical tables.

Let it be said that, on the whole, these reports are extraordinarily well done, and the names of their respective authors are a guarantee of accuracy, so far as this is possible. An introduction by Dr. A. L. Hall, a member of the staff of the Geological Survey of the Union, who acted as general secretary of the Congress, explains the scope of the work, and a most informative summary of the reports by Mr. A. C. Sutherland, formerly mine surveyor on the staff of the Union Government Mining Engineer, gives all the information which the casual reader would wish to have. So far as one can see, no country has been omitted, and although the same degree of accuracy, or rather approximation to accuracy, cannot be claimed for the gold resources report as for the previous three which have already been mentioned, it can be said that it is the best which can be done.

Gold has always been the premier precious metal. Mythology, the classics, and the Bible all teem with references to it, but never has it been talked about so much as to-day. True, the economists differ as to its utility, and one hears criticisms concerning its distribution, but all are agreed that it is the basis of the monetary system of most of the important countries of the world. It is also the yard-stick whereby wealth is measured and consequently the basis of credit. Yet, contrary to popular opinion, it is merely a commodity, subject like all others to ordinary economic laws, and when it costs a mine twenty-one shillings to recover gold from one ton of ore which contains only twenty shillingsworth of gold, the mine which has that ore must assuredly go out of business. Moreover, with all the searching during the centuries—and the search still continues—no other metal or commodity seems capable of taking its place.

No wonder, therefore, that there have been gold rushes in California, Australia, the Klondike, and in South Africa; and these will continue. True, we do not hear of them so much to-day, because our old world has been fairly well prospected during the past fifty years. But one would not expect to hear of a gold rush in Ireland, yet it is well known that there is plenty of alluvial gold in County Wicklow, and there was a veritable rush there in 1795, when 800 oz. were recovered by peasants in six weeks. The summary already referred to shows that the British Empire is responsible for more than 70 per cent of the world's production, the Transvaal itself accounting for more than 50 per cent. Gold was first discovered in Bechuanaland by Carl Mauch in 1866; and since returns were made, the recorded value of the Transvaal output alone is now more than one thousand million pounds. The United States, which has long been out of the race for the premier position, is only a little way behind South Africa, and Australia comes next, with a total value of about six hundred millions.

Dr. Pirow, Government Mining Engineer to the Union of South Africa, on page 337 makes the following remarkable statement: "Since the year 1884, prior to which date no reliable figures are available, the Union of South Africa has produced a total of 229,051,118 fine ounces of gold, equivalent to 22·4 per cent of the total estimated world production to date, or 34 per cent of the production since the Union first entered the list of gold producers".

Though gold is widely distributed, the countries which have contributed substantially to the world's store in the past are comparatively few in number and some of them have ceased production altogether. Australia has fallen from its high position, but that is due entirely to political causes. When these are removed, it is possible that this great country may again become one of the principal producers.

The economist of the orthodox school will naturally be more interested in reserves rather than production, and this is possibly the weakest part of the reports. It has to be recognised, however, that these depend on economic considerations, and the zero line of payability is, therefore, never constant. It appears, however, that it is to the British Empire, and more particularly to South Africa, Canada, and to a lesser extent to Australia, that the world must look for its future supplies. In the Transvaal alone it is quite possible that gold to the value of one thousand million pounds may still be won—a stupendous total. There is no report from Panama, but that country's prospects as a producer appear to be good.

It remains to be said that the printers are the well-known South African firm of Wallach's, of Pretoria, which is the administrative capital of South Africa. But Pretoria is not a large city, and as the reports are printed in English, German, and French—the three official languages—and one in Italian, the production is indeed a remarkable tribute to their ability.

WM. CULLEN.

Short Reviews.

Bergey's Manual of Determinative Bacteriology · a Key for the Identification of Organisms of the Class Schizomycetes. By David H. Bergey, assisted by a Committee of the Society of American Bacteriologists, Francis C. Harrison, Robert S. Breed, Bernard W. Hammer, Frank M. Huntoon, with an Index by Robert S. Breed. Third edition. Pp. xviii + 589. (London: Baillière, Tindall and Cox, 1930.) 27*s.* net.

This publication, which has now reached its third edition, is an extension and elaboration of the admirable and painstaking work of the Committee on Characterisation and Classification of the Society of American Bacteriologists (1917, 1920). When one considers the labour involved in a compilation of this nature, it would be agreeable if one could be persuaded that the value of the results obtained is commensurate with the effort expended. But even the most cursory examination of the pages of this manual suggest that too much is taken for granted in the published descriptions of various micro-organisms.

When, for example, one finds organisms of almost precisely the same morphological, cultural, and biochemical characters and of serological identity classified, not only under separate species but even under separate genera (*Pseudomonas fluorescens* and *Phytomonas* spp.; *Pseudomonas aeruginosa* and *Phytomonas aptata*; *Corynebacterium pseudotuberculosis* and *Shigella pfaffi*), one wonders where the authors' taxonomic conceptions may eventually lead us. The closely related species, *B. whitmori* and *B. mallei*, are, moreover, included in separate genera (*Flavobacterium* and *Pfeifferella* respectively), and the genus *Shigella*, in addition to *S. pfaffi* mentioned above, is made to include a rough variant of *Salmonella gallinarum* (*Shigella jeffersonii*). Turning to the genus *Salmonella* itself, one finds that practically no attention has been paid to the mass of brilliant and elaborate research made in recent years that has thrown so much light upon the complex serological relations of this extremely natural and self-contained group of bacteria.

A comprehensive and critical revision of the text would appear to be necessary when the next edition of this work is contemplated.

R. St. J.-B.

Textbook of Logic. By Prof. A. Wolf. Pp. 407. (London: George Allen and Unwin, Ltd., 1930.) 10*s.* net.

The best text-book on a special subject is not always written by the scholar with the greatest reputation in that subject. It is gratifying, therefore, that a logician of Prof. Wolf's measure should have written a text-book which can unhesitatingly be put in the first rank.

Logic in the past has too often erred on the side of mechanical formalism and remained to the student out of all relation to common sense and practical needs. In the author's own words, it has become "the recruiting place for the sadly depleted philosophy classes". Prof. Wolf, whose very position at the London School of Economics keeps him in touch with most of the sociological and humanistic developments of the day, is emphatically alive to the practical needs of the student and scholar alike. His close contact with social science makes his treatment of logic fruitful in the application to modern types of argument, while the style is lucid and pleasant, and the treatment, in spite of its full dose of symbolism and technical instruction, distinctly attractive.

The exercises, given at the end of the book and therefore not impeding the continuity of the argument, will enable the student to apply the sound principle of the author that logic, no more than algebra or geometry, can be mastered by reading alone.

Pioneers of Public Health: the Story of some Benefactors of the Human Race. By M. E. M. Walker. Pp. xv + 270 + 23 plates. (Edinburgh and London: Oliver and Boyd, 1930.) 12*s.* 6*d.* net.

The pioneers whom Mrs. Walker has chosen to commemorate are the twenty-one eminent men whose names adorn the walls of the new building of the London School of Hygiene and Tropical Medicine, a drawing of which forms the frontispiece. As Sir Humphry Rolleston points out in the foreword, twelve of the pioneers are British, four are from the United States, three from Central Europe, and two from France. Among the various departments of public health, epidemiology and State medicine are represented by Thomas Sydenham, Lemuel Shattuck, Sir Edwin Chadwick, William Farr, Sir John Simon, and Hermann Biggs; naval and military hygiene by James Lind, Sir John Pringle, and Edmund Alexander Parkes; preventive medicine by Johann Peter Frank, Edward Jenner, Max von Pettenkofer, Major Walter Reed, and General William Crawford Gorgas; bacteriology by Pasteur, Lister, and Koch; and protozoology by Surgeon-Major Timothy Richards, Lewis Alphonse Laveran, Sir Patrick Manson, and Sir William Leishman. A concise but sympathetic account of each pioneer is accompanied by his portrait and followed by a brief list of references.

L'Esprit et ses maladies. Par Marcel Nathan. (Bibliothèque générale illustrée, 15.) Pp. 80 + 60 planches. (Paris: Les Éditions Rieder, 1930.) 20 francs.

Dr. Nathan provides us with an excellent summary of the prevailing French attitude towards the mind and its diseases. He divides his small book up into three sections: the brain and the mind, the so-called organic psychoses, and the so-called functional psychoses. To include mania and melancholia as functional or non-organic conditions in the present state of our knowledge is scarcely justifiable. They are probably of metabolic origin. The best part of the book is the illustrations, some of which are actual photographs of patients, while others are reproductions of well-known pictures, by various Continental artists.

The Beginnings of Science.*

By Dr. Charles Singer.

When did science begin? Can any question be more fundamental for the history of rational thought? An adequate answer would doubtless demand the formulation of an exact and generally acceptable definition of science. No one, perhaps, has yet succeeded in accomplishing this seemingly simple task. But without insisting on a precise delimitation of the term 'science', we may get some way, at least, by taking its current if inexact sense. Thus we may treat science as simply the systematic *process* of recording natural happenings with the object of discerning some relation between them.

I would emphasise the word *process*. Science is often discussed as though it could be presented as a body of knowledge or doctrine, but reflection will soon reveal that this point of view cannot be maintained. For is it not the case that science that has ceased to develop soon ceases to be science at all? The science of one age is often the nonsense of the next. Think, for example, of judicial astrology, or of the doctrine of lucky and unlucky numbers. Who, if he did not know their history, would recognise these as the debris of finely conceived and far-reaching scientific hypotheses, which once attracted clear-thinking minds seeking for rational explanations of the world in which they lived? We may smile, if we will, at such an explanation of the face of the earth as the doctrine of successive disasters followed by successive creations. The view that fossils are the early and clumsier attempts of an omnipotent Creator may even move us to theological wrath. Yet such conceptions were but stages in the development of geological ideas, just as the scientific views of our own time are but a stage in a great secular process which will continue when we are no more.

It therefore behoves the historian of science to be very charitable, very forbearing, in all his judgments and presentations. He must not ask too much of previous ages, nor must he judge them by the standards of his own. He needs constantly to recall that he is dealing with work of erring and imperfect human beings, each of whom had, like himself, only a very partial view of truth. There is an unquenchable and irresistible tendency innate in the human mind to erect general laws or rules in explanation of the happenings of the world. That tendency is no less present in the historian of science than in the great minds whose work he records, and if he is to be judged at all by posterity, he can but echo the epitaph:

> Reader, thou that passest by,
> As thou art so once was I;
> As I am, so shalt thou be,
> Wherefore, reader, pray for me.

Time, still, like an ever-rolling stream, bears all its sons away. It is the stream itself and the spirit that dwells therein that the historian of science has to study.

Science, then, is a process that can be followed through the ages; it is not a mere passive body of knowledge. The sheer validity and success of the scientific process, as applied in our own time in western Europe and America, has given rise to popular misunderstanding as to the nature of science, and some misapplication of such terms as 'science' and 'scientific'. We hear of the *science* of some prize-fighter, and a book has been published on the "Science of the Sacraments". There is nothing in the laws of this or any other country which forbids its citizens from giving the words of their language such significance as they may choose, but the word *science* as employed in these connotations has no clear link with the great progressive method of acquiring knowledge with which the historian of science has to deal. The very form of the adjective from science might itself give pause to those who would force the word to cover such topics as the skill of the prize-fighter or a knowledge of the theory and practice of religious rites. The word *scientific* means, derivationally, *knowledge making*, and no body of doctrine which is not being progressively *made* can for long retain scientific attributes.

During the last two generations the evolutionary conception of Nature has become so general that it now pervades our thoughts on every aspect of living activity, nor can we understand an organic product until we know how it came to be what it is. Now, the efforts of the human mind are essentially such products. It has thus become generally recognised that to comprehend, for example, the constitution of a State or the teaching of a religion it is absolutely necessary to know its past. This is the true reaction of evolutionary doctrine on the study of history.

On the study of science itself, however, this reaction of evolutionary doctrine has been less generally recognised. Why this should be is perhaps not altogether clear. One reason may be that the triumphant and absorbing successes of the application of the scientific method have deflected attention from the process itself. Another reason, which is perhaps but a restatement of the former, is that the very rapid growth of the products of the scientific process in quite modern times has turned men's thoughts away from its more ancient achievements. Yet it is clear that if we would understand the process itself, we must examine its application in the past and watch its action under conditions different from those in which we ourselves live. Only thus can we hope to attain any real insight into the nature of the process and of the effect it has had on man's estate throughout the ages.

Among the criticisms that can be made of any attempt to trace the history of science, there is one that should be met at the outset. It has been said that the history of scientific activity presents a field so vast that it cannot be compassed at first hand by any single mind. The criticism is without validity. If pressed, it would not only prevent the writing of the history of science, but would also prevent the writing both of history and of science. Who, of his own knowledge, can compass the history of even a single country? Who, of his own knowledge, can deal with the animal kingdom, with the science of geometry, or with the structure of the earth? Yet this has not prevented, and should not prevent, the writing of histories of England and of Europe, of works on zoology, of treatises on mathematics, or of text-books of geology. The scope of such books in reference to the first-hand knowledge of their writers must be effectively infinite. The difficulty in writing them—as in reading them—is the difficulty in getting a philosophical grasp of the principles involved. In obtaining such grasp, first-hand knowledge is of primary importance. Yet this knowledge, applied in such a field, is but a means to an end, and the writer must be judged by his grasp of the principles he sets forth, rather than by the actual number of experiments he has made or experiences that he has undergone.

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* Inaugural address delivered to the Second International Congress of the History of Science and Technology, by the president, on June 29, at the Royal Geographical Society.

But to return to our question as to when science began. The question can as little be answered as the question, When does a man begin to grow old? "Before that I to be begun, I did begin to be undone." Anthropologists have detected germs of the scientific process in the lowest and rudest races of mankind. As soon as a child begins to observe, he begins to make generalisations. The savage sees the action of a living thing in the wind and the flow of the water. He generalises from his imperfect observation that movement means life. The baby calls every male "daddy"; his, too, is an elementary generalisation based on imperfect experience. Both ascriptions are imperfect attempts at deducing laws.

Here, however, we encounter a real gap in the historical narrative. We can see the scientific element in the baby's generalisation or in the savage's belief. Yet we cannot, with any confidence, trace them forward in a continuous stream to anything that we should call science in the current use of that term. How far, then, can we trace the matter the other way, ascending the stream of time? In this attempt the last decade has been particularly fruitful, and I shall venture to devote the remainder of my remarks to the special nature of this recent historical achievement. As is too often the case on the scientific front, the pioneers are more concerned with their own progress than with the relation of their advances to those of others. The onlooker truly sees most of the game, and perhaps it is not going too far to say that the game cannot be clearly seen except by the onlooker. This is the justification of the professed historian of science. Without him research in one department would rapidly lose touch with research in other departments. This is so with recent scientific history. Let us seek in the same spirit among the records of a far earlier scientific history.

As we trace the records of science back into the mists that shroud the dawn of history, we see its varied disciplines dwindling to two, namely, to medicine and mathematics. So far as complete works are concerned, the earliest of all scientific treatises that have come down to us are in the medical class. They are contained in the miscellaneous group of tracts known as the "Hippocratic Collection".

The "Hippocratic Collection" takes its name from the alleged 'father of medicine'. In a less critical age this mass of writings was all ascribed to Hippocrates, and there are some who still find it difficult to abandon the old paths. Nevertheless, there is no evidence, worthy of the name, that any part of any of these works was written by Hippocrates, nor indeed is there any real evidence that Hippocrates wrote anything. It is, however, certain that some works in the "Hippocratic Collection" were composed in the fifth century B.C., at which period their eponymous author was born. Sections of some of them may well date back to the sixth, and portions of them even to the seventh century. Moreover, it has long been recognised that these medical writings were an integral part of a far wider and more deeply based contemporary rational movement in philosophy.[1]

It has indeed been argued that the relations between the medical and historical writings of ancient Greece are closely paralleled by the relations between the evolutionary and historical writings of a generation or two ago. We might put it that Hippocrates was to Thucydides as Darwin was to Buckle or Lecky. A good case for the comparison has been made recently by Prof. Cochrane of Toronto.[2]

However this may be, it is evident that behind these earliest surviving scientific monuments of the fifth, sixth, and seventh pre-Christian centuries there must be a scientific tradition that was already ancient when the Greek world was still young. Of this more ancient rational tradition the mathematical fragments have been more successfully pieced together than the medical.[3] Thus we have details of the achievements of the followers of Pythagoras, and perhaps of Pythagoras himself, whose life occupied the greater part of the sixth century. Moreover, Thales, the sage of Miletus, of whose scientific achievements there can be no doubt, takes us yet further back and into the seventh century. He takes us, too, beyond Greece, for his mother was a Phœnician. He himself had travelled in Egypt. Phœnicia suggests contact with Mesopotamia and the ancient Sumerian civilisation. Recent discoveries in that region, notably those that deal with the treatment of metals, suggest a command of natural forces which demanded theoretical scientific knowledge. Yet it is to Egypt that the Greeks commonly ascribed the origin of their medical and mathematical knowledge.

Among the Greeks before Thales and the seventh century, our view of the rational spirit grows very dim. In the "Works and Days" of Hesiod, written in the eighth century B.C., we get some astronomical lore. Such knowledge, however, must have been common property in the Near East, and indeed in every early agricultural community. In the absence of an adequate calendar, some astronomical knowledge is necessary for the elementary operations in the field. Hesiod, it is true, has something rather beyond farmers' astronomy, but in him we have the independent scientific element at a well-nigh irreducible minimum.

Can we, then, trace the rational tradition among the Greeks behind Hesiod and the eighth century ? I think we can. In the Iliad of Homer we obtain glimpses, distant, it is true, of an independent rational medical system. The Iliad tells of a great deal of fighting, in the course of which no less than 147 wounds are well described, and in many cases their treatment detailed. Now this treatment is always on entirely rational grounds, and magical elements are conspicuous by their absence. This and many other hints in the Iliad imply the practice of scientific medicine by recognised practitioners, without relation to folk-medicine. Thus, with the aid of the Iliad, we may trace the scientific tradition among the Greeks as far back as the ninth or tenth century. It is noteworthy that in the Odyssey the origin of medicines is ascribed to Egypt.

In view of the consensus among the Greeks as to their debt to Egypt, all traces of the scientific spirit revealed in the Egyptian papyri are of peculiar interest. Yet the finds have been, till recently, extraordinarily disappointing, and the contrast between Greek science and Egyptian science is greatly to the disadvantage of Egypt. For the inferiority of the Egyptian position as against the Greek, due weight has not always been given to differences in the records of the two civilisations.

First, we have to remember that the picture that we form of Greek thought is derived from the literary remains of the Greek people. That there have been irreparable losses to that literature is true, but the surviving part has come down to our time because it was read by the generations that came between the Greeks and ourselves, and it was read because, by each succeeding age, it was thought to be worth reading. Greek literature, as we have it, is thus, in essence, a selection. It is far otherwise with the Egyptian records. We have here merely what time has spared, and that old reaper has no more discretion with books than he has with the lives of men. He spares what he will and as he will. What kind of literature should we hope to recover from the wreck of our own civilisation ? Daily journalism and trade advertisements occupy many times more bulk, and therefore would have a better chance of survival, than the works of the philosophers and men of science.

Secondly, the remnants that have come down to us from ancient Egypt have mostly been recovered from tombs. They were the kind of things that the men of their day thought suitable to bury with their dead. The commonest of all are, in fact, rolls of the "Book of the Dead". If we had to compare them with something in our own civilisation, they would perhaps correspond to the inscriptions on tombstones, to hymn-books, and to prayers for special occasions. It is true that we have an admixture of other documents, but the proportional distribution of surviving Egyptian writings bears no relation to the proportional distribution of Egyptian interests.

Thirdly, it must be remembered that much surviving Greek literature is from the most vital period of Greek history. On the other hand, the overwhelming mass of Egyptian papyri are from the New or Middle Kingdom, whereas the Old Kingdom was the day of Egyptian power. The later scribes were content with copying earlier material. These later scribes were, moreover, commonly careless and not uncommonly incompetent, and, as it falls out, this was especially the case for the papyri that bear on scientific topics.

Bearing in mind these contrasts in the circumstances of Egyptian and Greek documents, let us turn to the surviving papyri of scientific content. These, like the earliest Greek scientific material, divide naturally into the medical and the mathematical. A number of documents fall into each of the two categories, but most of them are so debased or so trivial that we miss little if we take only the principal specimens. Of these there are two in each class that are of primary importance. In the medical class there is the long known Ebers Papyrus and the recently described Edwin Smith Papyrus. In the mathematical class there is the Rhind Papyrus and the very recently described Moscow Papyrus. These four contain practically all that is known of Egyptian medicine—other than that of a purely magical character—and most that is known of Egyptian mathematics.

The Papyrus Ebers, known for seventy years, is still not completely intelligible. It presents many linguistic difficulties, chief among them being the names of drugs. It is of the New Kingdom, and is generally dated as of the sixteenth century B.C. It is in the main a collection of remedies for various named conditions which are sometimes briefly described. Its general intellectual level is about comparable to an English family receipt book of the seventeenth century, of which several have been published. There is no definite physiological, pathological, or pharmaceutical theory, but there is also little that one can call superstition. The book is taken up with a list of traditional treatments of a more or less disgusting character. That sections are taken from a much older work is evident from a few isolated paragraphs in it that are devoted to anatomy. These are so confused as to be unintelligible, but it is obvious that the scribe is trying to abstract an older and more scientific document.

During the last few months Prof. Breasted, of Chicago, has presented us with his edition of an Egyptian medical document of a somewhat different order.[4] The Edwin Smith Papyrus has had a romantic history, having been originally discovered about the same time, and perhaps in the same tomb, as the Ebers. A series of remarkable circumstances left it in private libraries and unknown to scholars until a few years ago.

In general form the Edwin Smith Papyrus is not unlike the Ebers, in date somewhat similar or a little earlier, and its scribe no less careless and incompetent. He was, however, engaged in copying a document of greater scientific value, and probably of greater antiquity than that which was occupying the scribe of the Ebers Papyrus, for there can be little doubt that the original source of the Edwin Smith Papyrus was of the Old Empire. Moreover, the Edwin Smith Papyrus deals with surgical conditions, and especially injuries, while the Ebers is occupied with diseases. Injuries and their treatment lend themselves to clearer descriptions than do the diseases. We thus have in the Edwin Smith Papyrus a document of high value for comparison with certain works of the "Hippocratic Collection" of about twelve centuries later. Without discussion of details it may be said that through the mist of scribal ignorance and misunderstanding we can see in the Edwin Smith Papyrus an author who not only recorded actual case histories, but was seized at times of the spirit of science; that is to say, he records in order to learn something of the workings of the body as distinct from any attempt to treat his patient. Some of his observations, such as that injuries to the brain on one side result in paralysis of the other side of the body, are repeated in the "Hippocratic Collection", and do, in fact, throw light on the nature of physiological mechanism. The Edwin Smith Papyrus—or at least that part of it which survives—is devoted to injuries about the head. It gives us a glimpse—alas! that it should be so dim—of a lost and more ancient scientific literature to which such magnificent treatises as the "Wounds of the Head" and "Fractures and Dislocations" of the "Hippocratic Collection" may well have been related.

For Egyptian mathematics the most important document is the Rhind Papyrus, which was finely edited a few years ago by Prof. T. E. Peet, of Liverpool.[5] Its age is about that of the Edwin Smith Papyrus, though it is copied from an original of the nineteenth century B.C. It professes to be a 'guide for calculation'. Apart from simple rules for giving the areas of figures enclosed by right lines, we have the measure of a circle from which an estimate of π as 3·16 can be deduced, and a calculation with reference to the proportions of pyramids. In this last a certain relation which, as the Papyrus says, "makes the nature of the figure", is deduced from the side of the square base and vertical height or *per-em-us* as the Papyrus calls it. The word *per-em-us* is doubtless the source of the Greek word *pyramis* and our *pyramid*. The problem clearly links up with the mathematical triumph of Thales in deducing the height of a pyramid from its shadow.

The last scientific document of Egyptian origin to be considered is the Moscow Papyrus, which was only published in full by Prof. Struve a few months ago.[6] It is of the Middle Kingdom and thus older than the others. It contains the determination of the volume of a truncated pyramid and the area of a hemisphere.[7] Both are correct, the latter on the basis of the Egyptian value for π as 3·16. It yet remains to be seen whether these determinations are based on general formulæ—as is believed to be the case by Prof. Struve—or whether they are empirically obtained. If the former, it will be necessary to rewrite the history of ancient science and with it much of ancient philosophy.

The rationalisation of the Greek intellect within a very few centuries has always appeared something of a miracle—an epiphany. On the other hand, an ancient and slowly disintegrating scientific tradition in Egypt or in the Near East would fit in well with what we know of the early history of Greek science. Whether such traditions existed is a question of fact which can only be solved by the Egyptologists or Assyriologists. In the meantime, the Rhind, the Edwin Smith, and the Moscow Papyri have made such a view less fantastic than would have appeared to be the case ten years ago.

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[1] The more important works of the "Hippocratic Collection" are being edited by Mr. W. H. S. Jones and Dr. E. T. Withington for the Loeb Library. For a complete critical version we still depend on Emil Littré's "Œuvres complètes d'Hippocrate" in 10 volumes (Paris, 1839–61).

[2] C N. Cochrane, "Thucydides and the Science of History" (Oxford University Press, 1929).

[3] An excellent summary of Greek mathematics has recently been prepared by Sir T. L Heath, "A Manual of Greek Mathematics" (Oxford. The Clarendon Press, 1931).

[4] J. H. Breasted, "The Edwin Smith Surgical Papyrus", 2 vols. (University of Chicago Press, 1931).

[5] T. E. Peet, "The Rhind Mathematical Papyrus" (Liverpool, 1923). Another edition was produced for the Mathematical Association of America, 1927–29, by A. B. Chace, L S. Bull, and H. P. Manning, with a bibliography of Egyptian and Babylonian Mathematics by R. C. Archibald.

[6] W. W. Struve, "Mathematischer Papyrus des Staatlichen Museums der schonen Kunsten in Moskau" (Quellen und Studien zur Geschichte der Mathematik; Abt. A, Quellenband 1), Berlin, 1930.

[7] The Moscow Papyrus is discussed by Battiscombe Gunn and T. Eric Peet, "Four Geometrical Problems from the Moscow Mathematical Papyrus", *Journal of Egyptian Archæology*, 15, p. 167, Nov. 1929, and Kurt Vogel, "The Truncated Pyramid in Egyptian Mathematics", *Journal of Egyptian Archæology*, 16, p. 242, Nov. 1930. The work of Struve is critically reviewed by T. E. Peet in the *Journal of Egyptian Archæology*, 17, p. 154. May 1931.

Population Problems.

THE second general assembly of the International Union for the Scientific Investigation of Population Problems met in the rooms of the Royal Society of Arts on Monday, June 15, the chair being taken by the president, Prof. Raymond Pearl. Delegates of ten nationalities were present.

During the opening session the president reviewed the work of the Union during the three years of its existence, and claimed, with reason, that the progress made could be regarded as gratifying. Fourteen countries already have National Committees, which function with varying degrees of intensity, whilst in still other countries (Czechoslovakia, Greece, Poland) National Committees are in process of organisation. There are three International Research Commissions receiving funds from the Union and dealing respectively with population and food supply, differential fertility, and the vital statistics of primitive races. In addition, grants have been made to many individuals for investigations which fall outside the scope of these Commissions. Sixty-four per cent of all moneys expended is allocated to research. Nine numbers of the official bulletin have been published.

Election of officers took place, and Sir Charles Close succeeds Prof. Raymond Pearl as president of the Union.

During the morning sessions of the following three days, various modifications of the statutes and regulations shown to be desirable by the experience gained during the past three years were made. The afternoon sessions were devoted to the reading of scientific papers.

Prof. J. D. Black, chairman of the commission dealing with population and food supply, outlined a scheme which had been prepared to serve as a basis for the making of an inventory of the work already done on this particular subject and as a guide in the planning of future research. Prof. Jens Warming, of Copenhagen, discussed the trends in agricultural production in Denmark. In his country the increase of the harvest is greater than the growth of population, and if there should be a shortage of one kind or source of food (for example, grain, as was the case during the War) it is a relatively simple matter to adjust this by curtailing the amounts used for animal fodder.

Prof. P. K. Whelpton, of the Scripps Foundation, said that population increase was declining rapidly in the United States, being 9 per cent in 1930 as against 18 per cent in 1920. Consequently, the age composition had changed considerably in the last decade. The number of children under five has actually declined, while the number of persons over fifty has increased about 25 per cent. This slower growth and trend toward a nation of elders should have marked effects on economic, social, and political life, checking expansion and making for greater conservatism.

Prof. A. L. Bowley, of the London School of Economics, dealt with some economic aspects of the tendency of population in Great Britain. He showed that during the past twenty years wages have increased, especially so in the case of town labourers; so much so that in 1929 such a man in regular work had a wage sufficient to provide the bare necessities for a family of four children under fourteen years of age. Poverty in urban districts is due, not to low wages, but to illness, age, unemployment, incapability, death, or absence of the natural bread-winner. During the same period there has been a progressive change in the constitution of the family. The falling birth-rate since 1914 has resulted in a decrease in the number of child-bearing women, a fall in the number of children, and an increase in the number of old people. With the rise of the real wage and the reduction in the number of children per family, future generations will live in an environment progressively more and more favourable for satisfactory development. Smaller families mean better housing conditions and less competition for employment.

Dr. Karl Edin, of Stockholm, reported further on his study of differential fertility among the social classes. His figures show that in this city fertility tends to rise and not to fall with increase in income. Furthermore, sterility is greater amongst the poor couples. Prof. Eugen Fischer, of the Kaiser Wilhelm Institut für Anthropologie, reported on Dr. Muckermann's studies on differential fertility of the agricultural workers and university teachers in Germany. The conclusion to be derived from this study is that a social group, selected on the basis of intellectual achievement, is incapable of maintaining its numbers. Dr. L. I. Dublin, of the Metropolitan Life Insurance Company of New York, read a paper on the outlook for the American birth-rate. He concludes that the decline of the birth-rate is universal, and results primarily from voluntary control of conception and not from reduced fertility. He assumes that the population of the United States will become stationary in the course of the next generation or two with a birth-rate of 14·28 per thousand, and that, having reached this stationary stage, it will then proceed to decline at a rate that will reduce it to one-half in 300 years, in 161 years, in 108 years, or in 80 years, according to whether or not certain variables operate.

Prof. C. B. Fawcett dealt with some factors of population density. He estimates that the total habitable land area of the world is about 50,000,000 square miles and the approximate population of the world about 2000 million. The mean density of population over all the inhabited land of the world is therefore about forty persons per square mile. The actual distribution of population over the land varies from 680 per square mile in Belgium to 2·2 in Australia. It is difficult, perhaps impossible, to enumerate all the factors causing this wide variation in local densities, but amongst the most important are the following—natural resources of the land, mineral wealth and power, geographical location. Developments in modern transport have led to a readjustment of the balance between local fertility and density of population. Products gained locally are, in the great majority of cases, not used locally, but serve to maintain the population of distant regions; and therefore the age-old tendency for density of population to increase in proportion to fertility of the land has lost much of its strength. In some countries we even find that increase in food production locally is accompanied by a decrease in the agricultural and rural population. There is no indication that the fertile regions of the New World are likely to become the home of densely crowded peasant populations comparable to those of China. Prof. Fawcett argued that in Britain the Poor Laws during the last century and the Unemployment Insurance to-day both have had the unforeseen and undesirable result of restricting freedom in the matter of internal migration. The growth of the town-planning movement and of the consciousness of the need of a well-considered country-planning in many lands indicates the likelihood of a far greater governmental interference in the future.

Prof. J. W. Gregory spoke on some effects of current migration restrictions. During recent years there has been an almost complete suppression of immigration on the part of those countries which formerly received the bulk of European emigrants. One effect of such restriction in the United States is labour shortage, resulting in an increased internal migration of negroes and Mexicans. Higher wages and improved hygienic and social conditions tend to increase the duration of life and reduce the infantile mortality of the negro, and this, with the absence of European immigration, must raise the proportion of negroes in the population. This view was not accepted by several of the American delegates, one of whom instanced the fact that birth control clinics were now being opened and considerably used by the negro population of the Harlem district of New York.

Dr. G. W. Kosmak dealt with the position of the obstetrician in relation to certain aspects of the population problem. He expressed the opinion that certain developments in the practice of obstetrics at the present time may have a not inconsiderable effect in reducing the birth-rate; for example, the increase in operative deliveries, which result in a higher mortality, and at the same time undoubtedly produce increased sterility through infection. He pointed out that the dread of maternal mortality played its part in the encouragement of women to have recourse to birth control.

In a paper on the future of the Belgian population, Prof. Baudhuin, of the University of Louvain, concludes that the population is now approaching its maximum, which it will attain about 1940, when it will number 8,110,000; and that after this there will be a gradual decline, so that in the year 2000 it will be only 5,760,000.

Further interesting papers on this subject were presented by Mr. Lotka, Dr. Wicksell, and others, and, in the concluding sessions, papers dealing with the broader biological aspects of the population problem were presented by Mr. Elton, who dealt with the cyclical variation in the numbers of lemming, Arctic fox, and field mouse population, and by Mr. J. A. Fraser Roberts, who discussed the significance of the results of mass selection in the improvement of the breeds of domesticated animals.

The function of the Union is to discuss such matters as the above dispassionately and scientifically, and it is doing its best to carry out this duty, though somewhat hampered by want of funds. Much of the money which has hitherto been spent on the work of the Union has been presented by generous individuals and institutions in America; it is the turn of other countries to follow such a good example, especially as an excellent opportunity now offers itself. The chairman of the American National Committee, Dr. Louis I. Dublin, informed the general assembly that certain sources in the United States would be prepared to pay to the Union the sum of 5000 dollars a year, for three years, on the condition that a similar total sum was presented to the Union by individuals, or institutions, in other countries. This offer was gratefully accepted by the general assembly. Will not those who are interested help by their subscriptions to make this generous offer available? Subscriptions may be sent to the General Secretary, International Population Union, 46 Catherine Street, Westminster.

Prof. Eugen Fischer extended an invitation, which was unanimously accepted, to the Union to hold its third general assembly in Germany in 1934.

Obituary.

MR. W. F. DENNING.

As announced in NATURE for June 20, the veteran astronomer, Mr. William Frederic Denning, died at Bristol, mainly as the effect of the weakness of age, on June 9 last.

Mr. Denning was world-famous, having a reputation based on careful and assiduous use of the telescope, but known more especially for his naked-eye observation of the flight of meteors and his deduction from them of radiant points that form a large part of contemporary knowledge of this byway of science.

Denning was born on Nov. 25, 1848, at Redpost, near Radstock, in Somerset. When quite a boy the aspect of the night sky had an attraction for him, and at the age of seventeen he became possessed of a $4\frac{1}{4}$-inch refracting telescope, which was followed in 1871 by a 10-inch reflector, with which his more important observations were made. At the period when Denning began his astronomical career, the medium for publications relating to the science was the *Astronomical Register*, a monthly periodical started in 1863, in which astronomers made public their views and observations; and to this Denning began to contribute in 1868, his earliest communications being on the surface of Jupiter and the appearance of its satellites, and others on the visibility of Mercury with the naked eye, which was a subject to which he gave much attention throughout his life. A letter in the issue of December 1868 on his observation of the Leonid meteors of that year is interesting as foreshadowing the main work of his life. In 1869 an organisation known as the Observing Astronomical Society was formed under the auspices of the *Register*, which numbered more than forty active members in its second year, and of this Denning was secretary and treasurer. The pages of the periodical show how well he fulfilled the duties of his office during the few years of the existence of the Society. He was president of the Liverpool Astronomical Society in 1887-88.

Denning did not become a fellow of the Royal Astronomical Society until June 1877, but he contributed several short papers to the *Monthly Notices* before that date, with Mr. Proctor, Mr. Main, or some other as sponsor—among these being notes on the visibility of Mercury as a naked-eye object in the twilight, and of the possibility of seeing Jupiter and Venus in sunshine, which he said he was frequently able to do. The majority of them, however, were records of his observation of luminous meteors, and one communicated in April 1876 is specially to be noted, for it was a determination of twenty-seven radiant points that he had determined from his own observations, and was the first of a series of such papers that he contributed during his career. Reference is made in it to similar lists of radiant points by Greg, Tupman, Herschel (Alexander), and to a committee of the British Association on luminous meteors that had published full reports for several years past—for there were many workers in this field at the time, and Schiaparelli had already put forward his views on the relation between meteor-streams and cometary orbits. It is clear that at the beginning of the nineteenth century shooting stars were considered to be of electrical origin, though aerolites found on the earth were recognised as having come from without. It was not until about 1834 that the significance of meteor radiation was recognised as indicating direction in space, and hence later came the further conclusion that meteors move in orbits around the sun.

Denning evidently determined to associate himself with the band of workers in this new branch of science, and to take his full share in the arduous duty of observing. He has described his plan of working in his paper of May 1890, this being a catalogue of 918 radiant points of shooting stars observed at Bristol:

> "All the observations were made in the open air and from the garden adjoining the house. Attention was almost invariably given to the eastern sky. In mild weather I sat in a chair with the back inclined at a suitable angle; but on cold frosty nights I found it convenient to maintain a standing posture, and sometimes to pace to and fro, always however keeping the eyes directed towards the firmament in quest of meteors."

Denning's papers on meteors were many, and touch the subject at many points. Bare mention can only be made here of stationary radiants, a difficult subject depending largely on his observations as data. Almost the last of these papers was one in November 1923, which is a catalogue of 314 radiants from observations made at Bristol between the years 1912 and 1922, and, with those in three previous lists of which this is a continuation, brings the total of radiant points determined by him to nearly 1500. The number of meteors observed by him in the years specified was 6220, and of these the flights of 4008 were recorded. This paper contains some notes embodying items from his experience or his views on various meteoric subjects that make it valuable. A General Catalogue of more than 4000 radiant points determined by himself and others, compiled by him, is to be found in vol. 53 of the Memoirs of the Royal Astronomical Society.

Besides the large amount of naked-eye observing here indicated, Denning found time to use his telescope, and in this respect his success was noteworthy. The search for comets is a task requiring assiduity and patience, and he was rewarded for efforts of this kind by the discovery of five. His first was on October 4, 1881, and the comet then discovered, after being further observed by himself and others, was believed to be periodic, but was, however, not seen afterwards. Comets discovered by him in 1890, 1891, and 1892 were not periodic, whereas for the fifth, discovered in 1894, a period of 7·3 years was computed. Many nebulæ not previously known were found by him in the course of his search for comets, and the Nova in Cygnus of August 1920 is credited to him as its first observer.

It is difficult to summarise or comment on Denning's observations of Jupiter and the other planets, but they comprise many determinations of rotation period of the giant planet from observation of various spots. He gave to the world his knowledge so gained in a book, "Telescopic Work for Starlight Evenings", published in 1890; and a brochure on the planets Mercury and Venus, a reprint of chapters contributed to the *Observatory* magazine, is a valuable summary of experience. In 1895 the Valz prize of the Paris Academy was awarded to him for his meteoric work, and in 1898 Denning was the recipient of the gold medal of the Royal Astronomical Society, the grounds for the award being his meteoric observations, his cometary discoveries, and other astronomical work. He received the degree of M.Sc. from the University of Bristol in 1927 *honoris causa.* In the year 1904 he was granted a Civil List pension of £150 a year for his services to science, for he followed no profession. In his youth he had worked with his father, who was Borough Accountant of Bristol, and it is somewhat unexpected to learn that at that time he was a cricketer of skill and reputation, and that he might have been included in the eleven representing his famous county. But he preferred a secluded life that he could devote to astronomy. Though not inclined to make friends personally, he had a large list of correspondents, whom he was always ready to help with advice, and one passes from among us who lived solely for the acquisition of abstract knowledge, for which he endured much self-sacrifice and sought no personal reward.

H. P. H.

WE regret to announce the following deaths:

Prof. Solon Irving Bailey, emeritus professor of astronomy in Harvard University, on June 5, aged seventy-six years.

Prof. Friedrich Becke, formerly general secretary of the Vienna Academy of Sciences, on June 18, aged seventy-six years.

Sir Hugh Bell, Bart, chairman of the council of Armstrong College, Newcastle-on-Tyne, and past-president of the Iron and Steel Institute, who occupied a prominent place in the industrial life of the north of England, on June 29, aged eighty-seven years.

Mr. E. W. Blair, senior scientific officer of the Royal Naval Cordite Factory, Holton Heath, who was killed in the explosion at the factory on June 23.

Dr. T. F. Chipp, assistant director of the Royal Botanic Gardens, Kew, on June 28.

News and Views.

IN our Supplement of this week will be found the main part of Sir Richard Glazebrook's Guthrie lecture to the Physical Society of London. The lecture was founded to perpetuate the name of Frederick Guthrie, the physicist through whose action in 1873 the Society was formed. Born in Bayswater in 1833, Guthrie studied chemistry under Graham and Williamson at University College, London, and also under Bunsen at Heidelberg and Kolbe at Marburg. Returning to England, he held posts at Owens College, Manchester, and the University of Edinburgh, and from 1861 until 1867 was professor of chemistry and physics in the Royal College, Mauritius, where he had as a colleague Walter Besant, the novelist. In 1869 he became a lecturer in physics at the Royal School of Mines and the Normal School of Science, South Kensington, and this post he held until his death on Oct. 21, 1886. John Hall Gladstone (1827–1902) became the first president of the new society, and Guthrie occupied that position in 1884. Unlike Guthrie, who was a chemist first and a physicist afterwards, Sir Richard Glazebrook has devoted all his life to physics. Born in 1854, after graduating at Cambridge he became one of the first demonstrators under Maxwell in the Cavendish Laboratory, and held other posts in the University. His main work has been done in the National Physical Laboratory, of which he became the first director in 1899. During his period of office, which lasted twenty years, he saw the staff increase from three persons to more than five hundred, and under him the Laboratory came to fulfil its object, " to make the forces of science available to the nation ".

To Sir Richard Glazebrook the subject of standards has been a lifelong study, and his Guthrie lecture is a valuable and authoritative review of the ancient standards, the connexion between ancient and modern standards, and the scientific methods by which the latter are examined, compared, and reproduced. As in so many other matters, the first application of science to the question of the weights and measures of Great Britain was due to the Royal Society, while the replacement of the old French measures by the metric system was due to members of the Paris Academy of Sciences. Graham, Bird, Troughton, Kater, Baily, Sheepshanks, and Miller were among those who introduced accuracy into British standards, while the history of the metric system is connected with such famous names as those of Lagrange, Laplace, Borda, and Condorcet. Not the least interesting part of Sir Richard's lecture is that dealing with the modern methods of basing standards on the length of the seconds pendulum, the quadrant of the earth, or the wave-length of light.

THE annual inspection of the National Physical Laboratory by the general board, on June 23, was made this year the occasion for the official opening of the new physics building by the president of the Royal Society, Sir Gowland Hopkins. Sir Richard Glazebrook, the first director of the Laboratory, and Sir J. J. Thomson, Master of Trinity College, Cambridge, and chairman of the research committee of the Laboratory, also took part in the ceremony. In the course of a brief sketch of the history of the laboratory since its formal opening in Bushy House in 1902 by the then Prince of Wales, Sir Richard Glazebrook referred to the early difficulties of the Royal Society in finding a suitable site for the laboratory. Sir Richard traced the development of the laboratory during the time that he was director and later, when he was succeeded by Sir Joseph Petavel; and he contrasted the space allotted to physics in the early days with that now necessary to meet the requirements of the physics department. A warm tribute was paid to the interest and insight of the many eminent men of science and engineers who have made possible the continued development of the laboratory.

SIR J. J. THOMSON in a brief speech pointed out that the choice of the Bushy Park site has been more than justified, on account of the tremendous expansion which has taken place since the laboratory was first formed. Sir Joseph referred to the place of the laboratory in the general development of pure and applied science, and to its relation to university and industrial laboratories. At the conclusion of the addresses, the new building was formally declared open by Sir Gowland Hopkins, and those present were afforded an opportunity of inspecting it. The design for the new building was prepared by Mr. F. A. Llewellyn, of H.M. Office of Works. The proposed building has a frontage of 295 feet with wings of 135 feet in length, forming three sides of a rectangle. The central portion only, with a frontage of 180 feet, has been erected at present, and will be used to accommodate the heat and general physics section of the physics department, with part of the radiology and sound divisions.

ON June 24, H.M. the Queen opened the Tuke Building at Bedford College for Women (University of London). The new building, the foundation-stone of which was laid by H.R.H. Princess Mary, completes a quadrangle and is dignified and stately, if rather severe in outline. The total cost of the building will probably exceed £110,000, of which a little more than three-quarters has been raised by grants and donations. Among its features are a fine lecture hall capable of seating the entire student body of the College, new laboratories for physical and inorganic chemistry, experimental psychology, and physics, besides accommodation for other departments, including philosophy and mathematics. Perhaps the most attractive feature of the new extension, for those interested in science, is the astronomical observatory, containing a seven-inch refracting equatorial by Grubb, generously presented by the Woolwich Arsenal Institution. The Department of Psychology occupies the first floor of one wing and comprises a lecture room and laboratories. The latter are well equipped with modern recording apparatus and material for studying the special senses. A pendulum tachistoscope is built into one of the walls. There is also a kodascope for the projection of films in the study of evidence and report. Special features of the new chemical laboratories are the replacement of gas heating by electrical devices—we hope that the bunsen burner, that symbol of the nineteenth century laboratory, has not vanished completely—and the arrangements for lighting and ventilation. The name of the new building commemorates the long principalship (1907–29) of Miss Margaret Tuke, who contributed so much to the success and present position of the College.

THE Repton School Science Society was founded in 1866 and has had an almost unbroken existence since that date. Among the original members of the Society are numbered Prof. F. O. Bower and Sir Martin Conway, M.P., and the records of the earliest meetings are interesting in that they show that the subjects discussed have now become part of the routine science teaching in the school. The Society held a conversazione at Speech Day, June 26 and 27, which consisted of short lectures, demonstrations, and exhibits in physics, chemistry, and biology. The physics section included, among other things, a lecture on X-rays, in which members of the audience were 'screened' to show the heart beating and the bones of the arm; there was also a lecture on the electrical gramophone, illustrated by records kindly lent by the Bell Telephone Laboratories, New York. The demonstrations included the principle of the Radiovisor burglary alarm, and a model to show the effect of coal dust on explosions in mines. There were lectures on dyes and liquid air in the chemistry section, and among the demonstrations were a set of experiments to illustrate bleaching and a group of experiments on electroplating. A notable feature of this section was a model of a petroleum refinery, lent by the British Petroleum Company. The biology section contained numerous dissections and exhibits, a micro-film of simple unicellular organisms actually taken by members of the Society, and a demonstration of blood circulating in the tail of an anæsthetised tadpole. Living chick embryos in various stages of development were also shown.

NINETY-FIVE heads and skulls of Asiatic and American ungulates and carnivores have been selected for the British Museum (Natural History) from the collection of the late C. St. George Littledale, and form the most important addition to the collection of Asiatic ungulates since the Hume bequest came to the Museum in 1912. The Zoological Department of the Museum has purchased a specimen of the pigmy hippopotamus from the French Ivory Coast. This animal is confined to a comparatively small area of West Africa, and does not seem to extend into the great forest zone of the Congo. The New York Zoological Society has presented to the Museum a skeleton of the extinct giant tortoise of Charles Island, Galapagos. In 1832 the island was colonised, and within a short time the animals were exterminated. There was considerable doubt as to the exact species until a large number of complete skeletons, of which the present specimen is one, was discovered in a cave by Dr. C. H. Townsend in 1928. The collections brought home by Mr. Bertram Thomas from the Rub'al Khali, Arabia, are now being worked out, and a selection has been placed on exhibition in the Central Hall of the Museum. The mammals include two foxes of interest, an Arabian race of the common fox, and a fennec fox. The reptiles of the desert region are chiefly Asiatic in their relationships, whereas the affinities of those of the Qara Mountain region are with the reptiles of East and North-East Africa. The insects demonstrate very clearly the strong affinity existing between the fauna of southern Arabia and Africa. Many species have not been observed hitherto outside Africa; there is also a marked Mediterranean element. Recent acquisitions in the Mineral Department include two small diamonds, the first found in Sierra Leone; a piece of an unusual type of stony meteorite which was seen to fall on Nov. 25, 1930, at Karoonda, South Australia (see NATURE, Mar. 14 and April 25); and a mass of meteoric iron weighing 125 lb., found in 1922 at Piedade do Bagre, Minas Geraes, Brazil, which is a single crystal individual.

IN an interesting letter to the *Times* for June 16, the Rev. J. P. Rowland, *S.J.*, has estimated the position of the epicentre of the North Sea earthquake of June 7. From the times of the first and second phases on the Kew and Stonyhurst records, he finds the time at the origin to be 0 h. 25 m. 12 s. G.M.T. From this and the time of arrival at six British observatories, the distances of the origin from the various observatories were calculated and arcs of circles were drawn on the map with the stations and distances as centres and radii. The point in which the arcs for Kew and Stonyhurst intersect is adopted as the epicentre, namely, 53° 43·8′ N., 0° 53·2′ E. The arcs from the other stations, with the exception of Oxford, form a small triangle at distances of not more than two miles from this point. According to the *Daily Science News Bulletin* (June 8), issued by Science Service, Washington, D.C., the earthquake had but little effect on the seismographs in the United States. It was recorded at Washington and rather indefinitely at Georgetown University.

CONTINUOUS daily records of the hours of bright sunshine have been made by many of the meteorological stations in all parts of the world for many years, and these records have proved useful in various lines of scientific research. In one of the usual methods, a record is burned on a card by the solar rays concentrated by a glass sphere. Provided the instructions given with the instrument are carefully followed, this method gives fair results. Difficulties arise in interpreting the results on a day when the sun has been intermittently obscured by numerous small but dense cumulus clouds. The burned spots have to be considered collectively, and the estimate made of the total hours is only a rough approximation. In the *Canadian Journal of Research* for March 1931, Wallace A. Thomson describes a method of recording the bright sunshine by means of a photoelectric cell and an electric clock. When light of a definite intensity falls upon the photoelectric cell, the electric clock is automatically started by the action of a relay. This relay also stops the clock just as promptly when the sun disappears behind a cloud or below the horizon. It is thus only necessary to read the time on the clock at the end of each day, when the number of hours it has been running since it was last observed gives the number of hours of sunshine during that period of time. Comparative records are given of the hours of bright sunshine observed during a week at Manitoba Agricultural College by the author's cell and clock, by two types of sunshine recorder, and by personal observations by the author. It was found that the photo-cell and clock method never omitted any portion of the daily record that would not be considered questionable. On several days, the clock continued to operate until only half the sun was visible above the horizon. The other methods sometimes omitted about two hours of the record.

STRIKING progress continues to be made by the recently formed industry for canning English-grown fruits and vegetables. During the last two years, the number of firms in operation has risen from five to nearly forty, and the output has increased fourfold since 1928. The application of the National Mark Scheme in 1930 considerably stimulated the demand for English canned products, and although during this first season the scheme was applied to some half-dozen fruits and vegetables only, yet more than fifty per cent of the total output (which equalled the total imports of canned fruits other than pineapples from the rest of the Empire) was packed under the mark. Further, the high standard of quality required was well maintained. Encouraged by this success, the Ministry of Agriculture states in a recent weekly news-sheet that it is now extending the scheme to a much larger number of fruits and vegetables. Careful attention is also being paid to standardisation, particularly as regards sizes of cans, weight of fruit, and strength of syrup. Four sizes of cans will be put on the market, and two different strengths of syrup will be available. Lacquered cans, although already widely employed, will be required for red and blue fruits and for peas and beans sold under the National Mark Scheme. A large market for English canned produce is available in the Empire, particularly in South and East Africa and in India, several consignments having already been dispatched, but careful co-operation between the fruit and vegetable growers and the canner is necessary, if full advantage is to be taken of this rapidly expanding market.

THE most striking feature of the National electricity scheme in Great Britain is the grid, the common distribution mains of all the selected power stations. This makes necessary the standardisation of all systems of supply, and to effect this many difficulties have to be overcome. The principal difficulty is the standardisation of the frequency of the alternating current supplied by the various companies. The cost of this work was not over-estimated when it was put at eighteen million pounds, but it is defrayed by the Central Electricity Board in the first instance and will afterwards be recovered by a levy on the whole of the electricity supply undertakings in the country. There are three main areas affected. In central Scotland the Glasgow Corporation and the Clyde Valley Co. are changing over from 25 cycles to 50 cycles. A similar change is being made in Birmingham. The operation has to be done gradually, as provision must be made for the continued use of consumers' machinery during the change. The most difficult problem of all is the conversion of the north-east England scheme, where the greater part of an area of over five thousand square miles is supplied at a frequency of 40·8 cycles per second. A change of frequency affects every piece of rotating apparatus, from the power house to the smallest domestic motor. All electromagnetic devices are more or less affected. In making new installations it is necessary to erect machines which can work at dual frequency or, at least, which can readily be converted from one to the other. As the Electricity Board points out, this change gives an opportunity to many important industrial works of economically modernising and re-equipping their electrical machinery. Many ways of doing this are described in the *English Electric Journal* for June.

THE keen competition that is taking place for overseas traffic makes it necessary for marine engineers to keep abreast of the latest engineering developments. The expenditure of several millions on a new liner is only justified if it remain an efficient unit for at least twenty years. Too slavish an adherence to the policy of 'safety first' may lead to it being outclassed by a competing vessel. In the *Electrical Times* for June 4, A. D. Constable discusses fairly fully the case for the use of electric propulsion in a large high-speed liner. A detailed scheme is worked out, and he advocates notable innovations in marine engineering practice. At first sight a direct mechanical drive between the turbines and the propeller shaft seems more desirable than to install electric generators and motors between them, especially as the transmission losses in the case of large liners are about six per cent less for the mechanical drive. The cost of the electrical machinery is also the greater. On the other hand, the great flexibility of the electric drive, the possibility of using five propeller shafts and twin rudders, the economical working at all speeds, and the great convenience of having all the auxiliary services on board ship worked electrically, in many cases indicate that the all-electric ship is the more economical. Provided that every electrical machine and device is of the best materials and design and in accordance with the most modern specifications, the ship should run in all weathers with freedom from trouble and anxiety, and with an economy hitherto not reached in marine work. If in addition higher steam pressures were used in the boilers, a very appreciable reduction might be made in the excessive amount of space now occupied by the boilers.

THE annual report of the Director of the Imperial Institute, Lieut.-Gen. Sir William Furse, shows

(*Continued on p.* 29.)

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Standards of Measurement: Their History and Development.*

By Sir RICHARD GLAZEBROOK, K.C.B., F.R.S.

ANCIENT STANDARDS OF LENGTH.

WHEN man became a measuring animal, he naturally took as his standards the parts of his own body. The cubit, the length of the forearm from the elbow joint to the tip of the middle finger, was his unit of measurement; the Egyptian hieroglyph for a cubit is a figure of the arm, and this unit was divided into spans, palms, digits, etc. There were various cubits, differing somewhat in length, and our knowledge of them has come to us in the main from Egyptian monuments. It appears probable, however, that the Egyptians obtained their cubit originally from Chaldæa, and one of the oldest standards we know of is to be found in the Louvre, where there is a bust of Gudea, a Sumerian king of about 2300 B.C. On it there is engraved a scale showing sixteen digits of the Sumerian cubit, which was divided into thirty digits.

The cubit from which it appears probable that our foot and inch have descended is generally known as the Olympic cubit, because it passed from Egypt into Greece. It was, as we shall see shortly, about 18·24 in. long and was divided into two spans, the stretch from the thumb to the little finger, of about 9 in. A span was equal to three palms, the breadth of four fingers, each being about 3 in. in length, and the palm was divided into four digits, each ¾ in., or more accurately 0·76 in. There was also the fathom of 4 cubits, 72·96 in. or 6·08 ft., the outstretch of the two arms.

At a somewhat later date another unit, the foot, equal to two-thirds of a cubit, was introduced, and this was divided into twelve thumb-nail breadths—Gk. ὄνυξ—whence came the terms uncia, ounce, inch, used for the twelfth part of the troy pound and of the foot.

I have not heard of an existing specimen of an Olympic cubit, but we can determine its length in the following manner. Herodotus tells us that "the Egyptian cubit is equal to that of Samos", that is, the cubit used in Greece, and we can obtain the length of this from the measurement of various Greek temples. The Hecatompedon of the Parthenon is a square of 100 ft. in side. This was measured in 1846 by F. C. Penrose, who gave as the length of the Greek foot 12·1610 in.; whence the cubit, being 3/2 feet, is 18·2415 in.; this was corrected later to 18·2405 in., or (say) 18·24 in.

There is another link to be obtained thus. The side of the Great Pyramid is stated to be 500 cubits in length. This has been frequently measured. Sir Henry Lyons informs me that the result obtained a few years since by Mr. J. H. Cole, of the Egyptian Survey, was 230·364 metres or 755·76 ft. Earlier measures give much the same result. Sir Flinders Petrie found the average length to be 9068·8 inches or 755·7 ft., giving for the length of the cubit, if we accept the statement that a side of the base of the Pyramid measured 500 cubits, the value of 18·14 in. This is nearly the same as the 18·24 inches found from the Greek temple, and we may perhaps accept this value as close to the truth. This foot with its division into twelve thumb-breadths (ὄνυξ) became the Greek foot.

In due course, the foot passed to Rome, becoming somewhat altered in value; the Roman mile of 5000 Roman feet is generally said to be equal to 8 Greek stadia, each of 600 ft. or 400 cubits, so that the Roman foot was equal to 24/25 of the Greek foot, or 11·67 English inches. This makes the Roman foot equal to 0·973 English feet. Direct measurement by Martin Folkes and others give as the value 0·967 English feet, or putting it the other way round, 1 English foot = 1·03 Roman feet.

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* From the Guthrie Lecture for 1931, delivered before the Physical Society of London on May 15. I wish to express my indebtedness to many friends, and first and foremost to Sir Henry Lyons, for most of the historical apparatus shown during the lecture, to the Deputy Warden of the Standards for apparatus in his charge, then to the Director of the National Physical Laboratory and Messrs Sears and Dye for their valued help, and to Mr. Chrislelow for his care in preparing the slides. For the part relating to ancient standards, thanks are due to Col. N. Belaiew, C.B., to Mr. Sidney Smith, of the British Museum, and to the library staff of the Royal Society, who helped in looking up the references; while I am indebted to Mr. Hope Jones, of the Synchronome Co., and to Mr. Shreeve, representing the Bell Telephone Co., for information as to time measurements.

In time, Roman measures were established in Britain, but as to when and how the change from the Roman to the British foot took place we have no evidence. Various surmises are possible. It is known that the Gothic nations in the fourth and fifth centuries, established in the neighbourhood of the Crimea, used a large cubit. This became the basis of the Russian measures prior to the reign of Peter the Great, and may have travelled westward with the Goths and been brought to England by the Anglo-Saxons. But more likely it was a chance alteration. Maybe King Henry I. did fix the yard by the outstretch of his arm, and this happened to give a foot some three per cent in excess of the Roman foot.

King David of Scotland (*c.* 1150) ordained that the Scotch inch should be the mean measure of the thumbs of three men, the thumbs being measured at the root of the nail. There was a standard foot fixed in Old St. Paul's and all measures were referred to the standard, "qui insculpitur super basem columpnae in Ecclesia Sancti Pauli".

In the time of Queen Elizabeth, steps were taken to fix definite standards of measurement, but before telling of these it is desirable to refer to the history of weights.

ANCIENT STANDARDS OF WEIGHT.

The standard of weight in Sumerian times was the mina, the history of which has been very fully examined by Col. Belaiew. From the mina in course of time came the talent, and the Alexandrian talent formed the basis of the Greek, Roman, and western European weights until the advent of the metric system.

The Alexandrian talent was divided by the Romans into 125 libræ, each containing 12 unciæ, so that there were 1500 ounces to the talent. The weight of the talent has been found to be 93·65 lb. avoirdupois or 655,550 grains. Thus the weight of the Roman ounce was 437 grains while the pound contained 5244 grains. This weight became current in Britain, but the pound, instead of remaining at 12 oz. was raised to 16 oz., each of 437 grains, and possibly became the basis of our avoirdupois weight, a pound of 6992 grains. Another suggestion is that the pound avoirdupois came from the Attic mina of 6945 grains.

The Saxon kings, however, had brought to England as a standard weight the marc of Cologne. Two marcs weighed 7216 grains and were divided into 16 oz. each of 451 grains. Twelve of these ounces, reckoned as weighing 450 grains each, constituted the Tower or Mint pound[1] by which the coinage was weighed. In the time of Edward III., a Tower pound of silver was coined into 240 silver pennies each weighing 22·5 grains, giving 5400 grains for the pound and 450 for the ounce.

There was another pound in ordinary use, the Troy pound. Its origin is uncertain. In France we find a Marc de Troyes of 472 grains to the ounce and it may have come from that. Another suggestion is that the word troy has no reference to the French town but rather to Troy Novant, a monkish name of London founded on the legend of Brutus. Troy weight was mentioned in the reign of Henry IV., and in the time of Henry V. goldsmiths were ordered to use "la libre de Troy" and coin 360 pennies from a pound of 5400 grains. Thus a penny weighed 22·5 grains, and an ounce 450 grains.

The troy pound became the standard for the coinage in 1527, when Henry VIII. enacted that "the pounde Towre shall be no more used, but all manner of golde and sylver shall be wayed by the pounde Troye which maketh XII. oz Troye and which excedith the pounde Towre by III. quarters of the ounce". This would make the pound troy weigh 5737·5 grains. It was afterwards defined as 5760 grains, and the ounce troy (1/12 part) as 480 grains.

Throughout this time avoirdupois weights, though not defined by statute until 1485, had been used, and from quite early days a Libra Mercatoria one-fourth greater than the Tower pound and containing therefore 6750 grains was employed.

In the time of Edward III. (1352) we read of weighings "cum ponderibus de haberdepase", and weights of this denomination existed in the time of Elizabeth. "Haberty poie" pound is mentioned in the time of Henry VII. Henry VIII. (1532) ordered that meat shall be sold by weight called Haver-du-pois.[2] The Avoirdupois pound contained 16 Roman ounces of 437 grains each—6992 to the pound.

Elizabeth by her action in 1574 introduced what has become our modern system of weights and measures. She ordered a jury to examine the standard weights and measures in use, to report on them, and to construct standards "as well of troy weight as of avoirdupois ". The existing standards were found to be very erroneous, and a second jury was appointed in 1584. The result of their work was the production of 57 sets of weights, both troy and avoirdupois, which were distributed to the Exchequer and various local authorities. Some of these weights are still extant, and do not differ by more than a grain from the Imperial standard.

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[1] In 1842 a Tower pound from the Pyx Chamber was found to weigh 5404 grains.

[2] According to the "New English Dictionary", quoted by Nicolson, to whose book, "Men and Measures", I am indebted for much of this account of English weights, Averdepois is the best spelling of the name. *Aver* is an old-established English word for 'goods'.

Either at this period or previously the weight of the avoirdupois pound was raised by 8 grains, bringing it from 6992 to 7000 grains, at which it has remained ever since. Thus the avoirdupois ounce is 437·5 grains.

The Proclamation for Weights of Dec. 16, 1587, established avoirdupois weight, and ordered that no " person shall use any Troy weight but only for weighing of bread, gold, silver, and electuaries and for no other thing ".[3] In addition, standards of length and capacity were constructed; the standard yard of Elizabeth is continually referred to later and was an important factor in determining the length of our present standard. The work was well done, and supplied in a satisfactory manner the needs of the country for more than a hundred and fifty years.

THE PYRAMIDS AND THE CUBITS—EGYPTIAN STANDARDS.

Before continuing the history of these standards, it is of interest to go back to Egyptian times and to the Pyramids, and to learn more about those standards from which ours have undoubtedly come. I have based our foot on the common or Olympic cubit of 18·24 inches, but there were many other cubits. One in particular, the Royal cubit of Egypt, is closely connected with the building of the Great Pyramid.

John Greaves, Savilian professor of astronomy at Oxford in 1643–49, became professor of geometry in Gresham College, London, in 1631, and after some visits to the Continent started on a journey to the East in 1637. After visiting Rome and Constantinople, he arrived at Alexandria in 1638, and thence " he went twice to Grand Cairo to measure the Pyramids, carrying with him a Radius of ten feet, most accurately divided into 10,000 parts, besides some other instruments for the fuller discovery of the truth ".[4]

In his "Dissertation on Cubits", Newton sets down the dimensions given by Greaves for various parts of the Pyramid. He then argues, following Greaves, that the builder probably used a definite unit in the design of his work, and by comparing the figures endeavours to fix on that unit; the result is shown in the following table, in which are included the dimensions of two of the principal passages and of the great central chamber, as well as the length of one side of the great Pyramid.

TABLE OF GREAVES' MEASUREMENTS OF THE PYRAMIDS.

Part Measured.	Dimensions in Feet.	Value of Cubit deduced.
Breadth of entrance gallery .	3·463	2 × 1·732
Breadth of main gallery .	6·870	4 × 1·718
Height of side benches in main gallery . . .	1·717	1·717
Breadth of side benches in main gallery . . .	1·717	1·717
Length of central chamber .	34·380	20 × 1·719
Breadth of central chamber.	17·190	10 × 1·719
Length of north side of base .	693	400 × 1·732

The mean value for the cubit, excluding the first and last, Newton takes as 1·719 ft. The last line of the table, as will appear shortly, is clearly erroneous; as to the difference between the first line and the others, Newton remarks that it comes to about 1/7 in., which is " an error of no importance if we consider the much greater irregularities observed by Mr. Greaves in the best buildings of the Romans ".

As to the base measurement there is clearly some error; the true base was covered by debris until recently and could not have been measured by Greaves.

If we take Newton's value 1·719 ft. as the outcome of Greaves' measurements in 1638–39, we obtain as the length of the Royal cubit used in the interior of the Great Pyramid, 20·628 inches. There is ample evidence that a cubit of about this size was in general use. There is one in the British Museum, another in the Liverpool Museum, and a third in Paris. Mr. Nicolson mentions others.

The cubit is found also on the outside of the Great Pyramid; at each corner were vertical walls, used by the builder to set out the slope of the faces. Two of these are extant and are marked in cubits of this size. From this it would appear that the Royal cubit was used throughout the building. Moreover, there still exist a number of Nilometers, used in ancient times to measure the height of the Nile flood along the valley. These are marked in cubits. Several of them were measured by Sir

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[3] Nicolson, " Men and Measures," p. 102.

[4] The life of Mr. John Greaves, by Thos. Birch, Sec. R.S., prefixed to the miscellaneous works of Mr. John Greaves, Professor of Astronomy in the University of Oxford. Published by Thos. Birch, F.R.S., 1737.

Henry Lyons and Dr. Borchardt when in Egypt, with the following results :

Nilometer.	No. of Cubit Lengths.	Average Cubit in Metres.
Philae I.	12	0·520
Philae II.	12	0·532
Philae III.	16	0·535
Elephantine	12	0·523
Edfu	6	0·528
Esna	9	0·532
Luxor	6	0·529

The mean of these is 0·528 metre or 20·8 inches. Other measurements have given a rather less result.

The mean value found by Mr. Cole for the length of the side of the base was 755·8 feet. If this is to contain an even number of cubits of about the length found otherwise for the Royal cubit, that number will be 440. Assuming this as the number of cubits in a side, the length of the cubit is 1·718 ft. or 20·62 in.

The following give the lengths of the four sides of the base as measured by Sir Flinders Petrie and Mr. J. H. Cole:

	Sir Flinders Petrie.	Mr. J. H. Cole.
North	755 ft. 9 in.	755 ft. 5 in.
East	755 ft. 8 in.	756 ft. 1 in.
South	755 ft. 9 in.	755 ft. 11 in.
West	755 ft. 9 in.	755 ft. 10 in.
Mean	755 ft. 8·7 in.	755 ft. 10 in.

The agreement is practically complete.

Thus we have found good cause to suppose that there were two cubits in general use—there were others besides—one 18·24 inches in length, the other 20·62 inches. It is, perhaps, natural to inquire what was the reason for this, and Col. Belaiew pointed out to me a fact of interest in this connexion.

We know if we call l and L the lengths of the two, we have

$$\frac{l}{L}=\frac{18{\cdot}24}{20{\cdot}62}=0{\cdot}885=\tfrac{1}{2}\sqrt{\pi}\text{ approximately.}$$

Thus $l^2=\tfrac{1}{4}\pi L^2$.

Hence the area of a square having the small cubit for a side is equal to that of a circle with the large cubit for its diameter. This may, of course, be chance or it may be that some ancient Egyptian, wishing to construct a circle of the same area as the square, found the large cubit. We know that the value 256/81 was used for π, so that $\sqrt{\pi}=16/9$.

There are other curious facts connected with the dimensions of the Great Pyramid. Its perimeter, following Mr. Cole, is $4\times755{\cdot}8$ or 3023·2 ft. Earlier measurements made the base 760 ft. in length and the perimeter 3040 ft. Now the mean length of a nautical—meridian—mile, the sixtieth part of a degree, is 6080 ft. Thus the perimeter of the Pyramid is very approximately half a meridian mile. Did the wise men of old know this, and were they aware that the earth is spherical and about 8000 miles in diameter ? If the perimeter of the Pyramid was 2000 Olympic cubits, then the Olympic cubit is 1/4000 of a meridian mile and the Olympic fathom—the Greek *orgia* of 4 cubits—is one sixty-thousandth of a degree.

It is all very curious ; but can we credit such knowledge to the men who designed the Pyramids ? They placed them very accurately with regard to the meridian ; the faces of the Great Pyramid are only 3′ 43″ out, while the entrance gallery was directed towards α Draconis, the Pole Star some 5000 years ago. Thales of Miletus, born 640 B.C., taught that the earth was spherical and placed it at the centre of the universe. Pythagoras, born 580 B.C., said that the sun was the centre of the planetary world and the earth one of the planets.

THE ALEXANDRIAN TALENT.

In connexion with the weights, equally interesting questions arise when one begins to ask, How did men in ancient days settle on their system of weighing ? Their standards of length represented, without doubt, the lengths of parts of their own bodies; their weights may well have been chosen to represent a definite quantity of some commodity in daily use —wheat or barley, the weight and length of the grain of which has been in all countries intimately connected with standards of weight and length. The kilogramme was intended to be the weight of a unit of volume of water. How far back does this idea go ? We have seen that the Alexandrian talent weighed 93·65 lb. A simple calculation shows that the weight of a Royal cubic foot of water is 2594/27·71 lb. or 93·61 lb. Is it a coincidence that the weight of the talent of Alexandria is so closely that of a Royal cubic foot of water, or is the suggestion made by Mr. Nicolson that the agreement was designed, correct ?

THE FOOT AND THE OUNCE.

Here it is perhaps relevant to refer to another suggestion made by Mr. Nicolson in an endeavour to account for the difference between the Olympic and the British foot. It is that the foot was chosen so as to make a cubic foot of water weigh 1000 ounces of (at the time) 437 grains each. This will be found to be very closely the case. But I am digressing into curiosities of metrology. The weight of a cubic foot of water was investigated by the Oxford Philosophical Society in 1685. When Wren and the founders of the Royal Society moved to London, those of the members left behind at Oxford continued their meetings,[5] and at one of these, two members, Messrs. Caswell and Walker, described how they had made a hollow cube of very hard dry oak, each edge of which was very exactly one foot, with which they proposed to determine the weight of a cubic foot of water. At a later meeting they communicated their result to the Society, finding it to be 1000 oz., and their result, along with the weights found for the same volume of a number of other substances, was sent to the Royal Society and is printed in the *Philosophical Transactions*[6] along with their table of specific gravities.

This has brought us very close to what I may perhaps call the more scientific period of our subject, and we may leave the speculations, interesting though they are, that centre round the Pyramids and their architects.

THE ROYAL SOCIETY AND WEIGHTS AND MEASURES.

We come now to more modern times, some two hundred years ago, and from that date onwards we can trace with more certainty the history of our weights and measures.

In 1742, George II. was on the throne; the Royal Society had been founded for nearly eighty years and its fellows were actively engaged in the pursuit of natural knowledge; the importance of exact measurement was becoming more fully recognised. Vol. 42 of the *Transactions* for 1742–43 contains the account of various comparisons of weights and measures. In it is also described the laying down of 3 ft. on a brass bar belonging to the Royal Society from a scale at the Tower.

Owing mainly to the action of Graham, sundry comparisons with French and other measures were made, and with this object he had two yard measures and two pound weights carefully made and examined. One of each of these was sent to Paris by the Society and, at the request of the French men of science, were compared with the French standards by M. du Fay and the Abbé Nollet. This seems to have led to the suggestion that a formal comparison of the existing standards of length and weight was desirable, and a committee, under the chairmanship of Lord Macclesfield, undertook the task and reported on June 16, 1743.

Among the standards compared were those included in the following table :

Comparisons of Yards with the Exchequer Standard of Elizabeth.	
Royal Society yard	+ 0·0075 in.
Henry VII. yard	− 0·0071 in.
Guildhall yard	+ 0·0434 to 0·0396 in.
Clockworkers' yard	− 0·021 in.
Tower yard	+ 0·011 in.

The committee also examined a series of weights from the Exchequer and elsewhere.

From the time of Edward I., the troy pound is defined as containing 12 troy ounces each of twenty pennyweight; but no standard troy pound was found; 12 ounces taken from a box containing 256 ounce weights were therefore selected as representing the pound troy.

There was, however, a series of avoirdupois weights, from 1 lb. to 14 lb., marked Elizabeth Regina 1582, and a 7 lb. wt. VI. Ed. 1588. Various comparisons led to the following results for the lb. and oz. avoirdupois in grains :

Pound . . .	6998	7000·7	7000·2
Ounce . . .	437·4	437·54	437·51

Of the weights in the possession of the Royal Society, the avoirdupois pound was lighter than the standard by one grain, and the troy pound lighter by half a grain. This constitutes the earliest systematic comparison of our weights and measures that I have found.

It was realised that the length of the standards varied with temperature, but it was held that since all were of much the same material the differences would not be affected.

Two standard bars were made by Bird in 1758 and 1760 respectively for a committee appointed by the House of Commons under the chairmanship of Lord Carysfort. These were to be copies of the Royal Society standard as laid down by Graham, 1742–43. One, marked Standard Yard 1758, was presented to the House as the legal standard of length. Both were compared in 1768 with the Royal Society standard, while in 1785 a scale made for General Roy's measurement of an arc of the meridian on Hounslow Heath was graduated in terms of the same standard. Bills were presented to the House of Commons in 1765 to give effect to the recommendations of this and of a subsequent committee, but from some accident they did not become law and the country remained without legal standards for the next sixty years.

The modern method, employing micrometer microscopes, was used for the first time by Troughton in his comparison of a line standard constructed

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[5] Their Minute Book is now at the Royal Society, and from it these notes are taken.

[6] *Phil. Trans.*, No. 169, p 926, Mar. 23, 1685.

P20571

in 1792 for Sir George Shuckburgh. In 1814 a report was presented to the House of Commons by a new committee which asked Dr. Hyde Wollaston and Prof. Playfair for advice. They stated that the length of the pendulum vibrating seconds had been found to be 39·13047 in. and that the metre of platina measured, at the temperature of 55°, 39·3828 English inches, representing at 32° the ten-millionth part of the quadrant of the meridian. They recommended, upon the suggestion of Dr. Wollaston, "that a gallon containing ten pounds of pure water should be adopted as a substitute for the ale and corn gallons".

In 1816 there still remained considerable doubt both as to the length of the seconds pendulum and the relation of the metre to the inch; the Astronomer Royal, Dr. Pond, was instructed by Parliament to make the measurements necessary to remove the doubt. He asked for the assistance of the Royal Society, and a committee was appointed for the purpose.

A number of experiments were made by various methods (Capt. Kater's pendulum work is described in the *Phil. Trans.* for 1826, 1830, and 1831), and in 1818 a Commission was appointed, under writ of the Privy Seal, "to discuss the matter more minutely than could be done with convenience before a Committee of either House of Parliament".

The report of this Commission drawn up by Dr. Young is of great interest; and as a result a Bill giving effect to their conclusions was brought into the House of Commons by Sir George Clerk in 1822, and again, with a few amendments, in 1823. This was nearly identical with an Act passed on June 17, 1824, which came into force on Jan. 1, 1826.

The Commissioners ultimately recommended for the legal determination of the standard yard Bird's standard of 1760. It was found to agree very closely with Sir George Shuckburgh's yard, with which the length of the pendulum and the metre had been compared, and a facsimile of which was known to exist at Geneva, and the Act enacted "that the straight line or distance between the centre of the two points in the gold studs in the straight brass rod now in the custody of the Clerk to the House of Commons whereon the words and figures Standard Yard 1760 are engraved shall be and the same is hereby declared to be the original and genuine standard of that measure of length or linear dimension called a yard". The distance when the rod was at a temperature of 62° Fah. was denominated the Imperial Standard Yard, and all other measures of extension were to be multiples or sub-multiples of this standard.

For the standard of weight the Commissioners recommended in 1823: "That the Standard brass weight of one pound Troy weight in the year 1758 now in the custody of the Clerk of the House of Commons shall be, and the same is hereby declared to be the original and genuine standard of weight; and that such brass weight shall be and is hereby denominated the Imperial Standard Troy Pound". This troy pound was declared to contain 5760 grains, "and 7000 such grains shall be and are hereby declared to be a pound Avoirdupois".

For the recovery of the standards if lost, destroyed, defaced, or otherwise injured, suitable provision was made in the Act; the yard was to be recovered from the length of the seconds pendulum, which when vibrating in a vacuum at sea level in the latitude of London was stated to be 39·1393 in., while it was held that the pound could be reconstructed from the fact that a cubic inch of distilled water weighed by brass weights in a vacuum at a temperature of 62° had been found to weigh 252·724 grains.

THE MODERN STANDARDS.

The need for reconstruction came all too soon. In 1834 the Houses of Parliament were destroyed by fire; the pound standard was lost entirely, the yard standard was damaged, one of the gold plugs having been melted so that its centre point could no longer be determined with accuracy.

In 1838 the Chancellor of the Exchequer, the Right Hon. T. Spring Rice, set up a Commission to advise as to the steps necessary to replace the standards.

Meanwhile, since 1824 a number of criticisms of the means suggested for recovering the standards had been made. Certain of the corrections employed by Kater in determining the length of the seconds pendulum were shown to be in error; while the agreement among the various determinations of the weight of a cubic inch of water left the true value in doubt, and the committee of 1838, accepting these criticisms, threw over the methods provided in the Act of 1824 and advised, with regard to the pound, that it should be recovered by comparison with copies which were known to exist and that the pound avoirdupois should be the standard. As to the yard, it was stated that "Several measures now exist which were most accurately compared with the Standard yard . . . and by the use of these the values of the original standards can be respectively restored without sensible error". The committee, therefore, recommended a material standard, "the distance between two points or lines engraved on metal, but that the standard be in no way defined by reference to any natural basis, such as the length of a degree of a meridian on the earth's surface in an assigned latitude or the length of a pendulum vibrating seconds in a given place ".

The Government approved this recommendation and appointed a scientific committee in 1843 to reconstruct new Parliamentary standards of length and weight.

THE POUND.

Prof. Miller was entrusted with the construction of the pound, Mr. Baily with that of the yard. Prof. Miller has described his work very fully in a Royal Society paper.[7] The standard weight of 1824, made of platinum, was known as *U*. It had been compared in 1824–25 by Capt. Kater with five gun-metal standards deposited at the Exchequer, the Royal Mint, and with the civic authorities in London, Edinburgh, and Dublin.

In 1829, *U* had been compared by Capt. V. Nehus with a platinum pound (*R.S.*) belonging to the Royal Society, and also with two brass pounds and a platinum pound (*Sp.*) in the custody of Prof. Schumacher. These weights, with a number of gun-metal copies, were available for the construction of the new pound. The comparison showed considerable discrepancies in the values of the gun-metal and brass weights, and in the end it was resolved, " with the consent of the Astronomer Royal, to rest for the evidence of the weight of the lost Standard entirely on the comparisons of the two platinum Standards *Sp.* and *R.S.*"

As the result of this work, and the corresponding work on the yard, our present standards came into existence, and the Weights and Measures Act of 1855 prescribes that:

" Whereas by Act of the Fifth Year of King George IV. a standard brass weight of one pound troy, made in the year 1758, then in the custody of the Clerk of the House of Commons, should be the genuine standard of weight, and whereas there exist weights which had been accurately compared with the said Standard Pound Troy which afforded sufficient means for restoring such original Standard:

" The said weight of Platinum marked P.S. 1844 1 lb. deposited in the Office of the Exchequer as aforesaid shall be and be denominated the Imperial Standard Pound Avoirdupois. The one 7000th part of this shall be a grain and 5760 such grains shall be a Pound Troy."

Provision is made in the Act for recovery of the standard if lost by comparison with copies made and distributed among various authorities. Thus the pound avoirdupois became our standard of weight, and the pound troy followed in the path of the King's Tower pound.

THE YARD.

Mr. Baily, at the request of the committee, undertook the reconstruction of the yard. The account[8] of the work is given by Sir George Airy as chairman in a paper in the *Philosophical Transactions* of the Royal Society.

In addition to the damaged standard, the following were available for comparison: a scale, No. 46, belonging to the Royal Society, a scale belonging to the Royal Astronomical Society, two three-foot bars of the Ordnance Society. There was also the Shuckburgh scale of 1792, but on account of certain imperfections little importance was attached to it.

The standard was to be of bell metal or steel, a rectangular bar of about 1 in. square in section, with the ends notched away to half the thickness. The marks defining the length were to be on plugs inserted flush with the surface, and the standard was to be correct at 61° or 62° F. The ends were cut away in order that the marks might be in the median plane of the bar and the effect of flexure when supported at two points minimised. For the standard finally settled on, an alloy, since known as Baily's metal, consisting of copper 16 parts, tin $2\frac{1}{2}$ parts, and zinc 1 part, was used.

Faraday was consulted somewhat later as to the stability of such an alloy, and wrote: " I do not see why a pure metal should be particularly free from internal changes. . . . I suppose the labour would be too great to lay down the standard on different metals and substances, and yet the comparison of these might be very important hereafter, for twenty years do seem to do or tell a great deal in relation to standard measures."

Baily also introduced the method of drilling a hole in the bar down to the median section, and fixing the plug with the mark at the bottom of this instead of notching the end as Kater had done. His work was cut short by his death in August 1844.

At this stage, Sheepshanks offered to take Baily's place, and the question immediately before the committee was whether to attempt to restore the damaged legal standard or to construct a standard from the available material. It was plain that in the strictly legal or scientific sense the restoration of the standard must be indefinite and the latter plan was approved. Sheepshanks suggested that the necessary apparatus for his comparisons should be set up in the cellar of Somerset House, and made a report on the questions involved, the stability of the material, the thermometric difficulties, etc., as well as on the method he proposed to adopt.

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[7] On the Construction of the New Imperial Standard Pound by Prof. W. H. Miller, *Phil. Trans.*, 1856.

[8] Account of the Construction of the New National Standard of Length by G. B. Airy, Esq., Astronomer Royal, *Phil. Trans.*, 1857.

A meeting of the committee was held on June 4, 1847, to inspect these arrangements, and the minutes record that—

"The Committee approve entirely of the course followed by Mr. Sheepshanks and request Mr. Airy to take measures for the exam^n and discharge of the instrument makers accounts."

Airy's paper already referred to gives very full details of the construction of the standards; it also contains his investigation of the effect of flexure and the determination of best points of support.

Ultimately, six standards of Baily's metal were constructed which were found to have the length of 1 yard at the temperatures indicated below:

No. 1.	. . .	Correct at 62° F.
2.	. . .	" " 61·94 F.
2.	. . .	" " 62·10 F.
4.	. . .	" " 61·98 F.
5.	. . .	" " 62·16 F.
6.	. . .	" " 62·0 F.

Of these, it was arranged that No. 1 should become the standard yard, while 2, 3, 4, and 5 should be known as Parliamentary copies, and No. 6 should be retained by some officer of the Government for the comparison of other standard bars or for other scientific purposes.

Sheepshanks was taken ill while actually engaged in his comparisons; he died the day before Royal Assent was given in 1855 to the Act establishing the new measures. Thus as a result of the death of the two men who had done most of the work, the Royal Society paper in which an account of it is to be found was written by Airy. The Act (July 30, 1855) provides that:

"The straight Line or Distance between the Centres of the two Gold Plugs in the Bronze Bar deposited in the Office of the Exchequer as aforesaid shall be the genuine standard of that Measure of Length called a Yard and the said straight Line or Distance between the Centres of the said Gold Plugs or Pins in the said Bronze Bar (the Bronze being at a temperature of Sixty two Degrees by Fahrenheit's Thermometer) shall and be deemed to be the Imperial Standard Yard."

Thirty-seven copies were made and distributed.

Such were the conclusions enacted in the Weights and Measures Act of 1855, and they have remained unaltered up to the present time.

Since that date there have been various supplementary or consolidating Acts. In 1864 the Metric Weights and Measures Act was passed. It provided that "No contract . . . shall be deemed to be invalid or open to objection . . . on the ground that the Weights and Measures expressed . . . are Weights or Measures of the Metric System", and it gives a schedule of tables of metric measures expressed by means of legalised denominations of weights and measures in Great Britain, thus legalising the metric system but not providing any metric standards for purposes of comparison and verification.

In 1866 the custody of the Imperial standards of length and weight and of all secondary standards was transferred by Act of Parliament to the Board of Trade. Parliamentary copies of the yard and pound were placed at the Royal Mint, with the Royal Society, and at the Royal Observatory, Greenwich, and it became the duty of the Board to cause these to be compared every ten years with the standards in their charge. For this and other purposes connected with standards, the Board was to constitute a department to be called the Standards Office, and "shall appoint as Head of that Department an Officer to be called the Warden of the Standards", with assistants, clerks, etc., and the Act lays down the duty of the Warden.

The procedure was modified by an Act of 1878 which provided that the Board of Trade shall discharge the duties previously assigned to the Warden.

This Act also gives a schedule of metric equivalents and a list of metric standards in the custody of the Board, and provides (par. 38): "Whereas the Board of Trade have obtained accurate copies of the Metric Standards and it is expedient to make provision for the verification of Metric Weights, the Board of Trade may, if they think fit, cause to be compared with the metric standards in their custody all metric weights and measures submitted for the purpose".

A Metric Convention (Convention du Mètre) had been agreed to among a large number of nations in 1875. To this, Great Britain adhered in 1884, and comparisons between the metric and British measures were set on foot. In 1889 certified copies of the metre and kilogramme were deposited at the Board of Trade.

As a result of the comparisons carried out with great care by Mr. Chaney on behalf of the Board of Trade and M. Benôit of the Bureau des Poids et

Mesures, the value 1 metre, 39·370113 inches became the legal equivalent under an Act of 1897.

This gave to the Queen in Council power to make a table of metric equivalents in substitution for the table in the schedule to the Act of 1878 and provided that the Board of Trade standards, which may be made under par. (8) of the Act of 1878, shall include standards from the Metre No. 16 and the Kilogramme No. 18 deposited with the Board of Trade.

Under the provisions of this Act a table of metric equivalents was issued in 1898 according to which

1 metre = 39·370113 in.
1 kilogramme = 2·2046223 lb.

The most recent comparison of the yard and metre is that made at the National Physical Laboratory in 1927, which leads to the result that

1 metre = 39·370147 in.
1 inch = 25·399956 mm.

Here, perhaps, a reference to the Metric Convention is desirable. An International Metric Commission was convened at Paris in 1872 to consider the question of the construction and issue of metric standards of weight and measure. A committee was appointed to make the necessary preliminary investigations, and as the result a convention was agreed to on May 20, 1875, by a large number of States. Great Britain adhered to the Convention in 1884. The Convention provided that the contracting parties should set up at Sèvres an International Bureau of Weights and Measures at which the International prototypes of the kilogramme and metre were to be kept.

For the control of the Bureau an International Committee of weights and measures was established, consisting of fourteen members belonging to different countries. This committee was placed under the authority of a general Conference of weights and measures formed of delegates from all countries adhering to the Convention, which meets whenever convoked by the International Committee and in any case once in every six years.

INTER-DOMINION STANDARDS.

Before leaving this part of our subject—the present position of our national standards—a brief reference should be made to the Conference on Standardisation[9] held at the Board of Trade in October 1930 under the chairmanship of Mr. W. R. Smith, M.P., Parliamentary Secretary to the Board. The Conference was attended by representatives of Great Britain and Northern Ireland, the Dominions of Canada, Australia, New Zealand, the Union of South Africa, the Irish Free State, and India.

The work of the Conference was divided into two parts relating respectively to fundamental standards and to industrial standardisation. Sir Joseph Petavel acted as chairman of the section dealing with fundamental standards. The Imperial Conference held at the same time accepted the Report of the Conference on Standardisation and adopted the resolutions submitted therewith.

These resolutions, so far as they deal with fundamental standards, were:

(1) That it is desirable that there should be uniformity between the standards employed for all units of measurement which are in common use among the British Commonwealth of Nations.

(2) In order to secure uniformity arrangements should be made: (*a*) To provide in each Dominion and in India suitable reference standards for each unit of measurement required for use in that country where not already available; and (*b*) to introduce suitable procedure whereby all such standards shall be periodically compared with the corresponding standards at the Board of Trade or at the National Physical Laboratory.

(3) At least one member of the Commonwealth should undertake research work with the object of enabling the fundamental standards to be referred ultimately to natural standards such as the wave-length of light. It would be a great advantage if it were possible for research work of this character to be carried out independently by more than one member.

The Report of the Fundamental Standards Committee defines the fundamental standards both on the British system and on the metric system which constitute the fundamental units of measurement legal for use throughout the British Commonwealth of Nations. It is noted that in India the railway system of weights in common use is defined in terms of the pound.

It is explained that the term "reference standard" is used to denote a standard of suitable form and construction preserved under suitable conditions to serve as the basis of reference for the determination of any unit of measurement within one of the Dominions or of India.

In accordance with the recommendation of the Report, the errors, if any, of such reference standards in relation to the fundamental standards or to the theoretical definitions of the units they represent are to be ascertained from time to time by comparison with the corresponding standards in use in the United Kingdom, and are to be allowed for in the use of the reference standards.

The Report concludes with a list of the principal units for which reference standards are likely to be required, with suggested procedure in regard to each. Thus a simple and definite system has been set up by the Imperial Conference of 1930 for securing uniformity of standards throughout Great Britain, the Dominions, and India.

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[9] Report of the Conference on Standardisation (including Resolutions adopted by the Imperial Conference). Presented to Parliament by command of His Majesty, Nov. 1930. Cmd. 3716. 1930.

STANDARDS OF TIME AND ELECTRICAL STANDARDS.

In addition to this account of the development of standards of length and mass, Sir Richard Glazebrook dealt briefly with time. After noting that the measurement of time rested on astronomical observations and referring to various ancient means of indicating its passage, he described in some detail the clock recently developed by Mr. Shortt in association with the Synchronome Company and the crystal vibrator constructed by Mr. Marrison, of the Bell Telephone Company, referring in connexion with these to Mr. Loomis' paper read recently before the Royal Astronomical Society. In this connexion he mentioned work now in progress at the National Physical Laboratory.

As to electrical standards, Sir Richard recalled the fact that these had been dealt with very fully up to the year 1913 in his Kelvin Lecture before the Institution of Electrical Engineers, and he restated briefly some of the principal conclusions of that lecture. Coming to more recent times, he quoted the important resolution of the International Committee of Weights and Measures of Oct. 4, 1927, approving the organisation of a Consultative Committee for Electricity to advise the International Committee of Weights and Measures on questions relating to systems of measurement of electrical standards, and, after discussing the difference between the material standards of length and mass and electrical standards for which no permanent material standards can exist, he explained the plan approved by the Committee for their work.

It is not possible to equip the Bureau with invariable material standards against which national standards can be compared. Recourse must be had to experimental determinations of the fundamental electrical units in terms of the units of length, mass, and time. The national and other laboratories of several countries are already equipped for such work, and the staffs have considerable experience. It has been agreed, therefore, to leave all such work to these laboratories, and arrangements have been made with this object; the national laboratories will from time to time send the results of their work to Sèvres. Meanwhile, the International Bureau will organise the systematic exchange of standards (étalons) and secure the co-ordination (assurer la synthèse) of the results of comparisons made by the national laboratories, and will set up a collection of working and reference standards together with the laboratory equipment for the comparison with these of the material standards sent by various countries for exact determination.

In this way, while the experimental work of realising the material standards from the electrical units of the C.G.S. system will rest with the national laboratories, the International Committee will have the responsibility of fixing and promulgating the values to be employed for practical standards, and of fixing the date of any fresh revision.

As to the values of the present international units, Dr. Dye has prepared the following table :

Values of International Units (1831) in Terms of C.G.S. Units	
International ohm .	$(1{\cdot}00051 \pm 0{\cdot}00002)\ 10^{9}$
,, ampere .	$(1 - 0{\cdot}00006 \pm 0{\cdot}00006)\ 10^{1}$
,, volt .	$(1{\cdot}00045 \pm 0{\cdot}00008)\ 10^{8}$
,, watt .	$(1{\cdot}00039 \pm 0{\cdot}00014)\ 10^{7}$
E.M.F. of Weston Normal Cell at 20° C. . .	$1{\cdot}01876 \times 10^{8}$ C.G.S. units.

NATURAL AND ARBITRARY STANDARDS.

If we look back over the history of the past, we may note some interesting changes in the views of scientific men as to the bases on which to rest their standards of measurement.

It is obvious that weights and measures began with some natural objects selected for their convenience and sufficiently constant in quantity for the simple needs of the times. Such were the length of a man's forearm or the weight of corn—possibly of water—contained in a vessel approximately constant in volume.

In time, uniformity became more important, and so we pass from the length of the king's arm to the scale engraved on the wall or floor of the cathedral, and from the weight of so many grains of wheat taken from the middle of the ear to the mass of a lump of metal.

The jury of Queen Elizabeth's time, to which we owe our modern system, paid little attention, it is probable, to the origin of the yard or the pound; they fixed on the length of a metal bar and the weight of a lump of iron and prescribed that these were to be the standards, trusting to the permanence of these material objects rather than to any natural laws which might serve for their definition. They were, no doubt, severely practical; a change came in England in the early days of the Royal Society, when we find Caswell and Walker endeavouring to connect the weight and volume of a quantity of water and thus establish a natural standard of weight in terms of the standard of length—trying possibly to repeat what had been done in Egypt long ago.

Then, some fifty years later, Graham, realising that there was a definite relation between the period of a body in oscillation, its dimensions, and the distribution of its mass, endeavoured to connect the period of a seconds pendulum with its length, and set about the comparison of existing material standards, to find one in terms of which to express the length of the pendulum, thus leading to the Report of Lord Macclesfield's Committee in 1743.

Inter-comparisons between existing standards continued to be made, and the idea of basing that of length on the seconds pendulum increased in favour, until in 1814 the House of Commons asked for a formal statement of the length, and two years later the Astronomer Royal was instructed to determine it. Kater's work followed, with the result that, while in 1824 certain material standards—Bird's bar of 1760 and a brass weight of 1 lb. troy dated 1758—were made the legal standards, they were to be recovered, if lost, by reference to natural standards, the length of the seconds pendulum and the weight of a cubic inch of water.

This recourse to natural standards did not last long. Scientific men discovered that it was simpler to compare a standard with its copies, and to recover its value, if lost, by the aid of those copies, than to determine the length of the seconds pendulum or the mass of a cubic inch of water, and so, in 1843, the recommendations of 1824 were thrown over; the scientific committee, appointed to advise, recommended that the standards which had been lost in the fire of 1834 should be recovered from their copies, "and that the Standard be in no way defined by reference to any natural basis". More trust could be placed in the permanence of a material standard and on the accuracy with which it could be recovered by the inter-comparison of its copies, than on the result of any attempt to reconstruct it, based on some natural law; and so it has remained up to the present.

In France the history has been the same. The Constituent Assembly entrusted the Academy of Sciences with the duty of introducing a new system of measures, and in 1788 a report was issued on the choice of a unit of measure drawn up by Borda, Lagrange, Laplace, Monge, and Condorcet.

The report discussed the advantages of employing either the length of the seconds pendulum or that of a meridian of the earth as the basis of length measurement, and decided in favour of the latter, which, in the words of Laplace, "appears to be of very high antiquity". So the metric system came into being. Delambre and Mechain measured the length of an arc from Dunkirk to Barcelona, and hence calculated the length of the quadrant as 5,130,740 of a certain iron Toise, when at a temperature of 61·5° F. The metre was fixed as one ten-millionth of this length, and a standard metre constructed to represent it, while the kilogramme was to be the mass of a cubic decimetre of water at the temperature of its maximum density, and a platinum weight was constructed with great care to have this mass when weighed *in vacuo*.

While these material standards continue to exist, research has shown that they no longer represent the definitions. The metre is still the distance between the marks on a certain bar of platinum iridium, but the earth's quadrant is not 10^7 of these metres, while different meridians differ in length; the earth is not a spheroid. The best mean figure obtainable seems to be 1 meridianal earth quadrant $= 10{,}002{,}090$ m.

The platinum mass, known as the Kilogramme des Archives, is still the standard kilogramme, but the mass of a cubic decimetre of water, at 4° C. approximately, has been found to be 999·972 grammes, or alternately 1000·028 c.c. is the volume of a kilogramme of water at the temperature of its maximum density and under normal atmospheric pressure.

Neither the seconds pendulum nor a quadrant of the earth has proved to be more satisfactory than the material standard. This was the case when Michelson in 1889, realising that the wave-length of light of a given frequency was invariable, suggested its use as an ultimate standard of length. There was the difficulty of stepping from so small a unit as a wave-length of light up to the metre, but he pointed out that one can bridge over the distance by using a number of standards each approximately, but not quite, double the distance of the last, employing interference methods to determine the difference between the length of the larger standard and twice that of the smaller. Light directed so as to traverse the smaller distance twice was made to interfere with light which has only once traversed the longer distance. Michelson had an opportunity of carrying this idea into practice somewhat later at the Bureau des Poids et Mesures at Sèvres, and found from observations on the red line of cadmium that its wave-length is given by

$$\lambda_R = 0{\cdot}64384722 \times 10^{-6} \text{ metre.}$$

Somewhat later, in 1913, Messrs. Benoit, Fabry and Perot at the Bureau International repeated the measurement, using a modification of the method, and found

$$\lambda_R = 0{\cdot}64384704 \times 10^{-6} \text{ metre.}$$

Since that date measurements have been made in Japan by Messrs. Watambe and Timaszumi, leading to the value

$$\lambda_R = 0{\cdot}64384685 \times 10^{-6} \text{ metre,}$$

while Dr. Tutton communicated to the Royal Society on April 30 last his results, which gave

$$\lambda_R = 0{\cdot}64384698 \times 10^{-6} \text{ metre.}$$

A provisional value found at the National Physical Laboratory is

$$\lambda_R = 0{\cdot}64384714 \times 10^{-6} \text{ metre.}$$

At its meeting in 1925 the International Committee of Weights and Measures agreed in principle to define the unit of length by means of the wave-length of light, subject to the determination by the national laboratories of the most satisfactory method of realisation.

As a result, work has been in progress at the National Physical Laboratory for some time, and now is approaching conclusion, while work is also in progress at the Reichsanstalt and the U.S. Bureau of Standards.

Thus it will be seen that the International Committee is prepared to refer the standard metre to a natural standard against which it can be compared. This natural standard will thus be represented by the distance between two marks on a bar of platinum-iridium, and the constancy of this distance will be checked from time to time by comparison with the wave-length of light of definite period.

Hence there is a prospect that a natural standard of length will in time be generally accepted.

As to a standard of mass, up to the present it is not probable that the kilogramme, the mass of a lump of platinum, will be disturbed until we reach the condition when the mass of an atom of hydrogen or (say) an electron can be determined with sufficient accuracy. For a time unit, we already have a natural standard in the sidereal day, and while the frequency of a quartz or other oscillator will certainly be used for comparatively short intervals, it will not replace the day and hour for longer periods.

In electrical standards also a transference to natural standards is taking place. One of the first duties of the Comité Consultatif d'Électricité set up in 1927, as has been stated, is to determine the units in terms of which electromotive force, current, and resistance are to be measured. At present, while the units are defined in terms of the C.G.S. units of length, mass, and time, the standards used in daily work are the International Ohm, Ampere, and Volt. The definitions of these, as has already been explained, were agreed to at the International Conference in London in 1908.

The appliances needed for an absolute determination of the electrical units are elaborate and expensive. At the time of the London Conference it was realised that the necessary measurements could be made only in a few well-equipped standardising laboratories, while it was felt that the standards for daily use should be such as could be set up without serious difficulty in any laboratory provided with ordinary measuring and weighing apparatus of adequate precision. Hence the adoption of International Standards.

The arrangements proposed at Sèvres by the Comité Consultatif d'Électricité have altered this. When these are complete, any country can have its electrical standards compared against standards maintained at the Bureau, while by the collaboration of countries possessing laboratories, equipped for absolute measurements, these standards can be realised and maintained in much closer agreement with the C.G.S. units than is now the case with the International Ohm, Volt, and Ampere.

Since 1928, and indeed previously to that date, work has been in progress at the National Physical Laboratory in connexion with all the units.

The Ampere balance has been reconstituted; work has been put in hand on a novel method of measuring a resistance suggested some years since by Albert Campbell; preparations are going forward for further measurements with the Viriamu Jones Memorial Lorenz apparatus, and for a re-determination of the electromotive force of a Weston cell.

At the second meeting of the Comité Consultatif d'Électricité in 1930, reports as to progress were received from the National Physical Laboratory, the U.S. Bureau of Standards, the Central Chamber of Weights and Measures of Russia, and the Electrotechnical Laboratory of Tokyo.

While, of course, it will be necessary to have at Sèvres material standards or apparatus embodying the results of these various absolute measurements, the standards and apparatus will represent, with all the accuracy possible, multiples of the C.G.S. units themselves, and not standards adopted because, at the time they were defined, they were believed to represent the theoretical units to the highest accuracy then possible.

Thus in electricity we go back through the C.G.S. units to the natural standards of length and time, the wave-length of the red line of cadmium and the sidereal second.

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evidence of a large increase in public interest in the Exhibition Galleries in the Institute, the attendance during the year being 608,900, as compared with 398,000 in 1929. The more important work of the Institute, however, in advising as to the utilisation of the resources of raw materials in the British Empire and in promoting the production within the Empire of crops and products which at present are mainly obtained elsewhere, is still hampered by lack of funds. The Research Committee of the Imperial Conference, which met in London in 1930, investigated the Intelligence and Investigation Departments, which are mainly concerned with this vital but less publicly known work of the Institute, and recorded its opinion that this work could be carried out more efficiently and less expensively through the utilisation of the services of the Imperial Institute than in any other manner. During the present Empire-wide depression, no further Government funds are available to extend the Institute's work, but in March 1931 the Secretary of State for the Dominions was able to announce that Mr. Benjamin Drage had contributed £36,000 to the Empire Marketing Fund with the proviso that the sum, to be spread over a period of seven years, should be used to augment the income of the Imperial Institute. The Institute not only advises the Colonies and Dominions upon mineral resources; it is also busy trying to develop the production of commodities like tung oil, pyrethrum flowers, and so on within the British Empire, and is able to report that the London County Council has approved five Empire woods as fire-resisting timbers. The perusal of the Director's brief report will show how wide-flung are its activities.

Mr. J. Milton Offord has contributed to the March *Journal* of the Quekett Microscopical Club some interesting recollections of his association with the Club since 1878. At the meeting in January 1879, at which he was elected a member of the Club, Huxley was in the chair and E. T. Newton showed a model of the brain of the cockroach, constructed from slices of wood of appropriate thickness representing the successive serial microscopic sections of the brain. The outlines of the section had been drawn on the slices with the help of a camera lucida and cut out by a fret-saw. These prepared slices when fitted together formed the model—one of the early examples of a method which, after modifications, was, especially in the next twenty years, and still is, regularly employed in many laboratories. Mr. Offord refers to the large conversaziones which were a feature of the society's activities, and directs attention to one held in University College, London, in 1879, at which there were 185 microscopes, and 1050 persons were present. This was regarded as a small attendance for a conversazione and "was put down to the inclement weather, and it being held during Lent".

On June 27, Prof. G. M. Trevelyan, O.M., representing the National Trust, accepted the deeds of the property of the Longshaw estate for the Trust. This estate is 750 acres in extent, and is the first acquisition made by the National Trust in the Peak district of Derbyshire. It is a beautiful stretch of high woodland and moorland, surrounded by picturesque heights. When it was offered for sale, a sum of £15,000 was asked for the complete estate, and, since it was threatened to be disposed of as building sites, the Sheffield Council of Social Service and the Sheffield and Peak District branch of the Council for the Preservation of Rural England took steps to save the estate. £11,000 came from the city and neighbourhood of Sheffield and £3580 from other parts of the country, chiefly through the National Trust. The deeds of the estate were handed over to Prof. Trevelyan by Mrs. Gallimore, honorary secretary of the Longshaw committee.

On June 24 the Royal Society of Tropical Medicine and Hygiene moved its offices from Chandos Street to Manson House, 26 Portland Place, which has been secured as its permanent home and as a memorial to the late Sir Patrick Manson. With the help of Joseph Chamberlain, then Colonial Secretary, Manson founded the London School of Tropical Medicine in 1897; other countries followed suit and similar institutes have been set up in Hamburg, Amsterdam, Paris, and other centres. It was soon realised that this new knowledge should be co-ordinated, and in 1907 Sir James Cantlie, Dr. Carmichael Low, and others founded the Society of Tropical Medicine and Hygiene, with Sir Patrick Manson as its first president. Though Manson died in 1922, there was no adequate memorial to him, and last year the council of the Society resolved to buy and equip a house which should be known as Manson House in memory of Sir Patrick, and at the same time form a permanent home for the Society. A sum of about £11,000 has been collected and subscribed for this purpose, but a further £17,000 is required to complete the scheme. Any donations, great or small, will be gratefully acknowledged if sent to the president, Manson House, 26 Portland Place, London, W.1.

Sir Sidney F. Harmer, formerly Director of the Natural History Departments of the British Museum, has been elected an honorary member of the Société Zoologique de France.

The South Africa Medal for 1931 of the South African Association for the Advancement of Science has been awarded to Prof. H. B. Fantham, of the Department of Zoology and Comparative Anatomy in the University of the Witwatersrand, Johannesburg, for his researches on parasitic protozoa, soil protozoa, and heredity. The medal is being presented to Prof. Fantham at the Grahamstown meeting of the Association on July 6.

The Museums Association will hold its annual conference this year at Plymouth on July 6–11. All meetings of the Association will be held in the Abbey Hall. July 6 will be spent in committee meetings, and the president, Sir Henry Miers, will deliver his presidential address on July 7. The president's address will probably include some indication of a proposed survey of all the museums in the British Empire, to be financed by the Carnegie Corporation of New York. Among the papers to be read are: "A Suggested System of Museum Registration", by Mr. K. de B. Codrington, and "Paper for Museum Labels", by Dr. L. J. Spencer, on July 8; "Taxonomy in the

Museum", by Dr. W. T. Calman, "Present-Day Problems of Provincial Museums", by Mr. H. J. M. Maltby, and "The Preservation of Marine Life, Wet or Dry Specimens", by Dr. E. J. Allen, on July 9; and "Museum Problems in Canada", by Prof. J. H. Iliffe, "A Simple Way to test Museum Value", by Dr. Hay Murray, and "Why do we use Plate-Glass in Museums?" by Mr. Frank Loney, on July 10. All communications concerning the Conference should be addressed to the local honorary secretary, Mr. A. J. Caddie, Museum and Art Gallery and Cottonian Collection, Plymouth.

THE Report of Map Publication and Office Work of the Survey of India for 1929–1930 (Calcutta, 1*s.* 9*d.*) is chiefly useful for the detailed index sheets of published maps of India and adjacent countries. Good progress is being made with all the maps. The 'million' map is now practically complete for India, Burma, and adjacent countries. The modern '1-inch' map is making progress, and the modern '¼-inch' covers considerable areas in the most important parts of India. Additions have also been made to several other series.

THE last issue of the League of Nations *Quarterly Bulletin of Information on the Work of International Organisations*, No. 2, vol. 3, April 1931, contains brief reports of some three dozen conferences held and also a list of more than sixty forthcoming conferences to be held during the present year. It is desired to make this register as complete as possible. Information about coming scientific conferences of international importance would be particularly welcome and may be addressed to the Section of International Bureaux, League of Nations, Geneva.

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just circulated an important catalogue (New Series, 25) of second-hand works (more than 2000 in number) on entomology and arachnology, including the collection of pamphlets formed by the late W. F. Kirby. The list is obtainable upon application.

A USEFUL catalogue (No. 458) of about 900 second-hand books on philosophy, including many from the library of the late W. E. Johnson, Sidgwick lecturer in moral science in the University of Cambridge, has just been received from Messrs. Bowes and Bowes of Cambridge. Copies can be had from the publishers upon application.

MESSRS. H. K. Lewis and Co., Ltd., have just issued a supplement (1928–1930) to the catalogue of their Medical and Scientific Circulating Library which should be of service not only to users of the library, but also to others who may wish for particulars of books relating to science in its various branches. The supplement is arranged alphabetically, but a classified list of subjects included, with the names of the respective authors, is given at the end. The price to subscribers is 1*s.* net., to others 2*s.* net.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant quantity surveyor on the staff of the Miners' Welfare Committee of the Mines Department—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (July 8). A secretary of the Institution of Sanitary Engineers—The Chairman of Council of the Institution of Sanitary Engineers, 120-122 Victoria Street, S.W.1 (July 8). A visiting teacher of science capable of teaching physics and chemistry, hygiene, and some biology in the junior day school of the Smithfield Institute—The Education Officer (T.1), County Hall, S.E.1 (July 10). An assistant in the natural history division, National Museum, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin, C.8 (July 10). A lecturer in mining at the Sunderland Technical College—The Chief Education Officer, Education Office, 15 John Street, Sunderland (July 11). A full-time lecturer in charge of the electrical engineering department of the Chesterfield Technical College—The Principal, Technical College, Chesterfield (July 11). An assistant master at the Bolton Municipal Technical College, to teach mainly science subjects in the junior technical school and engineering departments of the College—The Director of Education, Education Offices, Nelson Square, Bolton (July 11). A librarian of University College, Nottingham—The Registrar, University College, Nottingham (July 13). A principal of the Neath Mining and Technical Institute—The Director of Education, County Hall, Cardiff (July 13). An assistant lecturer in physics at University College, Nottingham—The Registrar, University College, Nottingham (July 13). An assistant organising lecturer at University College, Nottingham, under the Miners' Welfare Adult Education Joint Committee—H. L. Featherstone, 14 Shakespeare Street, Nottingham (July 14). A woman senior demonstrator in pathology at the London (Royal Free Hospital) School of Medicine for Women and Royal Free Hospital—The Warden and Secretary, 8 Hunter Street, W.C.1, or the Secretary, Royal Free Hospital, W.C.1 (July 15). A lecturer in zoology at Birkbeck College—The Secretary, Birkbeck College, Fetter Lane, E.C.4 (July 15). A principal of the Harris Institute, Preston—Alderman H. Astley Bell, Harris Institute, Corporation Street, Preston (July 31). A keeper of archæology in the Liverpool Public Museums—The Town Clerk, Municipal Buildings, Dale Street, Liverpool (Aug. 1). An assistant town planner under the Government of Northern Rhodesia—The Crown Agents for the Colonies, 4 Millbank, S.W.1, quoting M/2748. A lecturer-in-charge of the building department of the Norwich Technical College—The Principal, Technical College, Norwich. Teachers of engineering drawing and mechanical engineering at the East Ham Technical College—The Secretary, Education Office, Town Hall, East Ham, E.6. A teacher of engineering at the Leyton Technical College—The Clerk to the Governors, 280 High Road, Leyton, E.10. A Principal of University College, Leicester—The Registrar, University College, Leicester.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Embryology and the Theory of Polyhedra.

A new volume of *Proceedings* of the Bologna Mathematical Congress begins with a short paper by Max Brückner, on the old problem of how many different polyhedra are possible of n sides—with the limiting condition that all the corners shall be trihedral. In my book on "Growth and Form" I dealt with the kindred problem of the possible number of arrangements of a plane assemblage of cells, their partition-walls all meeting three-by-three, as is actually the case in a system of soap-bubbles or of living cells. The problem of the polyhedra is just as interesting to the biologist; for any 'natural clump of cells, such as a totally segmented egg or 'morula', may be looked on as a polyhedron and may be studied accordingly.

Eighty years ago, Kirkman showed that the total number of 8-sided (convex, Eulerian) polyhedra, with trihedral corners, was *thirteen*; and Cayley, Steinitz, and others have extended the problem by a few stages. The number of possible arrangements increases rapidly; and now Brückner (whose results I only quote approximately) tells us that, for

$n = 13$, 14, 15, 16, the number of
n-sided polyhedra $= 5 \times 10^4$, 4×10^5, 3×10^6, $2{\cdot}7 \times 10^7$.

An 8-sided polyhedron, or 8-celled egg, may have its sides, or cells, arranged in 13 different ways; there is room for variety, but withal so limited that we must expect to find the same arrangement, or cell-pattern, repeated again and again in the 8-celled stages of divers organisms. But we no sooner come to the 16-celled stage than nearly 30 million arrangements of these sixteen cells are found to be possible. And it becomes plain that the study of 'cell-lineage', or the mapping-out in detail of the cell-arrangements after repeated cell-divisions, is only possible under the severest limitations—if it be possible at all.

D'Arcy W. Thompson.

St. Andrews.

Effect of Certain Substances and of Heat on Cells of *Abraxas*.

In continuation of the work already carried out last year on the effects of phosphorised olive oil on the male germ cells of *Abraxas*, we have investigated material from larvæ injected into distilled water, 2 per cent NaCl in water, phosphoric acid, and phosphorus in paraffin oil. We have also tried various temperatures for several hours.

In many of the preparations, in addition to the cytoplasmic inclusions, the spindle bridges, or parts thereof, swell up and form separate bodies, which are very similar to the abortive acroblasts already described. In material treated with phosphoric acid, heat, 2 per cent NaCl in water, and phosphorised paraffin oil, no very large bodies of the type already described[1] have yet been found. There is at present some doubt as to the actual mode of origin of some of these large elements in the spermatocytes and spermatids of *Abraxas*.

J. Brontë Gatenby.
Joyce C. Hill.

Trinity College, Dublin.

Paramagnetism of Bivalent Silver.

In collaboration with Mr. F. H. Burstall, one of us has recently prepared a series of silver salts of the type $[\mathrm{Ag\ 3\ dipy}]X_2$ in which dipy represents αα′-dipyridyl ($C_{10}H_8N_2$) and X a univalent anion (*J.C.S.*, 2594; 1930). The complex kation is therefore bivalent.

If this is due to the presence of bivalent silver, then an electron must have been extracted from the inner levels (probably the N level) of the silver atom, which consequently should be paramagnetic. We have therefore measured by the Gouy method the susceptibility of the chlorate at 20°. Parallel measurements were made in the same apparatus with copper sulphate, since the bivalent copper ion contains a similar incomplete sub-group. The following results were obtained:

Substance.	χ.	χ_M.	p.
$CuSO_4{\cdot}5H_2O$	$5{\cdot}86 \times 10^{-6}$	1457×10^{-6}	9·2
$[\mathrm{Ag\ 3dipy}](ClO_3)_2$	$1{\cdot}93 \times 10^{-6}$	1434×10^{-6}	9·1

The molecular mass susceptibilities of the silver and copper compounds are equal within the limits of the experimental error (5 per cent). The Weiss magneton number p is calculated on the assumption that the Curie law holds, and no allowance has been made for the diamagnetism of the rest of the molecule. The values are, however, in fair agreement with those found for other atoms in which a sub-group lacks one electron: for example, $Cu^{\cdot\cdot}$, 9·2; NO, 9·2; $VOSO_4$, $3\frac{1}{2}H_2O$, 8·95, $V_2O_2Cl_4{\cdot}5H_2O$ 7·94. These values are taken from the International Critical Tables.

G. T. Morgan.

Chemical Research Laboratory,
Teddington, Middlesex.

S. Sugden.

Birkbeck College,
Fetter Lane, E.C.4.

Forestry Practice and Research.

The leader on forestry research in Nature of May 16, and previous letters from Dr. Rayner and Prof. Tansley, would suggest that attempts to grow timber on poor land are in their infancy, and that the work of the Forestry Commission and other State forest departments throughout Europe is being carried on in complete ignorance of fundamental principles. It is fairly evident that no representation of this kind was intended, but at the same time the impression might be conveyed to the casual reader (if such an individual ever reads Nature) that research in connexion with afforestation has been practically ignored. This view may be perfectly correct in certain directions, but I think the practical forester is as fully aware of the value of genuine research as those engaged in any other industry influenced by biological factors. As regards the British forester, whether in the capacity of employer or employee, I scarcely think that he is guilty of the charge advanced by Prof. Tansley. Forest botany and pedology he may have failed to study through lack of opportunity, but in connexion with geographical botany, estate owners throughout the British Isles have carried out most valuable work for practically two centuries in testing exotic species on varying soils and situations. These tests of exotic species have already enabled two or three cubic feet of timber to be grown where only one grew before in connexion with the planting of species like Douglas fir or Sitka spruce, while they have conclusively proved the unsuitability of other species for the British climate, although strongly advocated by enthusiasts.

We know that many of the empirical methods adopted in farming and gardening have been explained, and in many cases justified, by science; others have been shown as useless or harmful; while in connexion with insects and fungi, invaluable weapons have been placed in the hands of the modern cultivator by science and research. But no one suggests that gardening or farming are industries which should have stood still until science had investigated them in all their aspects. Some years ago the Development Commission, which at that time was in charge of forestry development, adopted the principle that education and research should precede practical operations. Had this policy been adhered to, twenty years might have elapsed before a single plantation had been laid down with the aid of public money, while private planters in every direction had already provided, throughout the length and breadth of the British Isles, abundant examples of practical timber growing, good, bad, and indifferent.

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[1] Gatenby, J. Brontë, *Jour. Exper. Zool.*, vol. 58; 1931.

The Forestry Commission only came into existence in 1919, and had a definite function to perform, namely, the building up of a timber reserve within a definite period. Had it been able to confine its operations to soils and sites comparable to those which had already carried successful timber crops, the problem, from a technical point of view, would have been comparatively simple. It is no secret, however, that many areas have been acquired which are not likely to fulfil all that was expected of them, and it is on these that the scientific worker might carry out invaluable work if given the opportunity and encouragement.

So far as the practical man is concerned, however, the soil is the raw material upon which he has to work, and it is no exaggeration to say that he knows practically nothing about it other than a few of its more obvious mechanical and physical features. But this does not prevent him from growing cabbages or potatoes satisfactorily. On similar lines the forester plants trees and produces timber which he considers will meet a local or general demand some day or other, but it does not follow from this that he is able to explain how these trees grow, nor can he anticipate the results of his work within exact limits. The man of science may be able to influence him as regards his methods to an appreciable extent, but every cultivator, whether of farm, garden, or forest crops, knows perfectly well that he does many things badly for the simple reason that he cannot do them in any other way under average conditions. Weather and other natural causes over which he has no control frequently dominate the most carefully conducted operation, and unless the latter can be carried out as cheaply as the more rough and ready process to which experience has accustomed him, he is naturally apt to view innovations with suspicion.

In connexion with the branch of research already alluded to, namely, the introduction of exotics from the more temperate parts of the world, several instances might be given to show that experience, when properly interpreted, is the only safe guide in the long run. For example, the success of Weymouth pine in the British Isles (apart from *Peridermium Strobi*) would lead one to suppose that other species growing within the same region would also succeed. Yet *Pinus resinosa*, a useful timber tree in Canada, fails in this country, although associated with Weymouth pine in its native habitat. In Eastern Canada, *Pinus Contorta* is, as its name implies, a scrub pine, while in North-western Europe it grows, in the earlier stages at least, faster than any coniferous species on the poorest type of soil. Many similar examples of this kind could be given, yet probably the scientific worker, basing his conclusions on meteorological data, would give erroneous advice on matters of this kind.

The moral of all this appears to be that practice and science must work side by side, and regard themselves within their own spheres as equally important, neither trying to influence the other until the problem at issue is thoroughly understood.

The practical man has no grievance against research workers. On the contrary, he has every reason to welcome them. But it frequently happens that research confines its attention to one particular problem, and is inclined to dogmatise upon it, whereas the industry to which it applies is made up of a complex system of science, practice, economics, and politics which the research worker has no particular reason to consider. Every practical forester recognises the fact that soil and the root functions of the tree growing in it are mysteries which he cannot unravel unaided, and the article in NATURE on May 16 will be welcomed by every unprejudiced worker in the forestry field.

A. C. FORBES.

Dublin, June 15.

The Age of Flint.

A HUNDRED years have elapsed since Mantell opened the controversy regarding the formation of flint, but hitherto, despite a voluminous literature on the subject, the crucial point, the time of formation, has remained undecided. The main issue has been narrowed down to one of two possibilities: either the flint was formed contemporaneously, by precipitation of silica gels on the sea-floor, or it was formed subsequently to the deposition of the Chalk, by the solution and segregation of silica disseminated through the chalk chiefly from the remains of sponges. The arguments in favour of the rival views are fairly evenly divided, and a strong case can be made out for both contemporaneous and subsequent formation. In fact, almost every observation can be made to fit in equally well with either view; and, like the evidence, so the supporters of the theories, past and present, are evenly divided. An infallible criterion of the age of flint is, therefore, a prime necessity, and the purpose of this note is to suggest one, of which the only remarkable feature is its extreme simplicity. The condition of the sponge remains found in flint is in itself adequate proof that the formation was subsequent.

Siliceous sponges may be divided, according to their behaviour after death, into two classes, namely: (*a*) those in which the skeleton is composed of separate spicules and which rapidly disintegrate after death, the spicules becoming scattered; and (*b*), those in which the skeleton consists of a continuous framework, with separate spicules scattered in its meshes. To the latter belong the Lithistida and the Dictyonine Hexactinellida. Judging by experience of hauls of recent sponges from waters of all depths, it is probable that the time taken for the disintegration of those of class *a* may be from a few months, or less, to a year, seldom more. As to those of class *b*, although the interstitial spicules may be lost in a few months, or less, the dictyonine framework may persist for years. In fact, it is indestructible except by severe mechanical abrasion or continued action of solvents over a long period of time. Normally, therefore, the Dictyonine Hexactinellida and the Lithistida will stand the greatest chance of preservation where sedimentation is slow, and in any deposit laid down in depths of 100 to 1000 fathoms, where the two classes are approximately equally represented, the higher the rate of deposition the more of class *a* will be preserved as complete sponges, and the more likelihood of interstitial spicules being found in the skeleton of class *b*.

The sponge-remains in the English chalk belong predominately to class *b*; in fact, the number recorded for class *a* is negligible. Moreover, the interstitial spicules of the former are, practically without exception, lost. In other words, the sponge remains are precisely those which would be left after a long period of disintegration on the sea-bottom. These remarks apply equally well to remains found in chalk and in flint. Clearly, then, these remains suffered no rapid burial. Had the sponges found in flint been entombed by a fall of silica gel, a few complete and live sponges at least would have been embalmed in the process. It may, indeed, be said that the majority would be intact, and we should have had a large number of class *a* so preserved. Yet despite the numbers of flint nodules which must have been examined in the last century, we have nothing to show of class *a* except for isolated spicules. Nothing could be more decisive.

Frequently, one finds in flint the dictyonine framework of a sponge faintly portrayed in a brown stain, and the connexion between these and similar iron-stained impressions in the surrounding chalk is obvious. The replacement of the original silica by iron oxide must have taken place prior to the formation of the flint, showing clearly that that formation was not only subsequent, but also took place a long time after the burial of the sponge-remains.

There is yet one other factor, which also seems to have been completely overlooked. If flint had been formed by the relatively sudden precipitation of silica from solution, we have to explain why the remains of all forms of contemporary life found in it are so poor. Taking the Rhynie chert of Aberdeenshire as an example, in which remains of plants and animals, many of minute size, are so beautifully preserved, we should expect to find much better preservation of the fossils enclosed in flint. The famous Whittaker's three-inch, representing a continuous bed estimated at some 240 square miles in extent, should have embalmed a perfect representation of contemporary benthos. Yet this, and other flint similarly bedded, fails entirely in this respect.

The story of the formation is even yet far from complete, but that that formation was subsequent to the deposition of the chalk, nobody who has worked extensively at both recent and fossil sponges will deny.

MAURICE BURTON.

Department of Zoology,
British Museum (Nat. Hist.),
London, S.W.7.

Absorption Spectra of Crystals at Low Temperatures as References in the Measurement of Stellar Velocities.

THE vast work of determining and cataloguing radial velocities has made the slitless spectrograph almost indispensable. A number of stars may then be photographed on the same plate at the same time. Such a method is possible only if the starlight passes through some medium which has sharp absorption lines so that the spectrum of each star has within it the absorption lines for references. A medium having sufficiently sharp lines in the proper spectral region does not seem to have been found. I would suggest the use of the crystals of the rare earths maintained at the temperature of liquid nitrogen. Both Dr. Joy, of the Mount Wilson Observatory, and Dr. Shane, of the University of California, have considered in this connexion the absorption spectra of crystals of gadolinium at room temperature.[1] The absorption lines occur, however, in an unfavourable region of the spectrum.

The spectrum of the dysprosium ion appears particularly adapted for the purpose. At room temperature its spectrum taken with a three prism Steinheil spectrograph contains some diffuse lines between 4000 A. and 4800 A. At the temperature of liquid nitrogen, the lines are as sharp as those of gases. The crystal studied was dysprosium ethyl sulphate. It is possible, though not easy, to grow this crystal perfectly clear. A few trials would doubtless discover a more amenable salt of dysprosium. The acetate is probably easy to grow. A crystal about 2 cm. × 2 cm. × 0·5 mm. of another rare earth, cerium, was grown almost as clear as glass by evaporating a saturated solution in a desiccator containing concentrated sulphuric acid. Much larger crystals can be obtained when some precautions are taken as in the method of Freed and Spedding.

Because of its constant boiling point, liquid nitrogen is preferable to liquid air, by means of which it may readily be prepared. Also, it has the advantage of complete transparency should one desire to immerse the crystals in the refrigerating liquid.

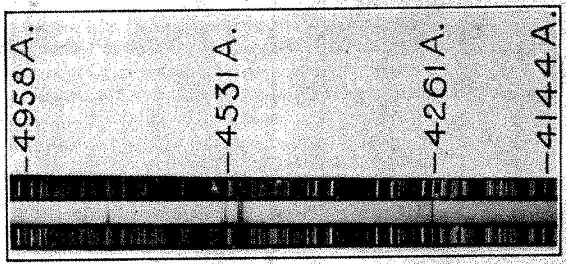

FIG. 1.—Absorption spectrum of dysprosium ethyl sulphate ($Dy_2(SO_4)_3 . 9H_2O$) at the temperature of liquid nitrogen.

The high cost of dysprosium might induce one to investigate other rare earths. Neodymium has also been found to possess sharp absorption lines in this spectral region, but they are not so fine as those of dysprosium. However, it is not necessary to employ pure salts of dysprosium. It may be desirable, also for spectrographic reasons, to make a mixed crystal with the corresponding colourless lanthanum salt.

No difficulty should be met in eliminating any serious change in temperature of the spectrograph because of the liquid nitrogen.

I wish to express my indebtedness to Mr. G. P. Kuiper, of the Leyden Observatory, for an interesting conversation. The work is one of a number made possible through the generous hospitality of Prof. W. J. de Haas. The Steinheil spectrograph was kindly placed at my disposal by Prof. W. H. Keesom.

SIMON FREED
(Fellow of the John Simon Guggenheim
Memorial Foundation).

Cryogenic Laboratory,
University of Leyden, Holland,
May 23.

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[1] Freed and Spedding, NATURE, **123**, 525; 1929: *Phys. Rev.*, **34**, 945; 1929.

Mortality among Plants and its Bearing on Natural Selection.

I HAVE read with great interest the letters from Prof. Salisbury and Dr. J. Phillips which have appeared in NATURE dealing with mortality in plants at different stages of their life histories. The observations are of the greatest importance, but I doubt whether the interpretation advanced by Prof. Salisbury in his letter of May 31, 1930, is supported by the facts. It seems to me that a distinction should be made between mortality and natural selection. The results obtained by Prof. Salisbury with *Silene conica L.* and *Verbascum Thapsus L.* would probably have been very similar if all the seeds in each case had been exactly alike, and, in any case, evolution under natural conditions is proceeding so slowly that individuals of any one species or variety in a taxonomic sense are very nearly identical. On the other hand, the seed yield of many individual plants runs into thousands and millions, which, combined with the losses between pollen production and germination, makes the chances against survival into the second generation of any single pair of gametes enormous. How far natural selection enters into this enormous mortality can never be known: for while accidental mortality deals equally with the less and the more favourable variation, competition verging on mortality puts a high premium on favourable variations, however small, as, for example, in competition for light or plant food.

With regard to the taxonomic characteristics of adult plants, it can for the moment be fairly assumed that they have been attained as a result of intense natural selection extending over millions of years, in which case little difference between individuals is to be expected, and little scope for progressive selection will exist. Whatever differences exist in the relative fitness of adult stages will be reflected in the seed yield, and I have frequently been struck by the wide variations in seed yield between different individuals of *Capsella Bursa-pastoris*, *Brassica Sinapis*, *Senecia vulgaris*, and *Bromus mollis*. One individual of these species may easily give rise to a hundred times more seed than another, so that even allowing for accidental differences of soil and situation the scope for natural selection in adult stages is fully comparable with that for seedlings.

The whole subject of seed yield, reproduction rate, and frequency of occurrence in plants needs careful study; since in all species a very delicate balance exists between rate of reproduction and mortality, and the slightest change in these should lead to striking changes in frequency in species with short life histories; yet observation shows that this is not the case. Assuming for the moment a habitat occupied by only one species, the number of adult individuals present would probably be very stable for wide differences in seed yield. If, however, *Lolium perenne*, *Dactylis glomerata*, *Bellis perennis*, *Taxacum Dens-leonis*, *Ranunculus bulbosus*, and *Carduus lanceolatus* are all present in one pasture, why does not one species drive out all the rest, and why is *Lolium perenne* usually more abundant than *Dactylis glomerata*, and *Ranunculus bulbosus* more common than *Taraxacum Dens-leonis*? In raising these questions, and in remembering rare individuals of still rarer species, one is driven to conclude that suitability to a given habitat plays a predominant rôle in the frequency of occurrence of a given species. One single favourable variation, when fully established, ought to have a marked influence on the frequency of a given species comparable with the results obtained by changing the habitat artificially, as, for example, by liming and draining. From the evidence before us, I must tentatively conclude either that nearly all mortality in plants is not progressively selective, or that progressive variations are occurring at such a rate that they are almost completely eliminated before they became established.

R. Weatherall.

Eton College, Windsor,
June 14.

The Heat of Dissociation of Fluorine.

The heat of dissociation of chlorine, bromine, and iodine has been determined by thermal methods by Bodenstein and estimated respectively to be + 56·8, + 45·2, + 35·6 kilo-cal. No data are yet known regarding the heat of dissociation of fluorine.

I have determined this quantity by reversing the arguments of Franck regarding the absorption spectra of molecules of alkali halogenides. It is well known that the alkali halogenide vapours like NaCl, etc., give a continuous absorption spectrum, the beginning of absorption corresponding to the atomic heat of formation $R = \mathrm{Na} + \mathrm{Cl} - \mathrm{NaCl}$. R is connected with the ordinary heat of reaction $Q . \{Q = [\mathrm{Na}] + \frac{1}{2}\mathrm{Cl}_2 - [\mathrm{NaCl}]\}$ by the relation $R = Q + \frac{1}{2}D_{\mathrm{Cl}_2} + \lambda_{\mathrm{Na}} - \lambda_{\mathrm{NaCl}}$, where D_{Cl_2} is the heat of dissociation of Cl_2; λ_{Na} is the heat of vaporisation of Na, λ_{NaCl} is the heat of vaporisation of [NaCl] crystals. It is found that if ν_0 be the frequency of the beginning of absorption, then $h\nu_0$ corresponds almost exactly to the value of R calculated as above in the case of ionic compounds.

I took anhydrous NaF and KF and vaporised them within a silica tube placed within the vacuum graphite furnace of this laboratory, and obtained their absorption spectra. For NaF, the absorption became noticeable at λ2370; for KF at λ2245. We can then calculate D_{F_2} from the relation $\frac{1}{2}D_{\mathrm{F}_2} = R - [Q + \lambda_M - \lambda_{MF}]$ in which R is calculated from the absorption spectrum data, the other quantities are taken from Landolt and Bornstein's tables. From NaF data, we get $D_{\mathrm{F}_2} = 78$ kcl., from KF data we get 74 kcl. It appears, therefore, that the heat of dissociation of fluorine is: 76 ± 2 kcl.

I propose to complete the work by performing similar experiments with other alkali fluorides.

Manohar S. Desai.

Physical Laboratory,
University of Allahabad,
May 18.

Hyperfine Structure in the Rubidium Spectrum.

In a preliminary note[1] the lines of the rubidium doublet $1S_{\frac{1}{2}} - 3^2P_{\frac{3}{2}}$ and $1S_{\frac{1}{2}} - 3^2P_{\frac{1}{2}}$ were stated to possess a doublet hyperfine structure with separation of about 0·1 cm.$^{-1}$ and intensity ratio about 2 : 1. These results were obtained with a Fabry-Perot etalon. Meanwhile the lines have been investigated with a reflecting echelon of high resolving power in order to detect the presence of weak lines due to the less plentiful isotope. A third very much weaker component was observed; the three observed components being at 0·00, 0·11, and 0·19 cm.$^{-1}$, with ratios 6 : 3 : 1. This structure is the same for both lines of the doublet.

The two strong lines are evidently due to the more plentiful isotope Rb 85, and the weak line is due to Rb 87. But as the ratio of the sum of the intensities of lines due to Rb 85 to the sum of those due to Rb 87 must be about 4 : 1 (the proportion in which the two isotopes are present), Rb 87 must possess an unresolved component of intensity rather greater than 1. This must be obscured by one or other of the Rb 85 lines. It is more probably the stronger line (0·00), as this line appears broadened and somewhat asymmetrical.

On this view, Rb 85 possesses a doublet hyperfine structure with separation of 0·11 cm.$^{-1}$ and intensity ratio slightly less than 6 : 3; the probable value of i, the nuclear spin, being 3/2. Rb 87 also possesses a doublet structure, with separation nearly twice as great, and intensity ratio probably smaller.

It is interesting to note that the lines of the heavier isotope are displaced to the violet. A complete account of this work, with photographs of the fine structure, will appear elsewhere.

D. A. Jackson.

Clarendon Laboratory,
Oxford.

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[1] D. A. Jackson, Nature, vol. 127, p. 924; 1931.

Hail Storm, June 14, at Doncaster.

Around my home at Bessacarr, on the Great North Road, three miles E.S.E. of Doncaster, on June 14, at 5 P.M. B.S.T., heavy rain was followed by hail measuring three-quarters of an inch in diameter, then—after a five-minute interval—by hail measuring one and a quarter inches in diameter—with a density of 85 to the square yard. The duration of the second shower was only one minute. Sound elm twigs a quarter of an inch thick were cut off the trees in thousands. The largest stones weighed 20 grams (¾ oz.): twenty per cent showed four growth rings about a white spherical nucleus a quarter of an inch in diameter. The intermediate transparent stages were one-eighth of an inch and the final growth three-eighths. None were angular, but a small number showed a quarter of an inch mosaic allotriomorphic crystallisation on their smooth ovoid surfaces.

A sandpit in the garden was temporarily flooded, and in the thin residual layer of mud the stones made excellent impressions. These were covered by waterproof fabric, and next day, after being sun dried, casts of many of these were taken and a reproduction of the surface made in plaster for the Doncaster Museum.

N. L. Silvester.

Waterdale, Doncaster,
June 19.

An Apparatus for Recording the Ultra-Violet Light of the Sky.

In Nature of June 13, p. 893, Dr. J. R. Ashworth describes a photographic apparatus for recording the ultra-violet light of the sky.

It may be doubted whether such a method can give quantitative results, or even relatively correct results on different days, for the following reasons.

First, a step wedge constructed of a diffusing medium, such as thin tissue paper, does not obey the logarithmic 'law', which is valid only for transparent media.

Secondly, photographic paper can be used as a quantitative instrument only by a null method, if any reasonable degree of accuracy is required, since it does not respond in a regular way to light stimulus. For example, equal values of *It* do not necessarily involve equal response by the photographic paper, owing to the existence of the Schwarzchild effect, while the sensitivity of the paper varies according to the atmospheric conditions.

A method which involves a visual estimate of a small change is also open to criticism, since different people have different acuities.

P. W. Cunliffe.

Wool Industries Research Association,
Torridon, Headingley, Leeds,
June 24.

Records of Actinic Value of Daylight.

Records of the actinic value of daylight are being regularly taken in connexion with the 'Jeremiah Horrocks' Observatory, Preston. Strips of sensitised paper carried on a rotating drum pass close behind a narrow slit through which light from the sky enters; the apparatus is set up so that the slit opening is fed with light from an area of the sky 45 degrees square, the centre of the area having an altitude of 45 degrees above the horizon toward the north.

The four records reproduced in Fig. 1 were taken on April 21, 22, 23, and 24 of this year and show the rapid variations of actinic value of diffused daylight. The records are positives, that is, the dark portions indicate absence of actinic light, and the slit width, approximately 0·5 millimetre, provided for an exposure of two minutes.

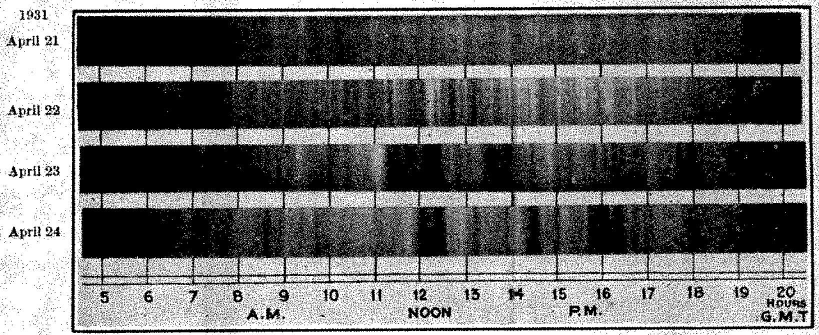

Fig. 1.

Records from three instruments have now been accumulating over a period of many months, and the work is still in progress.

Geo. J. Gibbs.

The 'Jeremiah Horrocks' Observatory,
Moor Park, Preston,
June 22.

Experiments in Prophylaxis.

The scope of two agents, which are scarcely recognised in an external field, seems to need inquiry.

Creosote rapidly penetrates the skin: it removes the irritation of insect bites (mosquitoes, bugs, harvest-bugs), and then the circulation soon dissipates the swelling. If applied to eruptions at the incipient stage, it dries them, and the foreign matter is imperceptibly exuded. On tender skin it can be diluted with any grease. Will this be equally successful with bites of plague-fleas? What effect would it have on early pustules of small-pox?

Another external germicide is dry sulphate of quinine, which cannot, like iodine, cause serious injury. On an abrasion or cut of blood-vessels it prevents infection and promotes healing; on a badly infected wound I have known it make an entire cure in a week. Solution of quinine will rapidly cure ophthalmia which is resistant to zinc. The scope of such remedies, especially in the tropics, should be determined, as they can be safely entrusted to the ignorant.

Flinders Petrie.

5 Cannon Place,
London, N.W.3.

Crystal Structure of Molybdenum Trioxide: A Correction.

I regret to say there are two errors in my letter on molybdenum trioxide, published in Nature of Jan. 17. The length c should be 3·67 and not 3·57 A.; and u and v should be interchanged, making $u \sim 30^\circ$, $v \sim 36^\circ$.

Nora Wooster.

The Mineralogical Laboratory,
The Museums, Cambridge,
May 28.

Research Items.

Giant Crescents: a New Stone Age Industry from South Africa.—Mr. C. van Riet Lowe describes a new stone age industry from South Africa in the *Trans. of the Royal Society of South Africa*, vol. 19, pt. 3. It consists of an assemblage of stone implements hitherto unrecorded from Mazeppa Bay, at the mouth of the Kogha River, halfway between the Great Kei and Bashee rivers on the Transkeian coast of the Cape Province. The implements are all found on the surface, so that there is no actual evidence of date; but their technique suggests a late Middle [Palæolithic] Stone Age. Material, debris, technique, weathering, show that they belong to a single industry practised from Mazeppa to Algoa Bay and as far inland as the south bank of the Orange River, that is over an area of approximately 20,000 sq. miles. This is a new culture. It is a typical blade-industry, including characteristically long blade-like implements, principally more or less isoscelene (acute angled) in shape and variants of these. Associated with the points, scrapers, and gravers, and by far the most characteristic and interesting product of the industry, is a type of implement only one of which had hitherto been found and recorded in the Union. It is an implement shaped like the quarter of an orange. The flat surfaces meet to form a more or less straight cutting-edge, and there is a strongly curved upper surface away from the cutting edge, coarsely flaked and retaining a portion of the original surface untouched in the middle. The implement may be regarded as a giant crescent. The specimen originally described came from the Kasougu River and was unassociated; but similar and finer specimens are now associated with a definite industry, the present collection coming from Mazeppa Bay. The average size for five specimens is 9·65 cm. by 3·35 cm. by 1·73 cm. Probably the industry represents a transition from the Middle to the Later [Palæolithic] Stone Age, and is an integral part of a cultural admixture from a contact between neanthropic and palæanthropic man.

The Vole Cycle in Britain.—Continuing his study of the fluctuations of voles (*Microtus*) in Britain, A. D. Middleton gives the results of a further series of trapping experiments (*Jour. Ecol.*, vol. 19, p. 190, 1931). As an accurate index of the numbers of voles present in a district the trapping system has proved to be somewhat unreliable, and recourse has been made to the field observations of local reporters. They show that 1930 was a year of uncertain fluctuations, for while in some areas the numbers definitely increased, in others they increased less markedly or even decreased. In some places, therefore, 1929 was a peak year, and in others 1930 seems to be on the way to ushering in another peak year. The conclusion is that the comparatively regular four-year cycle which the author has previously described for British voles is considerably modified by local conditions, and in some areas may not appear at all. The author states that the regular cycle may be evident, or may be quite obscured, according to the favourable or unfavourable nature of the local conditions. But this assumption of favourable or unfavourable local conditions requires proof; the suggestion which the author's vole map makes, since it is founded on more particular observations than were available before, is that even the four-year cycle is a little uncertain in its rotation.

Bovine Tuberculosis and the Pasteurisation of Milk.—The Ministry of Health has issued a memorandum on bovine tuberculosis in man with special reference to infection by milk (*Reps. on Pub. Health and Med. Subjects*, No. 63, London: H.M. Stationery Office, 6*d.* net). A large proportion of tuberculous disease in children less than fifteen years of age is caused by the bovine type of the tubercle bacillus, and it is estimated that more than 1000 children less than fifteen years of age die annually in England and Wales from infection of this origin, which is derived mainly from cow's milk. The proportion of milch cows in Great Britain infected with tuberculosis is probably not less than 40 per cent, of which probably between 1 and 2 per cent yield tuberculous milk. But as market milk is usually the mixed milk of several cows, the proportion of samples of milk containing tubercle bacilli varies in different areas from about 5 per cent to 12·5 per cent. Although much may be done by administrative and other measures to diminish bovine tuberculous disease, complete eradication by tuberculin testing and slaughter of reacting animals, the building up of tuberculosis-free herds, and preventive vaccination, is impracticable. Much may be done by the routine clinical examination of cattle, the testing of milk by microscopic and biological methods, and the keeping of the milch cows under hygienic conditions. The campaign in favour of clean raw milk, as by the use of certified and Grade A milks, while of great potential value, has hitherto met with limited success, probably due largely to the increased cost of such milks. So long as this remains the case, the pasteurisation of milk by retaining it at a temperature of 145° C. for 30 minutes constitutes the best safeguard against bovine tuberculosis derived from milk. The opinion is expressed that pasteurisation carried out in a suitable apparatus and under strict scientific control is capable of protecting the consumer from the danger of infection with the tubercle bacillus, and that milk so treated appears to retain its valuable food properties practically unimpaired.

Biological Research in Hawaii.—Nos. 6, 7, and 10 of Volume 9 of the *Occasional Papers* of the Bernice P. Bishop Museum (Honolulu, Hawaii, 1930) consist of papers by C. H. Edmundson, "New Hawaiian Medusæ", "Effect of Ultraviolet Rays in Regeneration of Chelipeds", and "New Hawaiian Crustacea"; whilst No. 11 is by C. Montague Cooke, jun., and H. E. Crampton on "New Species of *Partula*". The medusæ dealt with belong to the genus *Eleutheria*, which is characterised by the branched tentacles bearing groups of nematocysts or suckers, or both, and having a brood pouch dorsal to the stomach. Many of these medusæ, like the common British form *Eleutheria dichotoma*, creep about by means of their tentacles. Four species new to science are here recorded from Hawaii, chiefly differing from one another and from previously known members of the genus in the position of the clusters of nematocysts and in the margin of the umbrella. They represent the first creeping medusæ to be recorded from the North Pacific Ocean. A new species of *Kishinouyea*, one of the *Stauromedusæ*, is also described. Amongst the Hawaiian crustacea, new species of *Processa*, *Jousseaumea*, and *Axiopsis* are described, and a new genus of the Portunidæ. This new genus *Cœlocarcinus*, containing one new species, has very peculiarly modified fifth legs, having the last two joints developed into rounded foliaceous swimming paddles. The gastropod genus *Partula* is always interesting on account of the geographical distribution of the species, which are, as a rule, each characteristic of certain islands or groups of islands. Four new species are here described—*Partula cytherea* from remote mountain slopes of Tahiti, *Partula lanceolata* from Mango Island in Fiji, 200 to 500 feet, *Partula thurstoni* from Ofu Island, Samoa, and *Partula montana* from the high forest of the Afiamalu region, about 2500 feet, Upolu, Samoa.

A New Parasitic Copepod.—Mr. Isokiti Harada in his paper, "A New Copepod Species Parasitic on Formosan Fresh-water Fishes" ("Studies on the Fresh-water Fauna of Formosa": (1) Contributions from the Zoological Laboratory, Taihoku Imperial University, Formosa, Japan. Journal of the Society of Tropical Agriculture, 2, 71-76, 1930), describes a new ergasilid, which he names *Ergasilus japonicus*, parasitic on the two fishes from Lake Jitsugetasan, Formosa, *Cultriculus kneri* and *Pseudorasbora parva*. All the species of *Ergasilus* hitherto known live upon the gill filaments or within the gill cavities of their hosts, but this one lives on the outside of the body, especially on the mucous membrane at the base of the fins and occasionally on the outer surface of the operculum. None were found on the gill filaments, gill cavities, or elsewhere on the body surface. The cyprinoid fishes *Pararasbora moltrechti* and *Zacco temminckii* were also found to be parasitised by this species. All those on the fishes were females. The males are free-swimming and were collected on several occasions. Free-swimming females were also observed. *Ergasilus japonicus* differs from the other species of the genus in its habitat as well as in the arrangement of the spines and setæ of the legs, in their structure, and in the characteristic flattened swimming plate of the first swimming legs in the female.

A Liverwort as Pioneer on Burnt Forest Land.—Marie Lilienstern has recently attempted to throw some light on the occurrence of *Marchantia polymorpha* as a pioneer plant on burnt-out forest land (*Travaux de la Société des Naturalistes de Léningrad*, vol. 60, livre 3, 1930. Russian with French résumé). Pure culture work shows that *Marchantia* ceases to grow and develops very few gemmæ in the absence of potassium. On the other hand, the cultures show that high concentrations of potassium are not injurious, nor is exposure to guaiacol or pyrogallic acid, which are products of dry distillation of wood and occur in the surface layers of soil in burnt-out forests. *Marchantia* shows a preference for slightly acid conditions, which are also associated with the soil in such localities. It is still a little difficult to gauge the significance of these results without comparative cultures of other liverworts, which do not show any tendency to repopulate burnt forest land. It would be of interest to know whether any similar resistance to relatively high concentrations of potassium and to the presence of distillation products of wood is shown by any of the other plants that one associates with localities where there has been a fire—for example, *Funaria hygrometrica*, *Pyronema confluens*, and *Epilobium angustifolium*.

Irrigation in India.—The review of "Irrigation in India" for 1928-29 (Government of India: Public Works Branch, 2*s*.) gives a statistical and financial summary of the irrigation works in every province of British India. The rainfall in the year under review was on the whole normal, though in the plain areas there was a deficiency of about five per cent, and in the Central Provinces of eleven to twenty-two per cent. The total area irrigated by government works of all kinds was well over thirty million acres, which was nearly three million acres more than in the previous triennium. This total was slightly more than twelve per cent of the total area sown. In Sind it was as high as 90 per cent of the area sown, in the Punjab 30 per cent, and in Bengal as low as 0·3 per cent. Details of the irrigation scheme in project and works in progress are given.

Deep Trench on the North Sea Floor.—In recent surveys of the North Sea the surprising discovery of a trench 130 fathoms deep has been made about 100 miles east of Montrose. The Devil's Pit, as it has been called, is the deepest of a group of depressions found in a floor which was previously supposed to be an undulating plain at 38 to 50 fathoms. Another group of depressions, with a greatest depth of 87 fathoms, occurs farther south, about 65 miles east of Berwick. Prof. J. W. Gregory discusses the nature and significance of these depressions in the *Geographical Journal* for June. He gives reasons for not accepting the suggestion that they have a connexion with the earthquake that was felt in eastern Scotland and southern Norway on January 24, 1927, and he believes that the features are not new but were formerly missed by soundings having been too far apart. Recent soundings in the immediate vicinity of these trenches agree entirely with earlier records of shallow water. Prof. Gregory argues that the trenches are remains of the pre-glacial valley of the Rhine and date from the days when the Rhine and its British tributaries discharged to the North Sea about a hundred miles east of Kinnaird Head. He further points out that the existence of these preglacial trenches adds to the improbability of a Scandinavian ice-sheet having reached the British coast, since it would have filled the trenches with moraine matter. In this case floating ice must have been responsible for the transport of Scandinavian boulders to eastern England.

Long-Range α-Particles.—In the June issue of the *Proceedings of the Royal Society*, Lord Rutherford, F. A. B. Ward, and W. B. Lewis have described an investigation of the long-range α-particles from radium C by one of the new methods. Their results are most illuminating, as they show that, in addition to the well-known group with a normal range in air of 9 cm., there are at least eight other homogeneous groups with ranges between 7 cm. and 12 cm. Their numbers are, however, minute; for every million particles of the common 7 cm. group, there are only seventeen of the most frequent of the long-range groups (9 cm.), and between 0·2 and 1·3 of each of the others. No particles of range greater than 12 cm. were found, and if present, there is certainly less than one-tenth of a per cent of the number in the main set of range 9 cm. In discussing these results, it is pointed out that there must be some intimate connexion between the energy of these long-range particles and the energy of the gamma rays emitted by radium C, and the view is taken that the gamma rays arise from a transition of the α-particle within the nucleus between two different energy-levels. The energies of these levels can be found from the energy of the α-particles, and it is shown that the differences in energy between these levels and the normal level are in several cases in good accord with the energies of some of the stronger gamma rays.

Identification of Hydroxylic Compounds.—Phenylcarbimide has been employed in separating and characterising phenols from tar and tar products and also forms solid compounds with alcohols which have definite melting points. In some cases it can also be used to isolate several dihydric phenols from the aqueous liquors of low-temperature carbonisation, but with the less volatile phenols only oily products are formed. Morgan and Pettet, in the May number of the *Journal of the Chemical Society*, describe a more satisfactory alternative reagent, namely p-xenylcarbimide, the compounds of which, $C_6H_5.C_6H_4.NH.CO_2R$, are considerably less fusible than the corresponding phenylcarbamates, so that phenols which yield only oils with phenylcarbimide provide crystalline p-xenyl derivatives and, in addition, solubility relationships are modified. The paper includes a table of melting points of p-xenylcarbamates and phenylcarbamates, in which compounds formed from several alcohols and phenols appear.

Syntheses of Ethyl Alcohol.—In a paper in the June number of the *Proceedings of the Royal Society*, on ethyl alcohol as a product of high-pressure syntheses, G. T. Morgan and R. Taylor, after reviewing briefly the conflicting results which have been reported in attempts to prepare this substance from carbon monoxide and hydrogen interacting in the presence of catalysts, describe some new experiments which they have performed yielding positive results. The catalyst most used was prepared from cobalt nitrate and zinc permanganate, and the synthesis carried out at 400° and 200 atmospheres, about 75 c.c. of a composite liquid product being obtained per hour. From about four litres of this, the alcohol was separated and identified conclusively by a number of physical and chemical tests. Two acetals have also been separated from the crude products of the catalysis and identified, the more volatile one being ethylidene dimethyl ether, and the less volatile one propylidene dimethyl ether. Six other catalysts are described, each of which was found to induce the formation of appreciable quantities of ethyl alcohol.

Molecular Weight Determinations.—Rast, in 1922, suggested (without reference to the earlier work of Jouniaux in 1912) the use of fused camphor as a cryoscopic solvent, the novelty claimed being that the molecular depression of freezing point for this substance was so large that ordinary melting-point apparatus could be adapted to a micro-method for the determination of molecular weight. The value of the molecular depression constant for camphor was calculated as 400 by Rast from some results on the melting points of mixtures of salol and camphor obtained by Caille, whereas Jouniaux had obtained the higher value 498 from a study of a number of cooling curves of pure substances dissolved in camphor. In the May number of the *Journal of the Chemical Society*, Le Fèvre and Webb show that Caille's results appear to be erroneous, and that the higher value of the constant is to be preferred. They also show that bornyl chloride is a suitable cryoscopic solvent, having the very high constant of about 500. It has a lower melting point than camphor, and is less volatile. The results given are somewhat erratic and great accuracy is not claimed for them, but the method appears to be capable of development.

Astronomical Topics.

Encke's Comet.—Telegrams from Profs. Shapley and Stromgren report the detection of this comet by Mr. Bobone at Cordoba (Argentine), on June 21, at 22 h. 23·2 m. U.T. in R.A. 7 h. 35 m. 24 s., N. Decl. 8° 22′. The R.A. is 56 s. less and the Decl. 44′ less than the values predicted by Matkiewicz; this implies that the time of perihelion is about 18 hours earlier than the predicted value, which was June 3·85 U.T. For most comets this would not be regarded as an unreasonable amount, but this comet has been so carefully studied ever since 1819 that the predictions are usually accurate to an hour. It is too large to be due to Mercury, though a little of it may be due to that planet, if Matkiewicz did not allow for its effect; it was not very far from the comet at the last perihelion passage. Possibly the accelerative effect, which was noted in the last century, but which had nearly died out, has revived again. This is the first detection of a comet for ten months; the cometary nature of the object reported by Prof. Nakamura last November is doubtful.

Calendar Reform.—A Circular from the International Fixed Calendar League reports that the preparatory committee on calendar reform at Geneva has completed its report, which will soon be issued; it will form the basis of discussion at the international conference on the subject, which has been convened by the League of Nations to meet on Oct. 26. Nearly all the schemes of reform include the suggestion that one day in each year (two in leap years) should lie outside the sequence of weekdays, so that every year should begin with the same weekday. There is widespread opposition to this plan, and it is scarcely likely to obtain the support necessary for its universal adoption. The schemes for making the lengths of the months follow a more orderly plan are less controversial; but the reformers are fairly equally divided between the 12-months and 13-months division of the year. The advantage of the latter is the equality of all the months, except for the one extra day. Its chief drawback is that it does not divide into quarters. But it has been pointed out that the case would not be much worse than the present 'quarter-days', which do not all fall on the same day of the month. The discussions next October are likely to be lively.

Improvement in Time-Recording.—The great improvement in clocks, effected by Shortt, calls for a similar improvement in chronographs. Those in general use are limited to hundredths of a second. A paper by Alfred L. Loomis in *M.N.R.A.S.* for March gives a description of a very accurate form of chronograph. A broad sheet of paper is made to advance at a uniform speed past a comb of 100 teeth. The records on the paper are made by electric sparks from these teeth; the teeth are in electric connexion with a disc having 100 teeth, which rotates 10 times per second, so that each tooth corresponds to one-thousandth of a second. The results enable very accurate clock determinations to be made. These show that the maximum clock rate is attained when the pressure in the clock case is between 15 mm. and 25 mm. of mercury. Lowering the pressure from 15 mm. to 1 mm. caused the clock to lose a second a day; this unexpected result is due to the longer swing that occurs with low pressure. A paper immediately following this, by Prof. E. Brown and D. Brouwer, gives an analysis of the clock records extending over several months. The most interesting result is the detection of a small effect due to the moon. The theoretical amplitude is shown to be 0·000153 second, the period being half a lunar day. This is the direct action of the moon on the pendulum, but there are also indirect effects due to the change in the earth's attraction arising from tidal deformation. The analysis of the clock readings gave amplitudes varying from 0·000106 s. to 0·000150 s.; they are, therefore, of the right order for lunar effects. It is hoped that continuation of the observations, using four Shortt clocks, will make it possible to detect changes in the rate of the earth's rotation. The irregularities in the apparent motion of the moon and planets give grounds for believing that such changes occur.

Recent Advances in the Chemistry of the Vitamins.

AT the meeting of the Royal Society held on June 18, the President, Sir Frederick Gowland Hopkins, opened a discussion on the chemistry of the vitamins. He said that although many discoveries had been communicated in the past to the Society, there had been very few papers dealing with the vitamins. He felt great satisfaction that this discussion should occur during the first year of his presidency, especially as the subject was still growing in interest. The Society were to be congratulated on the presence of a number of foreign workers, so that the discussion would have an international character. As the subject was so vast, he proposed to limit it to the chemistry of the vitamins, and suggested that vitamins D, A, and the B complex be taken in that order.

VITAMIN D.

Prof. A. Windaus said that up to the present, investigations had had to be carried out on impure substances and chiefly by means of physical experiments. No stable equilibrium was formed between ergosterol and the products of irradiation. By further irradiation two crystalline substances could be obtained, neither of which could be converted into the other; it appeared therefore that two series of products were formed on irradiation. Reerink and van Wijk had found that no matter whether 10 or 50 per cent of the ergosterol was changed by long wave irradiation, the absorption spectrum of the product was always the same. He suggested that this was due to several substances being formed in constant proportion, and that the absorption spectrum was that of the mixture. None of the products of irradiation are precipitated by digitonin. Failure of precipitation, however, does not imply that a change has taken place in the hydroxyl group. On treatment with phenyl isocyanate the antirachitic activity of the irradiated ergosterol is destroyed. Treatment with warm caustic potash results in the reconversion of the phenyl urethane to vitamin D.

Prof. Windaus had found that the vitamin had the same molecular weight and formula as ergosterol and also contained three double bonds. The dihydro derivative obtained from irradiated ergosterol by treatment with sodium in alcoholic solution was inactive, but it is not certain that it is a derivative of vitamin D itself. The vitamin is more sensitive to a temperature of 180° than ergosterol; after heating, the absorption spectrum shows a band at 2820–2920 A.

Crude vitamin D is stable in oil, although the absorption spectrum and specific rotation rapidly change. The toxicity of the crude product varies with the potency, but it is still possible that the two properties may be due to different substances. The problem has not yet been solved. He had noticed that in vacuum tubes, in which crude vitamin D had been sealed, crystals appeared, but he had not been able to obtain them in a pure state by recrystallisation from cold acetone or by fractional precipitation. He had found, however, that when irradiated ergosterol was treated with maleic or citraconic anhydride in ethereal solution at room temperature for one to three days, a reaction occurred between certain of the substances present and the anhydride. When these inactive products were removed by solution in dilute caustic potash, crystals could be obtained from the ethereal layer on evaporation of the solvent. The yield was 50 per cent of the crude product, or 60–70 per cent of the material which failed to react with maleic anhydride.

Vitamin D crystallises in long needles of melting point 122°; $[a]_D^{18} = +136°$ in acetone, and $[a]_{Hg}^{18} = +168°$ in acetone.

The crystals show a band in the absorption spectrum at 2650–2700 A. Their potency was found to be 2–2½ times that of the M.R.C. standard.

He considered that the product obtained by Reerink and van Wijk was different from his, since it had a lower specific rotation and an absorption spectrum of a different shape, but that Bourdillon's crystals were probably the same. He agreed with the suggestion of the latter that there might be several compounds showing vitamin D activity, but considered that his crystals were responsible at any rate for the chief part of it. Vitamin D is an isomer of ergosterol in which there has been a structural rearrangement with an increase in the spatial size of the molecule.

Prof. B. C. P. Jansen said that Reerink and van Wijk had now obtained crystals of a melting point 140°. Their former product with a lower melting point had contained ether of crystallisation.

Dr. R. B. Bourdillon said that the discovery of the method of obtaining crystals of vitamin D by means of maleic anhydride was of outstanding importance and likely to lead to a solution of the problem of its constitution. He and his co-workers had obtained very similar crystals by distillation of irradiated ergosterol in a high vacuum. Their melting point was 123–125°. The specific rotation to the mercury line in alcoholic solution was +250 to +260°. The maximum absorption occurred at 2700 A. and was greater than that of ergosterol. The potency was 18–22,000 M.R.C. U./mgm., that is approximately the same or slightly less than that shown by Prof. Windaus' crystals. They had been able to prepare an oxalate and acetate and reconvert these back to the original crystals. They had found the rotation and potency to remain constant for some weeks in dry air or in vacuo. Neither by distillation at a temperature of 160° nor by further irradiation with loss of two-thirds of the potency had they been able to separate their crystals into two separate compounds. Moreover, on irradiation the loss of antirachitic activity and the changes in the absorption coefficient and specific rotation were absolutely parallel. They therefore considered that their crystals were a definite chemical compound and had ventured to call it 'Calciferol'. However, the unity of the compound was not absolutely certain, owing to variations in the specific rotation of different preparations. They had recently obtained some crystals with a rotation of +290°. He suggested that there were at least two vitamins, isomorphic and with the same absorption spectra, the lævo form being very unstable, while the dextro form was stable. This suggestion would explain the discrepancies in his own work and that of other observers.

Dr. O. Rosenheim said he considered the work now reported was the most important since the original researches on vitamin D. He thought that Windaus' and Bourdillon's crystals were identical, although it was possible that there might be an impurity present as in Reerink and van Wijk's preparation. Spectroscopic methods had not led to much advance, but success had come from biological and organic chemical research, and especially from Bourdillon's method of fractional condensation. He pointed out that if ergosterol was irradiated until 20 per cent had been changed and the 80 per cent of inactive material removed, the activity of the residue was only the same as that of the original irradiated material. On distillation of the residue, 20 per cent was obtained as crystals, but the activity was only twice that of the crude product.

VITAMIN A.

Prof. H. von Euler said that it was early noticed that fat soluble growth-promoting material was frequently associated with a red or yellow coloration but that the converse was not true. Working with Karrer, he had found that of all red or yellow substances examined, only carotene had vitamin A activity. Carotene was usually supposed to be optically inactive, but he, as well as Rosenheim and Kuhn working independently, had found that it could be fractionated into two forms, one melting at 170° and optically active, and the other melting at 183° and optically inactive. Both forms had growth-promoting power. The latter gave an earlier growth response, but after three weeks the differences between the two disappeared. A dose of 0·003 mg. daily would produce a daily increase in weight of one gram in the rat. Complete hydrogenation of carotene inactivated it, but reduction with aluminium amalgam at first increased the activity. Hydrocarotene containing eight double bonds is much more active than carotene, the daily dose required being only 0.0005 mg. It also gives a higher blue value with the Carr and Price colour test. The absorption spectrum is very similar to that attributed to vitamin A in cod liver oil.

Moore considers that carotene is converted to vitamin A in the body of the rat. Prof. von Euler had tried to effect this conversion in vitro, but only with the serum of the hen had he found that carotene could be converted into a substance very similar to vitamin A although not spectroscopically identical. He considered it probable that the transformation occurs in the blood, and that vitamin A may act as a catalyser in oxidation. He had also examined the anti-infective action of carotene and had found that it did not affect hæmolysis in vitro nor react with amboceptor, but that when it was given in excess to rabbits, the amboceptor in their blood was increased.

Dr. Rosenheim said that carotene is a mixture which has not yet been completely separated, and that it is dangerous to attribute activity to any particular isomer. The optical activities obtained by different observers vary considerably. It is possible that the transformation of carotene into vitamin A in the body may be only the accumulation of vitamin A present as a contaminant in the carotene. The band in the absorption spectrum of cod liver oil at 3280 A. may not be due to vitamin A but to a substance accompanying it.

Dr. R. A. Morton said that if the band at 3280 A. is to be attributed to vitamin A, then the latter cannot be present in carotene as an impurity. Dihydrocarotene is not vitamin A, since the band in its absorption spectrum is at 3170 A., the blue colour given with antimony trichloride is not the same as that given by the vitamin, and the ratio of blue colour to intensity of absorption is different.

VITAMIN B.

Prof. B. C. P. Jansen said that when 100 kgm. of rice polishings were extracted with dilute acid alcohol, 30 kgm. went into solution. By treatment with acid clay it was possible to adsorb nearly all the vitamin B_1, but only 100 grams of contaminating solid material. The vitamin B_1 present accounted for only 1 per cent of the adsorbed material. By fractional precipitation with silver nitrate and baryta it was possible to remove impurities at a strongly acid reaction and to precipitate two-thirds of the vitamin at pH 4–7: above this pH impurities were precipitated as well.

Further purification could be effected by precipitation with phosphotungstic acid, and decomposition of the precipitate with baryta, and precipitation with platinum chloride from alcoholic solution. When the platinum was removed with powdered silver, 1·4 gram was obtained, of which 0·4 gram was pure vitamin. By numerous fractionations with acetone from solution in absolute alcohol, 30 mgm. of pure vitamin were obtained. The formula by analysis was $C_6H_{10}ON_2HCl$. The process he had devised was therefore very wasteful. It could be improved by the use of Peters' method of fractional precipitation with phosphotungstic acid. Prof. Jansen had found that silicotungstic acid was as suitable. When the original 100 grams obtained by adsorption on acid clay were treated with this reagent, two-thirds of the vitamin were precipitated, but only 20 per cent of the total solid. A further improvement had been effected by Seidell's benzoylation process, which removes impurities. By this method von Ween had obtained 140 mgm. of pure vitamin B_1 from 75 kgm. rice polishings.

Prof. A. Seidell said that Prof. Jansen had had success with a method that had failed in his hands. He had felt that precipitating agents ought to be avoided, and so was led to the method of benzoylation in chloroform solution, which removes a considerable amount of nitrogenous material. He had not succeeded in obtaining crystals, although his purest preparation was nearly as active on rats, but when tested on pigeons by Peters' method the activity was found to be only 1/5 to 1/10 that of the crystals.

Prof. R. A. Peters said that he had hoped to be able to use the animal as a test object only and not concern himself with the physiological side of the problem, but he had found that it was only possible to reach a final conclusion on the chemistry when the physiology was also taken into account. He had been able to confirm Prof. Jansen's process up to the platinum chloride stage. Working with yeast he had obtained purification by removal of inactive material with lead acetate and baryta followed by adsorption of the vitamin by charcoal. By fractional precipitation with phosphotungstic acid at pH 5–7, vitamin B_1 was obtained. Its activity was 0·012 mgm. per dose, while that of Prof. Jansen's crystals in his hands was 0·008 mgm. Both preparations gave the Pauly reaction with the same intensity. Miss Reader had shown that 25–50 per cent of Prof Jansen's crystals had vitamin B_4 activity. She had now been able to isolate vitamin B_1 from B_4 by fractional adsorption on to charcoal in the earlier stages of the purification, but the separation of B_4 from B_1 was less complete.

Dr. B. C. Guha said that he had been able to separate B_1 from B_2 by electrodialysis. Vitamin B_1 appeared to be a strong base, while B_2 was a neutral substance.

The President, in summing up the discussion, said that the progress of the last few years should make them optimistic. He expected that we should soon know the constitution of vitamin D. The chemical problems involved were *a priori* difficult, but workers were finding that the compounds were amenable to the methods of organic chemistry. He thanked the visitors from overseas for taking part in the discussion.

University and Educational Intelligence.

CAMBRIDGE.—Dr. C. E. Tilley, of Emmanuel College, has been elected to the professorship of mineralogy and petrology as from October 1.

LEEDS.—The West Yorkshire Coal Owners' Association has offered the University of Leeds an additional grant of nearly £1300 a year for the purpose of financing a scheme of research into industrial fluctuations and other matters, with special reference to their bearing upon the coal-mining and allied industries. The University Council has gratefully accepted this offer, and the work will be carried out under the direction of Prof. J. H. Jones, head of the Department of Economics. The Mining Department of the University has enjoyed a large measure of support from the West Yorkshire Coal Owners' Association, which for some time past has been making a grant in aid of the Department of £1000 a year. The Association was also one of the largest donors to the appeal issued in 1925, its gift of £25,000 being one of the factors which allowed the Mining Department to be dealt with as the first item in the building scheme. The total of the contributions made by the Association to the University exceeds £40,000.

THE Congress of Universities of the Empire, under the presidency of H.R.H. the Prince of Wales, opened in London on July 1. On the first day several educational institutions and medical schools were open for inspection to members of the Congress and there was a special exhibition of educational and cultural films at Bush House. On July 3 the Prince of Wales held a reception and addressed the Congress in the Guildhall. The rest of the time in London was spent in visiting other educational institutions in and around London. On July 6 the Congress proceeds to Edinburgh, where it will remain in session until July 11. On July 7 the Lord Provost of Edinburgh will deliver an address, and in the afternoon there will be a meeting of members of the Universities' Bureau of the British Empire. The Marquess of Linlithgow will address the Congress on July 8, and this will be followed by discussions on the position of the university graduate in commerce and industry, and the standard and conditions of candidature for the degree of Ph.D. in relation to other post-graduate qualifications. The former discussion will be opened by Sir Robert Waley Cohen and the latter by Prof. D. Nichol Smith. On July 9, Lord Meston will give an address and Prof. F. E. Sandbach will open a discussion on the conditions of admission to universities. Later, Prof. W. E. Collinson will open a discussion on the provision of schemes of study leading to general honours degrees. Sir Donald MacAlister, Bart., will address the Congress on July 10. On the same day there will be a discussion on post-graduate study in medicine and surgery in Great Britain, which will be opened by Dr. H. L. Eason, and Sir Thomas Holland will open the last discussion of the Congress on the facilities for overseas students in British universities. Many excursions to places of educational and other interest, also receptions, have been arranged for the entertainment of members.

Birthdays and Research Centres.

July 6, 1873.—Mr. S. G. BROWN, F.R.S., electrical engineer.

I am at present engaged on gyroscopic problems concerned with the sea, land, and air, which have been placed before me by the British and foreign governments. I am always willing to deal with any problems, and in fact I welcome them.

I am also engaged at the moment with acoustical and sound reproduction apparatus, especially in connexion with talking picture equipments and adaptations.

I am convinced that there are still vast fields to be explored where my reed telephone and microphone sound relay can usefully be employed, and I am working on these. My latest invention is the Microbox pick-up, a gramophone pick-up which can be used without employing valves or high power amplifiers. The only energy required can be derived from an ordinary 6-volt battery, and the pick-up can be used with ordinary or portable gramophones and it replaces the ordinary electrical pick-up.

July 8, 1861.—Sir J. ARTHUR THOMSON, formerly Regius professor of natural history in the University of Aberdeen.

Since I retired from my Aberdeen professorship last autumn, I have been completing, with the help of Miss Isobel Dean, a large memoir on the Alcyonacea of the Siboga Expedition. Before I stop this sort of Linnæan work, to which I have devoted so many years, I should like to follow others in giving a general survey of the evolution of the alcyonarians. Along with my teacher and friend Patrick Geddes, I have just completed a somewhat detailed unconventional outline of general biology. But most of all, I am afraid, I have just been enjoying the luxury of doing nothing.

July 9, 1869.—Dr. J. W. MELLOR, F.R.S., principal of the Pottery Department, North Staffordshire Technical College, Stoke-on-Trent, and Director of Research of the British Refractories Research Association.

In the research laboratories, investigations are being conducted under the auspices of the British Refractories Research Association on the nature and properties of the materials employed in the silicate industries; on the nature of the action of industrial furnaces on refractory materials; and on the manufacture of materials best fitted to resist the destructive agencies in the different types of industrial furnaces.

July 10, 1854.—Dr. GEORGE LINDSAY JOHNSON, ophthalmic surgeon to H.M. Forces in Natal.

I am now engaged in completing a large work which has occupied my attention during my spare moments for upwards of forty years, namely, the comparative anatomy and physiology of the vertebrate eye, embracing nearly all available living families and genera of the mammals, reptiles, and amphibians, with references to the eyes of the birds and fishes. Two abstracts of this work have already been published in the *Transactions* of the Royal Society (1901 and 1904), with more than a hundred illustrations in colour and numerous illustrations in black and white on plates and in the text. I hope to have this work published during the current year. My chief reason why its publication has been delayed is due to the great expense of printing the coloured drawings, of which there are more than three hundred.

The practical utility of this work lies in its affording help towards the classification of the Vertebrata, which in a great many instances requires modification. This is especially the case among the families and genera of the rodents. There are still a few animals' eyes to be examined and depicted which I have hitherto been unable to procure or depict. Finally, the optical problems of refraction and accommodation, especially of amphibian mammals, require to be restudied. I would appeal to my colleagues (especially mathematicians and oculists) to assist me in this latter undertaking.

Societies and Academies.

LONDON.

Mineralogical Society, June 9.—**G. E. L. Carter**: On an occurrence of vanadiferous nodules on the coast of South Devon. The author describes an occurrence of vanadiferous nodules in the red marls that underlie the Budleigh Salterton pebble beds on the coast of South Devon. These nodules consist of siliceous and argillaceous material impregnated with vanadium oxide and calcium carbonate. A typical nodule examined at the Imperial Institute showed a roughly concentric structure, ill-defined black shells alternating with shells of light-coloured material. Radiating black bands stood out as ribs on the surface of the nodule. Analyses by Miss Hilda Bennett showed that the black portion of the nodule contained 13·96 per cent of vanadium oxide, estimated as pentoxide. The light-coloured portion of the nodule contained only 1·91 per cent of vanadium oxide, and was relatively richer in calcareous and siliceous matter than the blacker and more vanadiferous portion.—**M. H. Hey**: Studies on the zeolites. Part 2: Thomsonite (including faroelite) and gonnardite. A chemical, optical, and X-ray study of a considerable number of thomsonite specimens has led to the conclusion that thomsonite and faroelite form a continuous isomorphous series. The true symmetry of thomsonite is shown to be didigonal polar (C_{2v}). The unit cell is shown to contain $(Ca,Na)_6(Al,Si)_{20}O_{40} . 12H_2O$. The mean refractive index ranges from 1·517 to 1·535, falling with increase in the Si/Al ratio. Apparatus has been designed and applied to measure the vapour pressure of thomsonite at various temperatures and degrees of dehydration, and it appears very probable that a dimorphous high-temperature form exists, the transition being readily reversible. Gonnardite is probably identical with the high-temperature dimorphous form of thomsonite (meta-thomsonite), and is therefore to be regarded as a separate species.—**A. Russell**: An account of British mineral collectors and dealers in the seventeenth, eighteenth, and nineteenth centuries. A second instalment: John Woodward (1665–1728) and Charles Francis Greville (1749–1809).—**L. J. Spencer**: Hoba (South-West Africa), the largest known meteorite. The large mass of meteoric iron discovered in 1920 on Hoba West farm, 12 miles west of Grootfontein, measures about 10 × 9 feet on its flat upper surface, and is estimated to weigh 60 metric tons. It belongs to the group of nickel-rich ataxites. Chemical analysis by Mr. M. H. Hey shows iron 83·44 per cent, nickel 16·24 per cent, with small amounts of cobalt, copper, sulphur, phosphorus, and carbon. Photomicrographs (× 820) by Dr. J. M. Robertson show a minute plessite-like structure.—**L. J. Spencer**: Twelfth list of new mineral names. Since the publication in 1928 of the eleventh list of this series (the first was in 1897), 120 names have been collected from the current literature. In addition to the bibliographical reference, a brief description of the essential characters of the mineral and derivation of the name are given.—**J. Drugman**: On different habits of fluorite crystals. In fluorite the cube is usually the predominating form. Crystals of other habits—octahedral, rhombic-dodecahedral, and triakis-octahedral—are described. The temperature during the growth of the crystal has perhaps influenced its habit.

EDINBURGH.

Royal Society, June 1.—**H. Briggs**: The relation between the yield of crude oil and the composition of retortable carbonaceous minerals. Using graphical methods, the author showed that, while on the one hand the yield is connected to the percentage of volatile hydrocarbons, and on the other hand to the C/H ratio, these relations are too intangible to be of value. A more definite relation exists between the yield and the percentage of volatiles diminished by twice the oxygen percentage—a conclusion leading to the formula $Y = 0{\cdot}47\ (V - 2O)^{\frac{4}{3}}$, in which Y is the yield of crude oil in British imperial gallons per ton, V the percentage of volatile hydrocarbons, and O the percentage of oxygen in the mineral retorted.—**C. H. O'Donoghue**: Abnormalities of the vascular system of the Anura. One or more striking abnormalities in the blood vascular systems of forty-two specimens of *Rana temporaria* are described. A consideration of the developmental history of the vessels shows that many abnormalities are due to the retention of larval arrangements, and some due to the failure of a portion of the adult system to develop. For others there appears to be no explanation at present available, as, for example, the absence of a precaval vein on one side accompanied by the development of a transverse anastomosis whereby the precaval drainage is transferred to the other side. Connexions between the visceral arteries and veins and the lung find no explanation in the development of vessels or lungs, but analogous vessels to and from the visceral trunks and the swim bladder are found in some Teleostomi. The abnormalities throw a light on the normal relationships of certain vessels in the adult, and often suggest homologies with those of the generalised elasmobranchs.—**G. L. Purser**: The early stages of development of the vertebrates. The only growth-centre is the organiser, the position of which, throughout the phylum, is correlated with the apical pole and a meridian of latitude on the egg which depends upon the amount of yolk. Gastrulation is the formation, under the influence of the organiser, of a meristematic ring, by the proliferation of which the primary germ layers are laid down and growth to any length is made possible. There is no concrescence and the origin of the mesoderm is the same throughout the phylum, except for variations in the head. The evolution of yolkier eggs made it necessary for this ring to be split into a yolk and an embryogenic blastopore, which evolve into the edge of blastoderm and primitive streak respectively. In mammals the homology of all primitive streaks makes the derivation of the trophoblast and Rauber's layer or *Trager* from the yolk-laden cells of lower forms essential. Loss of yolk began in correlation with mammary secretion. Blastula-formation within the confining coats of the zygote is impossible, and the slipping of the cells over one another causes the final enclosure of the apical cells by the abapical ones. The true and false amnia are products of the extra-embryonic cœlom, which allows the expansion of the life-preserving allantois. The 'doubleness' of the endoderm of the blastocyst is due to the absence of yolk and consequent continued extension of the endoderm from the meristematic ring, first seen in the frog.—**Richard Elmhirst**: Studies in the Scottish marine fauna: the Crustacea of the sandy and muddy areas of the tidal zone. A study of quantitative samples from various parts of the coast reveals definite specific zoning in the genera *Bathyporeia* and *Corophium*.

PARIS.

Academy of Sciences, May 11.—**Jean Pierre Robert**: Some properties of *n*-metaharmonic functions.—**J. Dieudonné**: Univalent functions.—**Edouard Callandreau**: The lines of slip of a pulverent mass.—**L. Escande** and **M. Teissié Solier**: The conditions of working of the Pitot tube.—**Georges Marboux**: An electrical oscillator of low frequency stabilised by a tuning fork. The apparatus described and figured is closely analogous with the apparatus using piezo-electric quartz. The tuning fork replaces the quartz. —**M. Auméras** and **A. Tamisier**: The constitution and stability of two copper-nitrogen complexes.—**Dumanois, Mondain-Monval, and Quanquin**: The presence of peroxides in the gases from internal-combustion motors. An experimental proof of the formation of peroxides and of aldehydes under conditions of working of an ordinary internal combustion engine.

Rome.

Royal National Academy of the Lincei, Dec. 7.—**T. Levi-Civita**: Plane sections of a body and orthobaric directrices.—**Enea Bortolotti**: Specialised differential quadratic forms. Ricca's calculus is shown to be easily extensible to these forms.—**F. Conforto**: Metric and foundations of absolute differential calculus in a continuous functional space.—**Miron Nicolesco**: Metaharmonic functions in n variables.—**E. Okhlopkova**: Certain problems on the limits of the theory of logarithmic potential. The theory of the functions of the complex variable is applied to the solution of certain problems of the limits of the theory of logarithmic potential for the circle.—**V. Hlavaty**: The curvature of non-holonomous varieties.—**D. Graffi**: An observation on the equation of the motion of a body of variable mass.—**A. Signorini**: The profile of bridge piers. The variation in kinetic energy between a stream disturbed by bridge piers and the non-disturbed stream is found to be independent of the configuration of the profile of the piers.—**E. Bossa**: Correction to the note on "The Hall effect for the metals, nickel, iron, and copper, in feeble magnetic fields".—**Remo de Fazi** and **Antonio Hemmeler**: Reactions between organic and mineral compounds (1). Natural sulphides and certain acyclic compounds. Pyrites yields (1) ferrous and ferric chlorides, ferrous sulphide, sulphur, carbon, and thiophosgene when treated with carbon tetrachloride at 320°-400° or at 450°; (2) ethyl mercaptan and ethyl sulphide respectively with ethyl alcohol and ether at 450°-500°; (3) thioacetic acid, traces of methyl mercaptan, methyl sulphide, carbon dioxide, hydrogen sulphide, and sulphur with acetic acid at 480°-500°; (4) hydrogen sulphide, carbon and sulphur dioxides, and thioacetic anhydride with acetic anhydride at 450°-480°. Stibine gives carbon disulphide and antimony trichloride when treated with carbon tetrachloride at 300°-325°, and thioacetic anhydride and antimony trichloride when treated with acetyl chloride at 300°-350°.—**A. Mazzucchelli**: Electrolytic deposition of chromium from ammonium chromo-oxalate.—**Carmela Ruiz**: Strophomenides of the Permian of the Sosio basin (Palermo).—**Constantino Gorini**: Acido-proteolytes and thermophiles in the pasteurisation of milk. Experimental results confirm the importance of these organisms in the pasteurisation of milk, and emphasise the necessity of cooling the milk thoroughly immediately after pasteurisation and keeping it cool until it is consumed. Examination for these bacteria furnishes a means of judging of the efficiency of the pasteurisation.—**G. Mezzadroli** and **E. Vareton**: Action of ultra-short electromagnetic waves (2–3 metres) on amylase. These waves exert a favourable effect on the enzymes of seeds, especially on the amylase. When subjected to their action for 30 minutes prior to steeping, barley attains its maximum saccharifying power 0·5–1 day earlier than the untreated control, this period being increased to 2 days if irradiation is continued daily. Moreover, the absolute value of the maximum saccharifying power is increased by as much as 15 per cent.—**D. Cattaneo**: Observations on the structure of the vitreous.—**B. Finzi**: Tuberculin and anæsotuberculin.

Vienna.

Academy of Sciences, Feb. 12.—**E. Haberfelner**: Graptoliths from the Upper Silurian of the Carnic Alps. Part I. Summit, north side.

Feb. 19.—**A. Muller** and **E. Feld**: The thermal decomposition of hydrochloric-1, 6-diamino-*n*-hexane.—**A. Muller** and **E. Feld**: Synthesis of γ-amino-*n*-capronic acid and of α'-ethyl-α-pyrrolidine.—**E. Tschermak**: Some flower anomalies and their mode of inheritance in primulas. Doubling of flowers is common in the plant world, but the formation of a corolla-like calyx, so-called 'calycanthemie', is only known in Primulaceæ and a few other orders. The inheritance of calycanthemie has been studied by crosses between these and normal forms of *Primula acaulis*, *elatior*, and *officinalis*, also by crosses with *P. Juliæ*. In double garden primroses, andrœcium and gynæceum become petaloid, but in double auricula the gynæceum generally remains intact, its doubling concerning the corolla. It is also possible to raise hybrid primulas in which doubling is combined with calycanthemie.—**H. V. Graber**: Report No. 5 on geological and petrographic researches in the Upper Austrian and Bohemian primitive rocks.—**K. Fritsch**: Contributions to the knowledge of the Gesneriaceæ. (3) The inflorescence of *Haberlea rhodopensis*.—**G. Orban**: Radium Institute communication No. 271. Investigations on the natural ionisation of air with the Wilson chamber using alcohol vapour.

Feb. 26.—**A. Tornquist**: The mineralisation phases of the younger east-alpine ore deposits.—**A. Rollett**: The course of esterification with mixed anhydrides and mixtures of anhydrides.—**H. Lieb** and **M. Mladenovic**: Elemic acid from Manila elemi-resin.—**M. Mladenovic** and **H. Lieb**: A new resinic acid from Manila elemi-resin.—**F. Holzl**: Hexacyano-cobaltic-acid and methyl alcohol.—**K. W. F. Kohlrausch**: Additive nature of the atomic chemical combining force.—**F. Werner** and **R. Ebner**: Results of a zoological expedition to Morocco. Two new forms of fish and several previously undescribed Amphibia and Reptilia.—**O. Pongracic**: Contributions to the anatomy of the Gesneriaceæ.

March 5.—**H. Rebel**: The biological significance of societies of larvæ.

March 12.—**M. Kohn** and **S. Fink**: On dichlor-phenols, trichlor-phenols, and their bromination products. Thirty-sixth communication on bromo-phenols. —**M. Kohn** and **L. Steiner**: Brominated hydroquinone and toluhydroquinone ether. Thirty-seventh communication.—**M. Kohn**: Debromination by benzol and aluminium chloride.—**G. Orban**: Radium Institute communication, No. 272. Researches on the radioactivity of the alkali metals by the cloud track method. No activity was detected with cæsium. The β-rays of potassium and rubidium were examined. —**A. Schedler** and **M. Toperczer**: First report on the distribution of declination in Austria at the epoch 1930·0. A new magnetic survey was undertaken in 1928, declination, inclination, and horizontal intensity being measured at more than a hundred evenly distributed points. A table of results is added.

Official Publications Received.

BRITISH.

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1930. Pp. 16. (Zomba.)

The Empire Forestry Handbook, 1931. Edited by Fraser Story. Pp. 189. (London: Empire Forestry Association.) 8s. 6*d*.

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1930. Pp. vii+175. (London: H.M. Stationery Office.) 3s. net.

The Lister Institute of Preventive Medicine. Report of the Governing Body, 1931. Pp. 32. (London.)

Transactions of the Institute of Marine Engineers, Incorporated. Session 1930, Vol. 42, May. Pp. 1045-1051+cxii. (London.)

FOREIGN.

Bodily Positions in Restful Sleep. By Dr. H. M Johnson. Pp. 24 (Pittsburgh: Mellon Institute of Industrial Research)

Spisy Lékařské Fakulty Masarykovy University (Publications de la Faculté de Médecine). Svazek 9, Spis 86-98. Pp. xvi+16+13+24+11+4+6+4+26+8+8+14+10+8. (Brno: A. Píša.) 30 Kč.

Biologické Spisy vysoké Školy Zvěrolékařské (Biologické Spisy Academiae Veterinariae). Svazek 8, Spis 111-126. Pp. iii+53+23+8+14+15+10+16+20+10+13+43+43+13+13+30+21. (Brno: A. Píša.)

CATALOGUES.

Ephedrine B.D.H. Pp. 10. Manganese Butyrate B.D.H. Pp. 7. (London: The British Drug Houses, Ltd.)

A Catalogue of Interesting and Scarce Books. (No. 459.) Pp. 36. (Cambridge: Bowes and Bowes.)

General Literature and Miscellaneous Subjects (Catalogue No. 539) Pp. 100. (London: Francis Edwards, Ltd)

The Taylor-Hobson Outlook. Vol. 3, No. 19, June. Pp. 173-180. (Leicester and London: Taylor, Taylor and Hobson, Ltd.)

Colour in Photography. Pp. 16. (London: Burroughs Wellcome and Co.)

Diary of Societies.

FRIDAY, JULY 3.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7 30 —Dr. W. D. Lang: The Inland Lower Lias of Dorset.—Dr. W. F. Whittard: The Geology of the Ordovician and Valentian Rocks of the Shelve Country, Shropshire

ASSOCIATION OF ECONOMIC BIOLOGISTS (Summer Meeting) (at Farnham House Parasite Laboratory, Farnham Royal).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (at Bath).

MONDAY, JULY 6.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Presentation to Dr. Nellie B. Eales of Makdougall-Brisbane Prize.—Dr J. F. V. Phillips, J. D. Scott, and J. Y. Moggridge: Photochemical Measurements of Light-intensity in Two Common Vegetation Types in Tropical Africa, by means of an Improved Eder-Hecht Photometer. (*To be read by title.*)

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

TUESDAY, JULY 7.

ROYAL SOCIETY OF MEDICINE, at 4.30.—Annual General Meeting.

WEDNESDAY, JULY 8.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—E. J. Sullivan: The Grotesque in Art.

CONGRESSES.

JUNE 29 TO JULY 4.

INTERNATIONAL CONGRESS OF THE HISTORY OF SCIENCE AND TECHNOLOGY.

Friday, July 3, at 10 A.M. (at Science Museum).—Interdependence of Pure and Applied Science.

Saturday, July 4 (at Oxford).

JUNE 29 TO JULY 4.

CONGRESS OF NAVAL ARCHITECTS (Institution of Naval Architects and Association Technique Maritime et Aéronautique) (at Paris).

Saturday, July 4.—Papers on—
Shipbuilding.
Marine Engineering.
Civil Aviation.

JULY 1 TO 4.

CONGRESS OF UNIVERSITIES OF THE EMPIRE (in London).

Friday, July 3, at 11 A.M. (at Guildhall).—Reception, and Address by H.R.H. the Prince of Wales (President).

Saturday, July 4.—Visits.

JULY 6 TO 11 (IN EDINBURGH).

Tuesday, July 7, at 10.30 A M.—Address by the Lord Provost of Edinburgh.

Wednesday, July 8, at 10.30 A.M.—Address by the Marquess of Linlithgow.
At 11 A M.—Sir Robert Waley Cohen and others: Discussion on The University Graduate in Commerce and Industry.
Prof. D. Nicol Smith and others: Discussion on The Standard and the Conditions of Candidature for Ph.D. in relation to other Post-graduate Qualifications.

Thursday, July 9, at 10.30 A.M.—Address by Lord Meston.
At 11 A.M.—Prof. F. E. Sandbach and others: Discussion on Conditions of Admission to Universities and their Effects.
Prof. W. E. Collinson and others: Discussion on The Provision of Schemes of Study leading to General Honours Degrees.

Friday, July 10, at 10.30 A.M.—Address by Sir Donald Macalister, Bart.
At 11 A.M.—Dr. H. L Eason and others: Discussion on Post-graduate Study in Medicine and Surgery in Great Britain.
Sir Thomas H. Holland and others: Discussion on Facilities for Overseas Students in British Universities.

Saturday, July 11.—Visits.

JULY 4 TO 11.

ROYAL SANITARY INSTITUTE (at Glasgow).—Subjects for Discussion:—
The Rôle of the Hospital Relative to the Development of Preventive Medicine.
The Proposals of the British Medical Association for a General Medical Service, from the Standpoint of Preventive Medicine, and in Relation to National Health Insurance.
Development of the National Health Insurance Scheme.
Administration of the Local Government Act, 1929.
Eugenic Sterilisation.
Health Certificates before Marriage.
Pregnancy and Tuberculosis.
Maternity and Child Welfare Work.

JULY 6 TO 11.

CONFERENCE OF MUSEUMS ASSOCIATION (at Plymouth).

Monday, July 6, at 5.15 P.M. and 8 P.M.

Tuesday, July 7, at 10 A.M.—Official Welcome by the Mayor.
At 10.20 A.M.—Sir Henry A. Miers: Presidential Address.
At 11.5 A.M.—Lt.-Col. J. M. Mitchell: Address.
At 11.45 A M.—Discussion.
At 12 noon.—Councillor J. Bailey: The 1924 and 1931 Loans Acts.
At 3 P.M.—A. J. Caddie: Plymouth Porcelain.

Wednesday, July 8, at 9.30 A.M.—W. G. Constable: The Courtauld Institute of Art.
At 10.15 A.M.—S. C. Kaines Smith: Art Museum Problems.
At 11 A.M.—K. de B. Codrington: A Suggested System of Museum Registration.
At 11.45 A.M.—Dr. L. J Spencer: Paper for Museum Labels.
At 6 P M.—Meetings of Regional Federations.

Thursday, July 9, at 9 30 A.M.—Annual Business Meeting.
At 11.30 A.M.—Dr. W. T. Calman: Taxonomy in the Museum.
At 12.15 P.M.—H. J. M. Maltby: Present Day Problems of Provincial Museums
At 2.30 P.M.—Dr. E. J. Allen: The Preservation of Marine Life, Wet or Dry Specimens.

Friday, July 10, at 9.30 A.M.—Prof. J H. Iliffe: Museum Problems in Canada.
At 10.15 A.M.—Dr. H. Murray: A Simple Way to Test Museum Value.
At 11 30 A.M.—F Loney: Why do we use Plate Glass in Museums?

Saturday, July 11.—Excursions.

JULY 9.

BRITISH ELECTRO-FARMING CONFERENCE (at Royal Agricultural Show, Warwick), at 3.—M. M. Harvey: Electricity on the Farm, including Dairy and Poultry Farming.

JULY 9 AND 10.

OPHTHALMOLOGICAL CONGRESS (at Oxford).

Thursday, June 9.—Symposium:—L. Paton, Sir Percy Sargent, Dr. H. M. Traquair, N. Dott, and Prof. A. Schuller: The Diagnosis of Intracranial New Growths.
Prof. G. Elliot Smith: The Evolution of the Instruments of Vision (Address).

Friday, June 10.—Dr. Baillart: Tonometry.
P. Adams: An Ophthalmological Mélange (Doyne Memorial Lecture).
J. Craig and Prof. Schuller: Discussion on Penetrating Wounds of the Eye.

GENERAL MEETING.

JULY 8 TO 10.

INSTITUTION OF MINING ENGINEERS (at Manchester).

Wednesday, July 8, at 11 A M. (at College of Technology).
Dr. T. D. Jones and C. E. Morgan: The Candle-powers of Safety-lamps before and after Underground Shifts.
Prof. W. H. McMillan: Comparative Photometric Tests of Miners' Electric Hand Lamps.
Prof. R. V. Wheeler and D. W. Woodhead: The Flame Safety-lamp: The Use of Reflectors.
Discussion on The Problem of Lighting in and about Mines.
At 2.15.—Prof. H. Briggs: History of the Coal-oil Industry.
R. Faulkner: Roof Control in the Arley Seam, No. 1 Pit.

Thursday, July 9, and *Friday, July* 10.—Visits.

EXHIBITION.

JULY 6 TO 25.

EXHIBITION OF CANAANITE AND HYKSOS ANTIQUITIES (at University College, London).

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SATURDAY, JULY 11, 1931.

CONTENTS.

PAGE
British Chemical Industry 45
Electron Diffraction. By Prof. D. R. Hartree . . 47
Auto-frettage, and the Theory of Strain . . . 49
Indian Ethnography. By R. E. E. 50
Short Reviews 51
Development of the Hudson Bay Region and the North-West Territories of Canada. By Dr. Brysson Cunningham 53
Modern Whaling. By G. A. S. 56
Obituary:
  Dr. Louis Dollo. By A. S. W. 57
  Lieut.-Col. H. T. Morshead, D.S.O., R.E. By S. B. 58
  Mr. Herbert Tomlinson, F.R.S. By S. S. . . 58
  Dr. Karl Bělař. By C. D. D. 59
  Miss Anne L. Massy 59
News and Views 60
Letters to the Editor:
  Influence of Hydrogen on Chemical Changes in Silica Vessels.—Prof. Morris W. Travers, F.R.S., Leslie E. Hockin, and Thomas J. P. Pearce 66
  The Composition of the Blood of Aquatic Animals and its Bearings upon the Possible Conditions of Origin of the Vertebrates.—Prof. W. J. Dakin 66
  Effect of Light on Urediniospores of Black Stem Rust of Wheat, *Puccinia graminis tritici*.—W. A. R. Dillon Weston 67
  Ultra-Violet Rays and Mosquito Larvæ.—Dr. Malcolm E. MacGregor 68
  The Form of Fæcal Pellets and Specific Identification.—Prof. Roderick Macdonald . . . 68
  The Theoretical Magneton Numbers in Weiss Units.—Dr. C. J. Gorter 68
  Measurement of the Electricity Liberated during the Downgrade Reactions of Organic Compounds.—J. H. Wolfenden 69
  X-Ray Fibre Photography.—S. Zeidenfeld . . . 70
  "The World List of Scientific Periodicals."—Sir P. Chalmers Mitchell, C.B.E., F.R.S. . . . 70
  'All or None'. a Question of Nomenclature.—W. W. Waller 70
  Polarisation of Raman Scattering by Hydrogen Gas.—S. Bhagavantam 70
Research Items 71
Astronomical Topics 73
National Physical Laboratory, Teddington. INSPECTION BY THE GENERAL BOARD 74
The International Congress of the History of Science and Technology. By Dr. Thomas Greenwood . 77
The British Australian New Zealand Antarctic Research Expedition 79
A New Heat Engine 80
University and Educational Intelligence . . . 80
Societies and Academies 81
Official Publications Received 83
Diary of Societies 84

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British Chemical Industry.

DURING the past hundred and fifty years or less, scientific method in general and chemical research in particular have gradually invaded the industrial arena. Some of the results of this invasion are patent even to the least initiated, whilst others are accepted without a thought of their origin. Popular interest in scientific research is a thing of recent development; it is only in quite recent years that science, even industrial science, has been 'news', but there is now no lack at least of lip service to the part which it plays in industrial prosperity, as well as in providing the minor needs and newer comforts of everyday life. A few casual preparations excepted, chemical manufacture scarcely existed at the close of the eighteenth century; fifty years ago it was still but an apprentice in the world's workshop. Now it is one of the great fundamental businesses of the civilised world, and one which plays a large part in the maintenance of Britain's industrial, and therefore political, equilibrium. The industry is peculiarly one which depends for its very existence on discovery and invention; it is born in the test tube and nurtured on the laboratory bench in universities and in the research departments maintained by the State and by industrial concerns. It is an industry which demands continuous improvement in its methods, and offers unlimited opportunities of development and expansion; it cannot stand still, but must ever move forward along the paths mapped for it by an army of trained investigators.

Chemical industry is not, of course, exempt from the operation of the so-called laws of economics, and in the present period of world-wide depression it shares in the common suffering; how far the state of the market may be attributed to overproduction, to irrational or antiquated technique, or even to fundamental defects in our commercial methods or in our social system itself, must remain for the present a subject for study and discussion. Nevertheless, reports of progress assure us that the chemical industries are, on the whole, affected less than others, and that this circumstance is largely owing to the astonishing technical progress which is being made in every direction. It may also be due—in fact, it can scarcely fail to be due in some measure—to the familiarity of the directors of such concerns with the results accruing from the daily application of scientific methods of research and control, and to their determination to apply similar methods to management and salesmanship. The customer has to be studied no less critically than the process;

and to preach co-operation while ignoring the advantages of standardisation is to invite a well-founded charge of inconsistency. Standardisation is a word which, rightly, assails our social and artistic feelings, but in industry it is a potent economiser and an efficient lubricant; the attention which it is now receiving—exemplified by the formation of a new Standards Association which includes the chemical industries—is therefore a matter of surprise only in respect of its somewhat tardy appearance. In another report on applied chemistry we read that " in spite of the world-wide depression in the iron and steel industries . . . much attention has been devoted to improvements . . . and modifications . . .", whilst from yet another we learn that " the experience of the oil-seed, fatty oil, and allied industries has proved no exception to this general phenomenon [of depression, loss, and unemployment]. . . . These industries, however, owe much of their present strength to the extent to which rationalisation has proceeded in them, commercial foresight having made much use of scientific discovery and technical development."

One reason, evidently, for the citizen's new interest in scientific discovery and invention, and therefore in scientific education, is to be sought in a realisation of the close connexion between the acquisition of new knowledge and the stability of his own economic position; at the same time he may fairly be credited with an increasing interest in the knowledge itself, an interest which deepens as his own education widens. He will shortly have an opportunity of displaying that interest, and of surveying the circumstances in which the chemical industries have reached the position which they now occupy in Britain. This year the Society of Chemical Industry celebrates the fiftieth anniversary of its foundation. A scientific society fifty years old does not now rank as juvenile, yet how short a period is fifty years in a nation's life! As a contribution to the jubilee celebrations, Dr. Stephen Miall, editor of *Chemistry and Industry*, has written an account * of the development of chemical manufacture in Great Britain. For reasons which we have examined, his book will be regarded by many intelligent, although not scientific, people as one of the more important publications of recent years; scientific people will welcome it as a noteworthy work of reference which is unique in its authority and scope. Dr. Miall has accomplished a task of some difficulty, for until 1882 there was no journal devoted to British chemical industry, and, moreover, there were few books that attempted to describe the progress of any considerable parts of the industry. By combining the advantage of personal contact with its leaders with the goodwill shown by members for an object undertaken by their society, he has received a great mass of valuable information which otherwise might, in a few years, have been irretrievably lost; it is this fact, no less than the attractive manner of presentation, which recommends his story to chemists and non-chemists alike.

It might be thought that the manufacture of 'heavy' chemicals, such as alkali and sulphuric acid, is at least a simple, self-contained, and established process which offers little bait to the pioneer; yet we learn how complex it has become, how one part is dependent on others, and " almost every effort to prevent waste involved the manufacture of some new product ". Unfamiliar names and unsuspected associations will whet the curiosity of the student of chemistry: Josias Christopher Gamble, who, like Joseph Priestley, was a minister of religion and devoted much attention to chemical experiment, became a manufacturer of bleaching powder, alum, sulphuric acid, and Glauber's salt; whilst Walter Weldon's fame is reputed to be shared by the history of bleaching and of ladies' fashions.

Economists tell us that prices depend on the gold output; Dr. Miall observes that the increase from about seven million ounces in 1887 to about twenty million ounces now is largely due to the invention of the cyanide extraction process by a chemist named MacArthur and two brothers, Glasgow medical men, named Forrest. It is obvious that material success will always be dependent on business acumen as well as on technical advance, and this subject is discussed in the chapter on the dyestuffs industry in relation to the acknowledged supremacy of the German dye industry during the forty years or so preceding the War. The reasons which Dr. Miall advances are concerned with the patent laws, with the lack of import duties, with relative business ability, with selling organisation, with inadequate opportunities for the publication of new discoveries, with our lack of chemical engineers, and with the fact that in the late 'sixties and early 'seventies there were far greater facilities for learning organic chemistry in Germany than in England. This reason is regarded as almost sufficient without any others, and its prominence is a striking commentary on the anxiety with which professors of organic chemistry in Great Britain recently regarded a proposal—since fortunately postponed—to remove certain importation restrictions on dyes. Their knowledge of the history of the dyestuffs industry in Great Britain and of the intimate relation which subsists between the work of the universities and the future of this and allied industries aroused justifiable fears that organic chemistry itself, and with it the vitality of the dependent industries, would suffer severe damage by premature removal of that protection.

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* A History of the British Chemical Industry: Written for the Society of Chemical Industry on the Occasion of the Fiftieth Anniversary of its Foundation. By Stephen Miall. Pp. xvi+273+35 plates. (London: Ernest Benn, Ltd., 1931). 10*s*. 6*d*. net.

Abounding evidence is presented by Dr. Miall of the generous way in which successful industrialists have endowed the prosecution of scientific researches; the results have proved not merely a source of profit and a means of increasing employment, but also a source of inestimable material benefit to the human race. In some instances the endowment has taken the form of financial aid to existing research departments of academic institutions and of the creation of fellowships for the support of investigators; in others, of the foundation of new centres of research. A notable example of the latter form of service to humanity is to be found in the enterprises of the Wellcome Foundation, Ltd. These include a Bureau of Scientific Research, an Entomological Field Laboratory, a Museum of Medical Science, Tropical Medicine, and Hygiene, Physiological Research Laboratories, Chemical Research Laboratories, and a Historical Medical Museum. Thus a firm engaged in the manufacture of drugs and fine chemicals seeks to promote progress in the discovery, manufacture, and use of new and important means for the alleviation of human ills.

This outlook, this conception of social duty, is typical of a number of members of the British chemical industry, and the nation has reason to be grateful for the public spirit which is thus demonstrated; they will not be grudged the commercial advantages which their policy affords, and their example will be commended to other industrial firms in a position to do likewise. It may be true, as Dr. Miall says, that the man of business pursues money, the man of science pursues truth, and the man who attempts to do both is handicapped in each direction; the shrewd observation can scarcely be claimed to apply to co-operative effort by men of business associated with men of science. The former know that truth pays, and the latter nowadays at least escape the fate of Leblanc or Lavoisier. Moreover, fickle chance may smile upon them, as it did upon Caro's (but not upon Perkin's) alizarin patent, or upon Perkin's failure to synthesise quinine, or upon Spence's basin of alum. But accidents and failures are, on the whole, best avoided. A hundred years ago, Prof. Thomas Thomson published a history of chemistry which is still read with pleasure and profit by students of chemical science. "Let the sciences advance for another century", he wrote in 1831, "with the same rapidity that it has done for the last fifty years, and it will produce effects upon society of which the present race can form no adequate idea." In 1931 Dr. Miall writes: "Chemical research and technical research proceed in a manner which is satisfactory, and the skill of our chemists and chemical engineers is such that they can cope with all the demands of the industry. We may be confident, notwithstanding present difficulties, that there will be enormous advances during the next twenty years in the application of science to industry, and that much of this advance will be due to chemists." In a foreword, Sir Harry McGowan declares that "To be worthy of our fathers is to surpass them". What will be the historian's verdict in 2031?

Electron Diffraction.

The Wave Mechanics of Free Electrons. By Prof. G. P. Thomson. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 8.) Pp. v+172. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 12*s.* 6*d.* net.

ALTHOUGH de Broglie's first suggestion that moving particles might be accompanied by a wave system was based primarily on the consideration of free electrons, the first development of the wave mechanics, subsequent to the advance made by Schrödinger, was largely concerned with stationary states of bound electrons and their immediate properties, such as their energies and the possibilities of transitions between them. This is not surprising, since any system of atomic mechanics must at least account for the existence of stationary states and their properties, and Schrödinger's development occurred at a time when the limitations of the orbital quantum theory, after its initial successes in this field, were becoming seriously felt.

Though its success in these applications was the first physical justification for the concept of waves accompanying moving particles, they are primarily theoretical, and to follow them in detail often demands considerable mathematical equipment. They appear somewhat sophisticated, and a physicist might well ask for some simpler and more direct evidence for the waves before taking them seriously and endowing them with some sort of physical reality. Such direct evidence is provided by the diffraction and interference phenomena shown by electron beams, which form the subject of the book under review and which its author was one of the first to study. Here he provides an eminently readable account of the experimental material and relevant theory, the balance being more on the experimental side than in most books on wave mechanics.

In the account of the experimental evidence, the author has kept strictly to his title, and only considered the phenomena shown by electrons. The pioneer experiments of Davisson and Germer on the diffraction of electron beams by crystals, the author's own work, and that of Rupp and of Kikuchi are clearly and carefully discussed, with a certain amount of technical detail which should be useful to others working on similar lines, and other work is referred to more shortly.

In the final chapter are considered some applications of the phenomena of electron diffraction, mainly to the study of surface films on solids. Among the differences between X-rays and electrons as tools for the investigation of the structure of matter are the smaller penetrating power of the electron beam and the much smaller amount of matter required to give a diffracted beam of electrons of photographable intensity; and these properties make the electron beam particularly valuable for the investigation of surface effects. It seems likely that many other applications of this tool of physical research will be found in the next few years, and some may well come to have technological importance.

As well as the experiments on diffraction, for which the results are very definite and the interpretation clear and simple, an account is given of those on refraction and polarisation, for which neither the results nor their interpretation are so definite.

The account of the experimental evidence on the diffraction of electron beams is preceded by an introductory chapter in which the antithesis between wave and particle properties and the dual nature of light and electrons are clearly put, and by three chapters dealing with the properties of waves in general, their diffraction by a space lattice, and a preliminary formulation of wave mechanics.

Following the account of the diffraction experiments come two chapters on the effect of refraction on the diffraction of electrons by crystals, and the intensity of scattering of electrons, considered mainly experimentally, with references to the theory; then follow two chapters on the theoretical interpretation of the phenomena, and one on the magnetic electron.

The interpretation of wave mechanics is a subject on which it is notoriously difficult to obtain complete agreement, and while recommending Prof. Thomson's theoretical discussions, the reviewer cannot agree with him at all points. One of the fundamental questions is the physical interpretation of the wave function ψ, which seems to merit closer discussion than it is given, in view of its central position in wave mechanics as a physical theory. Schrödinger's interpretation of $|\psi|^2$ as electron density is adopted at first, without a suggestion of its limitations, and the transition to Born's probability interpretation seems to be made rather casually; the more general validity of the latter would have been strongly emphasised by an example, such as that of partial transmission and partial reflection of a wave packet at a potential discontinuity, in which the interpretation in terms of electron density does not hold.

The application of wave mechanics to a system containing many interacting particles is only considered very shortly, but seems to have a very close bearing on the physical significance of wave mechanics, as in general it is found to be quite essential to consider the wave representing the whole system as a wave in co-ordinate space, and not as a superposition in ordinary space of the waves of the separate particles (although the latter may sometimes be useful as an approximation). If the wave of one electron is given a physical reality, this can scarcely be denied to the wave of a two-electron system; but this means giving a physical reality to co-ordinate space, which most physicists probably regard as a purely mathematical concept.

This suggests one answer to a question asked by Prof. Thomson, "What is the medium which transmits electron waves?" But even without this argument we might reply, "For what is a medium wanted?" Surely by now we have a more general concept of a wave than one which needs a displaceable medium as "a nominative of the verb 'to undulate'". Even a sound wave can be regarded primarily as the propagation of a pressure variation (which happens to be accompanied by a displacement), and if we speak of a wave of epidemic sweeping across a country (as we could do accurately, not only figuratively), we mean that the measure of the incidence of the disease varies in a particular way, and there is no suggestion of displacement of a medium in this case. Even the treatment of light waves which pictures them as due to displacements of an 'ether', implies a 'sub-ether' to provide a frame of reference for the displacements of the 'ether', and Prof. Thomson rightly objects to sub-ethers.

All who are interested in wave mechanics as a physical theory, and not only as a field for mathematical exercise, will find this book of interest and value, and stimulating in its discussion of points on which divergence of opinion is still possible. Among others, those who are making their first acquaintance with wave mechanics will find it valuable. In an introductory presentation, we may either follow the historical development, which may tend to upset the balance of the subject by unduly emphasising the stationary states, or we may start with the diffraction and interference phenomena of electron beams as established experimental facts and develop the theory from them. There is little doubt that the latter will usually be found the more convincing, and for this reason particularly we welcome a book in which the experimental evidence for these phenomena is collected and considered in detail, and especially one such as the present, in which theory and experiment are so well blended. D. R. HARTREE.

Auto-frettage, and the Theory of Strain.

War Office. Overstrain of Metals: and its Application to the Auto-Frettage Process of Cylinder and Gun Construction. By Major A. E. Macrae. Pp. ix + 378. (London: H.M. Stationery Office, 1930.) 21*s.* net.

BETWEEN 1840 and 1850, Rodman, in the United States, investigated a new method of casting thick iron cylinders. He cooled the bore so that the inside hardened first. The outside, cooling afterwards, contracted and thereby placed the cylinder wall in a state of stress, compressive on the inside, tensile on the outside. Further work was done forty years later by Kalakoutsky in Russia, by Prof. Perry at the beginning of the present century, and by M. Malaval during and since the War; the modern method of achieving the same result being to expand a forged steel cylinder hydraulically into the yield range, so that on release of pressure the permanent set of the interior places the exterior in elastic stress. Major Macrae now gives us a very complete record of the work done at Woolwich on this subject. Written mainly for gun-makers, this book should be of interest and value also to engineers in general, who will find therein a vast fund of experimental data on the testing of metals under both tensile and compressive loads up to and exceeding the elastic limit, and on the most suitable heat treatment to restore elasticity that has been lost by overstrain.

No time is wasted by the author on the work of his predecessors, no doubt justifiably; but there is a notable omission in Chap. iv. from the list of hypotheses which determine the criterion of failure of a metal. No mention is made of the 'strain-energy' theory propounded by Prof. James Thomson. The derived relation, $T^2+P^2+2\sigma TP=E^2$, is not so convenient to work with as that of the shear theory, giving in its simplest form $T+P=E$, which fortunately appears to give good results up to a point, but it might have been included in such a general review.

The first two chapters are mainly concerned with definitions and a review of some accepted principles. Chap. iii. contains the results, both tabulated and diagrammatic, of the principal preliminary experiments on the overstraining of steels, gun-metal, and manganese-bronze, and on the most suitable heat treatment to be applied after the process. The results are well arranged, and it is in this chapter that the civil engineer will find most of the 'meat'. Chap. iv. is devoted to steel cylinders under elastic strains; Chap. v. to the theory and practice of the new 'auto-frettage' method of gun construction. The argument of this chapter, particularly at the beginning, is very well and clearly built up. The experimental results on which the theory is based are extremely well set out in a series of diagrams.

Of the mathematical treatment it is not possible to be so enthusiastic. The arithmetical development is laborious, frequently redundant, and not always strictly logical. The classical theory of elastic stresses in a cylinder is revised, and at first sight there appears to be a proof (on p. 124) of the assumption, usually specified, that longitudinal stress is constant throughout a section of a tube. The apparent proof rests on the finding that $T-P=\text{constant}$; but the fact that $T-P$ is constant is inherent in the two differential equations:

$$\frac{d(PR)}{dR}=-T, \quad . \quad . \quad . \quad (2)$$

and

$$\frac{d(TR)}{dR}=-P. \quad . \quad . \quad . \quad (3)$$

Where does (3) come from? The equation before (2) on p. 123, from which it purports to come, gives (2) but not (3). Actually (3) is only correct if it is already assumed that $T-P=\text{constant}$. In other words, this assumption is tacitly made, though not stated, when equation (3) is inserted, and the equation is then used to prove the assumption that has already been made.

The development of the shear theory that is used considers stresses in two dimensions only, though in the majority of cylinders (gun tubes included) there are stresses in three dimensions. The author, on p. 137, advances an argument for neglecting longitudinal stress, but here he is not very convincing. There is evidently a need for a more general treatment of the theory.

A very convenient assumption made throughout the book is that the cross-sectional area of a cylinder remains constant during strain. But a word of caution is necessary. "By the Conservation of Volume . . ." is written on p. 201, much as if it were a principle analogous to the conservation of energy. As a principle it should, it is thought, be regarded with considerable reserve. The experimental evidence is interesting. Some figures support the assumption; others do not. On p. 275 it is wrong by 1½ per cent and on p. 279 by 5 per cent. Yet it is an extremely useful assumption to make, and it is hard to see how we can get along without it.

The last three chapters are devoted to problems that mainly concern the gun-maker. To him, the book is full (perhaps too full) of formulæ designed to give an answer to every numerical question that is likely to arise in his work. It is easy to criticise such a book: by a stringent revision of its mathematics there is no doubt that a considerable saving of space would have resulted, together with a great increase in readability. Classification and headings of sections, and indexing also, leave something to be desired. But as a record of an immense amount of careful and organised labour during years of experiment and research; to the engineer for its copious experimental results; and to the scientific worker for its unexplained curiosities—such as the bending in of the recovery curve before the stress on a test piece has been fully released (shown in the pull-push diagrams in Chap. iii.); the change in stress without change in strain after the application of heat (section F, Chap. v.); or the significant similarity between the cyclic curves in Chap. ii., and the *BH* curves obtained in finding magnetic hysteresis loss —it is a valuable contribution to that foundational fringe by which we are approaching a new aspect of scientific knowledge. To refer only to one parallel investigation—Herbert's recent work on the remarkable hardening properties of a metal when rotated in a magnetic field (*Proc. Roy. Soc.*, vol. A, 130, No. 814)—it is evident that a new line of inquiry requires attention. The question which all this subject brings so insistently before us is: Why do the atoms of a metal cling together at all? What really are the forces that oppose strain? Why, in fact, is a metal a metal, and not, for example, a gas?

Major Macrae's book is written for engineers and is not directly concerned with questions of this kind. But it is an important work, with which everyone interested in these matters should make himself familiar.

Indian Ethnography.

The Mysore Tribes and Castes. By the late H. V. Nanjundayya and Rao Bahadur L. K. Ananthakrishna Iyer. (Published under the auspices of the Mysore University.) Vol. 3. Pp. viii + 619 + 76 plates. (Mysore: Government Oriental Library; Bangalore: Government Book Depot, 1930.) 12.8 rupees.

THOSE interested in Indian ethnography will welcome the appearance, after an interval of twelve months, of vol. 3 of the Mysore Survey Records, carrying the reader from C to K. The volume opens with a somewhat lengthy article on Christians (Roman Catholic and Protestant), which might clearly have been very considerably curtailed. In a work such as this, which deals primarily with tribes and castes, any attempt to convey the essentials of the Christian creed and ritual seems at first sight a little out of place. We are given parts of the marriage service, and certain well-known prayers which are obviously available elsewhere; whereas, a detailed description of such caste distinctions as the Roman Catholic Church has thought it wise to tolerate as a concession to the engrained prejudices of converts is unfortunately not to be found. In Goa and the adjacent Portuguese territory, it has been found that three classes, Brahman, Charado (that is, Kshattriya), and Sudra Christians, remain as an indication of the converts' former Hindu status. We should have been interested to learn whether, in Mysore, the caste distinctions permitted, as indicated on p. 56, take a similar or a more detailed form.

The student, however, will find in the rest of the volume much that will amply repay the effort of careful study. Unquestionably, one of the most valuable additions to our present knowledge of the castes of Southern India is the admirable tables on pp. 579-582 giving details of the exogamous divisions of the trading caste known as Komatis or Shettis. According to the author of the article on Komati, these traders style themselves Vaishyas, claim to have come to Mysore from Ayodhya, and to have been divided into 102 exogamous *gotras*. These *gotras*, as the writer points out, are really totemistic divisions named for the most part after well-known trees, plants, fruits, and flowers. We recognise at once the *Rui* (*Calotropis gigantea*) and the *Shami* (*Prosopis spicigera*) which apparently constitute the totems of the Kausika and Valmiki *gotras*. A comparison of the 101 entries in his list with the well-known *devaks* of the Marathas and kindred tribes in the Deccan discloses a remarkable series of coincidences, and is therefore of no little importance.

We are informed (p. 542) that the use of the article known as the totem is eschewed; and that when there is any doubt concerning the correct totem for a subdivision, it is usual to fall back on the screw-pine (*Pandanus odoratissimus*), itself a well-known totem in the Deccan and elsewhere, which they must abstain from using.

In Indian ethnology, it is well known that the lower the status of the tribe or caste dealt with, the more usual it is to find marriage regulated by totemistic divisions, and the larger the number of articles embraced by such totem lists. It is particularly noteworthy that Komatis, as we have found in the case of the Marathas in the Bombay Presidency, still possess so much evidence of a primitive origin.

As was to be expected, we find in this volume a good list of similar divisions among the Holeyas, a low caste of scavengers and dealers in horns and hides. Reference should also be made to the articles on Gollas, Halepaiks, Helavas, and Kadu Gollas by those interested in further lists of totemistic divisions. The lists would have been more valuable if the writer could have supplied, in each case, the botanical name of the tree or plant referred to, in order to assist identification and comparison with the contents of other lists. On pp. 169-174 and on pp. 540-541 will be found a list of words used by Dombars and Komatis that may be of interest to philologists. Many of them seem, at first sight, to be mere corruptions of other and well-known forms of the same words.

An interesting sidelight on primitive customs is furnished by the note on p. 168 under the article on Dombars, a wandering tribe of acrobats and tumblers. It appears that it is considered a great sin among Dombars to kill a cat; but that this offence can be washed away by eating the cat afterwards! This seems a very simple way of avoiding the wrath of the cat-godling involved.

There is so much good material in this volume that a critic is disposed to restrict adverse comment to a minimum. But a few such comments seem called for. The cross-references in the case of synonyms and subdivisions have again been omitted. It is understood that this defect will be made good when vol. 1 is finally published: but such cross-references ought to be in alphabetical sequence in each volume, to be of real value to the student.

Misprints are undesirably frequent; on p. 518, footnote, "Tile" for "Title" makes nonsense of a translation of the Kanarese word *biradu*; on p. 580, "Hilly Basil" scarcely suggests the "Holy Basil" (*Ocymum sanctum*), for which it seems to be intended. The name of the writer of this review has been spelt in three different ways, and we again find the late superintendent of the Ethnographical Survey of the Central Provinces unfairly referred to repeatedly as Russel. The illustrations are in many cases excellent; but here again a little more care in correcting the spelling would have been useful. *Kare okkalus* are black cultivators (corresponding to Kala Kunbis in Marathi); *Kara okkalu* does not convey the same meaning. The tailor caste, which is the subject of an excellent article, appears as Dārzi in the text and Darji in the illustrations. Such small blemishes are surely both avoidable and unnecessary.

However, we may genuinely offer our congratulations to the compiler on the progress that is being made with the publication of these valuable records; and we shall await the two remaining volumes with much interest. R. E. E.

Short Reviews.

Instinct and Intuition: a Study in Mental Duality. By G. B. Dibblee. Pp. 394. (London: Faber and Faber, Ltd., 1929.) 25*s*. net.

MR. DIBBLEE was led into researches into the nature of intelligence, instinct, and intuition by his previous work on the "Psychology of Supply and Demand and of Economic Value". His conviction that demand is dependent upon value, and that value is determined by "plain human unreasoning instinct" rather than by intelligent judgments, made him desire to understand more about the psychological process underlying human reasoning and what he calls extra consciousness, as well as about its physiological basis.

According to Mr. Dibblee there are, physiologically speaking, two areas of intelligence in man. There exists "an instinctive intelligent faculty, lying on the physiological side of our central faculty of conscious reason, and . . . an intuitive faculty, lying on the intellectual side, a partner, in fact, of the intellect, but outside the limits of conscious operation". The seat of the first is in the thalamus, that of the second in the cortex. He thus breaks away from Lloyd Morgan, who finds the seat of human intelligence mainly, if not solely, in the cortical area.

Mr. Dibblee is not afraid of frankly metaphysical hypotheses—nay, prophecies. He believes in the coming of telepathy: "We shall recognise as a commonplace fact, that unknown vibrations and waves are passing between individuals all the time. The method of physically tuning waves and vibrations, so as to be serviceable in personal communications, will no doubt be becoming as much a branch of psychology as now it is to study the internal mechanism of the eye or the ear." Whether this horrible prophecy will come true is, fortunately, not certain, as most physicists would agree. We should obviously be deprived of the last resort of privacy, morals, and decency, and life itself would become intolerable.

In the last paragraph of the book, Mr. Dibblee tells us that "the parallel capacity in our intuitive faculty brings us extra-consciously into intimate relations with minds or a mind quite probably very different from our own". Thus the book will no doubt be taken up by the metaphysical schools of thought in our modern culture, and if the argument be physiologically sound, it certainly provides a charter for a new psychology of religious revelation.

Exploring for Plants. By David Fairchild. From Notes of the Allison Vincent Armour Expeditions for the United States Department of Agriculture, 1925, 1926 and 1927. Pp. xx + 591. (New York: The Macmillan Co., 1930.) 21*s.* net.

THE author of this work is the head of the Foreign Plant Introduction Service of the U.S. Department of Agriculture. To deserve his attention, plants must have at least some political economic value, though he delights in the charm of the settings where his subjects occur. Every effort must concentrate on the introduction and establishment of the plant within the United States; all standards and comparisons are by American values. It is given to few to be allowed to indulge their fancies; Dr. Fairchild had a unique opportunity to follow his hobby and the work in which he delights, thanks to the assistance of Mr. Allison V. Armour and his yacht the *Utowana*. His party visited the Canaries and Mediterranean countries, parts of Malay, and West Africa.

"Exploring for Plants" is the record of the expert economic botanist, who recounts, with the freshness of first impressions, the plants and plant products he observed and collected, the food, peoples, and customs of the countries visited, and the vicissitudes of the three expeditions. There was little that escaped the keen eye of Dr. Fairchild, and toll was levied of every plant bearing seed, in the hope of being able to establish it in some part of the United States.

The book is profusely illustrated with pictures, but the only maps are two line blocks tucked away towards the end. The author is an experienced traveller, and on the far eastern tour he, unfortunately, had several opportunities of proving his conviction that one must be ill in a foreign country in order to know what the civilisation of that country is like.

The Elements of Analytical Geometry. By J. I. Craig. Vol. 1: *Straight Line and Circle.* Pp. xiv + 415. (London: Macmillan and Co., Ltd., 1930.) 12*s.* 6*d.*

IT is not often that the writer of a mathematical book is privileged to have such a varied experience as the author of this volume. Mr. Craig declares in the preface that he has been called upon to "deal with questions in fields as diverse as Celestial Mechanics, Sport, Geodesy, Hydrography, Meteorology, Ballistics, Census, Agriculture, Food Supply, Statistics, Pensions, Public Health, and Currency Theory". In all these, he pays a tribute to the value of the mathematical habit of thought, in general, and to the practical utility of analysis applied to geometry, in particular. The course embodied in the book is the immediate outcome of lectures delivered at the Royal School of Engineering, Cairo, and these are based to a large extent on a long experience in the application of analytical geometry to the solution of practical problems. The straight line and circle form the subject matter of this first volume, and the treatment is not only full—trilinear and tangential co-ordinates and vector equations of the circle being included—but also, as might be anticipated, is characterised by numerous practical applications. Amongst these, such interesting topics as railway curves, circular nomograms, and sound-ranging are excellently dealt with. Whilst, however, the book certainly has a practical bias, the theoretical side is not only well covered, but also appears to be mathematically sound. The volume, which has also been translated into Arabic, should be very useful, especially to the engineering student who desires more than a superficial knowledge of analytical geometry.

Chemische Thermodynamik: Einführung in die Lehre von den chemischen Affinitäten und Gleichgewichten. Von Prof. Dr. Hermann Ulich. Pp. xvi + 353. (Dresden und Leipzig: Theodor Steinkopff, 1930.) 18·50 gold marks.

IT is a pity that some universal agreement cannot be attained in the symbolism employed in thermodynamics. Prof. Ulich in this volume on chemical thermodynamics uses symbols which differ from those employed by Nernst, Gibbs, and G. N. Lewis, and thus does not subscribe to either a European or an American standard. This defect is to some extent mitigated by the fact that a compilation of the thermodynamic symbols employed by different authors is given in the introduction. Many books on chemical thermodynamics are inclined to stress the purely mathematical treatment, without bringing the significance of the various equations home to the physical chemical reader by examples. This volume may be commended, in that numerous applications of the three laws are given. It is agreeable to find entropy tables both for elements and compounds now included in a text-book on thermodynamics, as well as exemplification of the practical utility of Gibbs's chemical potential function μ. The last chapter in the book, on surface phenomena, is the least satisfactory; but in the others the reader will find much of interest and of value. E. K. R.

Development of the Hudson Bay Region and the North-West Territories of Canada.

By DR. BRYSSON CUNNINGHAM.

THE romance of the mythical 'North-West Passage' which inspired the hopes and fascinated the imaginations of the pioneer navigators of the sixteenth century and their successors for several generations thereafter, has had a curious and interesting sequel of recent years, culminating, after some hesitations and two changes of programme, in the approaching completion of a new commercial port and harbour on the western coast of Hudson Bay, forming the terminal of a branch railway line from the Winnipeg-Prince Albert section of the Canadian National Railways, and the contemplated inauguration of a regular service of steamers through Hudson Strait to the North Atlantic Ocean. No longer is the extravagant and visionary idea entertained of a new sea route from Europe to India; in its place has arisen a much more rational and feasible project for the effective development of the spacious and, at present, sparsely occupied regions lying in Manitoba, Saskatchewan, and the great North-West Territories of the Dominion, and the systematic exploitation of their enormous wealth of natural resources, by providing them with a direct outlet to the ocean highways of the world.

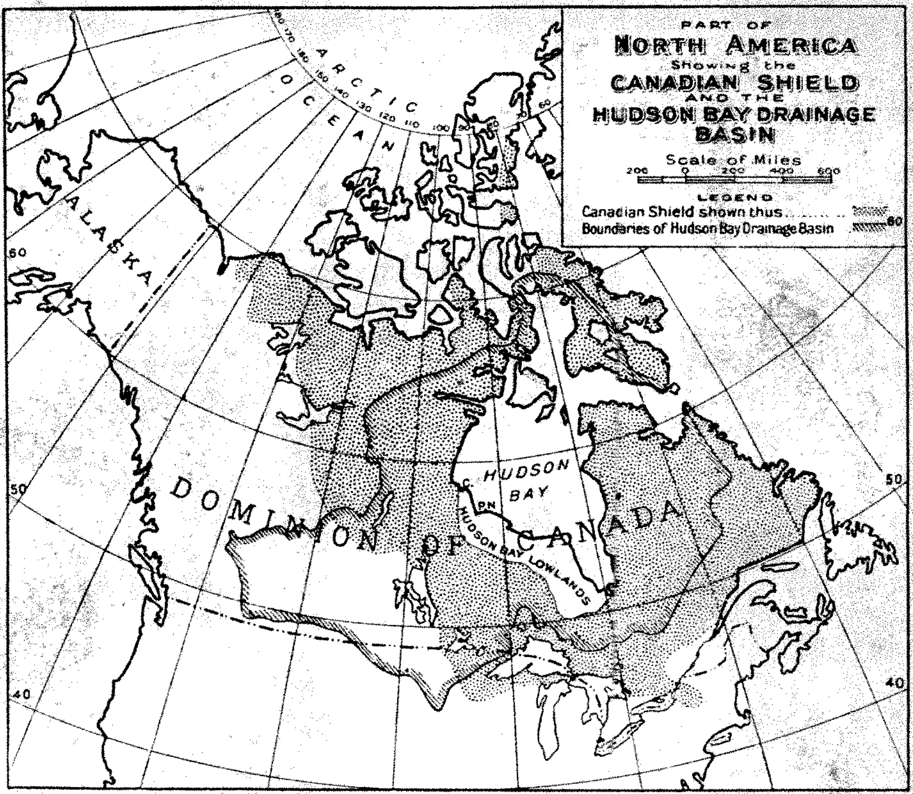

FIG. 1.—Churchill and Port Nelson, on the shores of Hudson Bay, are indicated by C. and P.N. respectively. From "The Hudson Bay Region", by F. H. Kitto, issued by the Department of the Interior and the Natural Resources Intelligence Service, Ottawa.

The vast inland sea, with an area of well over half a million square miles, called Hudson Bay after the famous navigator, penetrates far and deep into the North American Continent (see Fig. 1), and were it not that the sole avenue of communication with the outer Atlantic lies through a region so far north (within 5° of the Arctic Circle, in fact) as to be blockaded for the greater part of the year by a formidable and impassable barrier of ice, it would be a network of busy trade routes, since its waters lap a coast-line fully as extensive as the entire Atlantic seaboard of the United States. Unfortunately, too, Hudson Bay, which is fairly deep in itself, except along some parts of its south-western shore, is lacking in serviceable natural harbours. On the western and southern coasts (excluding James Bay, which is quite shallow) there are only two inlets which afford any pretensions to shelter and anchorage for vessels of modern draught. These are Nelson and Churchill, situated at the mouths of rivers bearing the same names.

The harbour of Nelson, however, is scarcely more than an open roadstead; it is exposed, shallow, and difficult of approach. Despite the fact that a terminal at Churchill would involve a longer railway line and the consequent drawback of a correspondingly longer haul for traffic, the authorities decided at the outset in its favour, and work was commenced in 1911 on the new branch line, with Churchill as its objective, on a route entirely north of the Nelson River, which measured 474 miles in length from the junction at The Pas with the existing line. For some reason, however, the impression gained ground that the constructional difficulties of a line to Churchill would be considerable and even prohibitive, and before much progress had been made, this consideration, combined with the economical question of haulage, caused the Government to alter its plans and to locate the railway with the view of an approach to Nelson. This change enabled the route to be shortened by 50 miles, and the line was actually laid for a distance of 332 miles as far as Kettle Rapids (Fig. 2), where the river Nelson is crossed for the second time, the first occasion being at Manitou Rapids. At this stage of progress, the War intervened and operations were suspended.

It was not until 1926 that work was actively resumed, and then the whole question of the rival merits of Nelson and Churchill as prospective port terminals came up for reconsideration. A special Committee of the Senate recommended that expert advice from a leading authority on harbour development should be obtained, with the result that Mr. F. Palmer (now Sir Frederick Palmer) was commissioned by the Government to investigate the position and report. Mr. Palmer's conclusions were formulated in the autumn of 1927. He had no difficulty in deciding that, on all the evidence, the balance of advantages as a port terminal is definitely and unmistakably on the side of Churchill. Moreover, the constructional difficulties of the land route were found to have been greatly over-stated, and it was ascertained that it would be no more difficult to construct a line of railway to Churchill than to Nelson, the only drawback being that the distance is 87 miles greater.

The cost of the longer line, however, could be more than compensated by the saving in artificial harbour protection works. For, as regards protected harbourage, Churchill presents features indubitably more favourable than those of Nelson. The former port has an easy approach from deep water to a sheltered situation, with ample draught for the requirements of modern shipping. "At Churchill", states Mr. Palmer's report,[1] "Nature has provided magnificent breakwaters, consisting of rocky cliffs rising to heights of from 40 to 70 feet, enclosing a harbour 6 miles in length and from 1 to 2½ miles in width at low water and 1½ to 4 miles at high water. The entrance to the harbour consists of a narrow gap between these headlands, with a low water width of 1600 ft., a width of 850 ft. at 30 ft. depth, and 750 ft. of width having depths exceeding 60 ft. Inside the entrance there exists an area of 140 acres with depths of 30 ft. and over at low water, and a further area of about 180 acres with depths varying from 18 to 30 ft. at low water, beyond which there is a vast area of lesser depth."

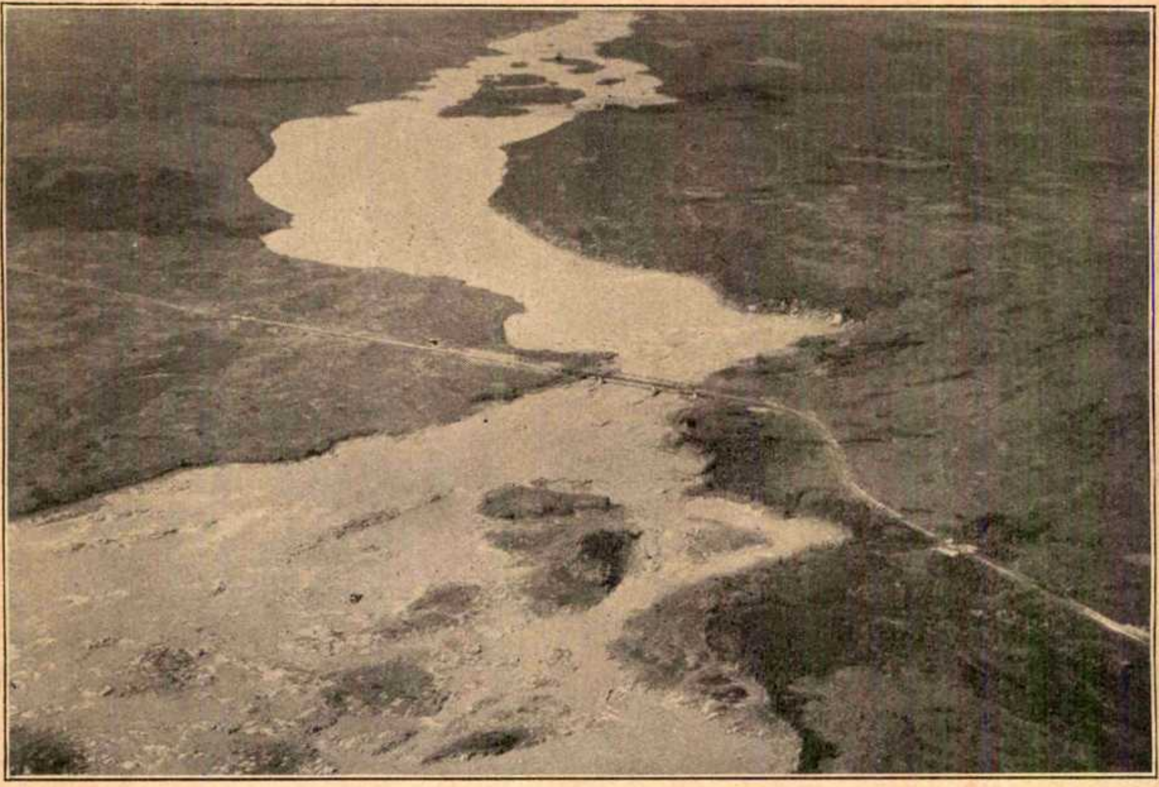
FIG. 2.—View of Kettle Rapids, Nelson River, showing the railway line and crossing. By courtesy of the High Commissioner of Canada.

The Government promptly acquiesced in the findings of this Report, and since that date it has been energetically pursuing the realisation of the project, which, as stated earlier, is now within reach. The site of the wharves and terminal is shown in Fig. 3. The port is expected to be fully open for traffic in 1932, and it is hoped that an experimental shipment of grain will be made during the summer season of this year.

The great problem (and the one uncertain factor in the case) is the question of ice. The sole seaward approach to the new port will be through Hudson Strait and the navigability of this passage is only practicable during a season of very restricted extent. As soon as the decision was finally made to adopt Churchill as the strategic point of sea contact, steps were taken to study the environment and navigable channels of the Strait, and an aerial expedition was sent out by the Department of Marine and Fisheries, which established itself for observational purposes on three bases at points on Hudson Strait. The reconnaissance extended from the spring of 1927 to the autumn of 1928, covering two navigational seasons. The report of Capt. N. B. McLean, the officer in charge, cautiously indicates the duration of free navigational movement as about four months in the year. "Taking July 19 as an opening date for the Strait, and November 16, when ice was first reported at Nottingham in 1927, as a closing date, we get a season of 120 days, or practically four months, during which commercial vessels could have navigated with safety and without the assistance of ice-breakers. It must, however, be borne in mind that data obtained during two seasons only is entirely insufficient on which to base any accurate statement in regard to the opening, closing, or length of the season of navigation." [2]

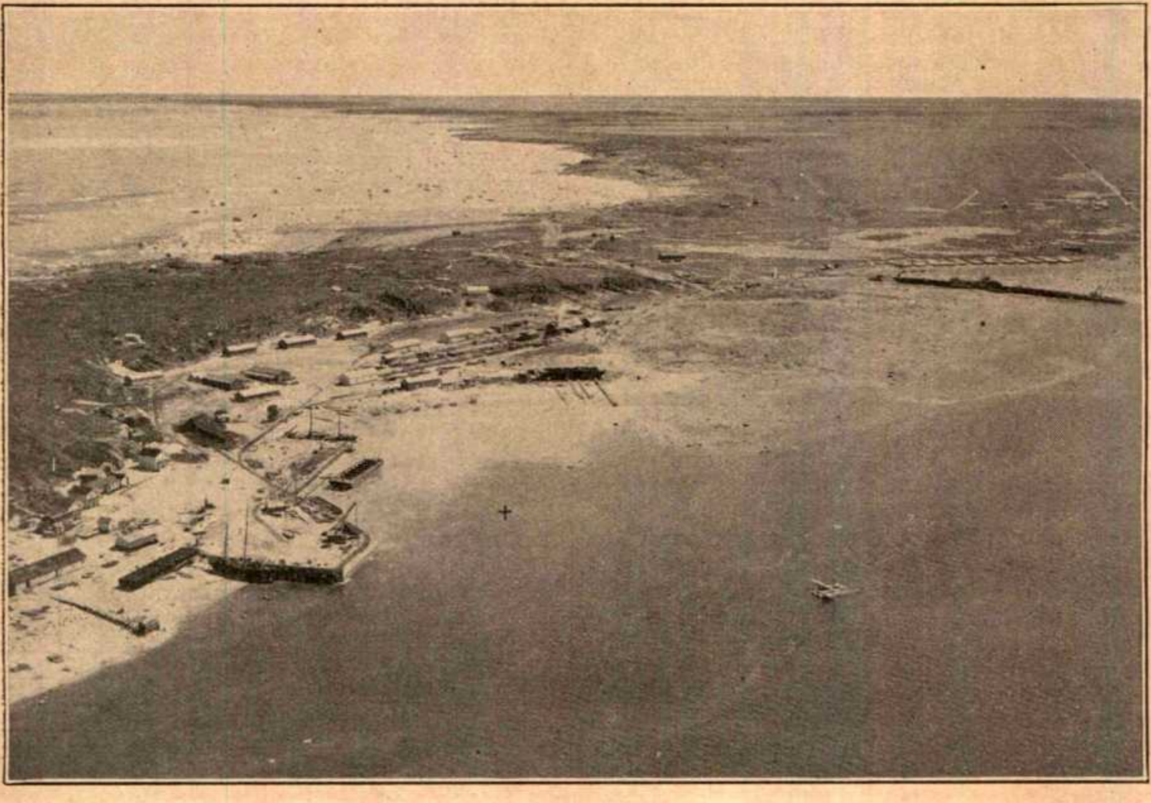

FIG. 3.—View of Churchill Harbour, looking east, and showing the site of the new port terminal. By courtesy of the High Commissioner of Canada.

The navigational period is obviously very restricted, and the prospect of any appreciable extension by modern ice-breaking operations is not altogether too promising, but, on the other hand, it must be remembered that much can be done by intensive seasonal working. Montreal is a port similarly handicapped in regard to ice conditions, though perhaps not quite to the same extent, yet in a short summer season of about seven months no less than 200 million bushels of grain have been shipped and dispatched to Europe. Careful organisation and capable working may lead to correspondingly effective results at Churchill.

Should the experience of the new route prove satisfactory and its commercial feasibility be confirmed, the prospects of developing the almost illimitable hinterland behind the Bay are very alluring. The harvests and agricultural products of the western provinces have hitherto reached the British market either by way of the Great Lakes and the ports of eastern Canada or, alternatively, by the Pacific ports and through the Panama Canal. To Liverpool, the distance from Edmonton or Calgary by the latter route is between 10,000 and 11,000 miles, and by the former about 5200 miles. The Hudson Bay route will mean a further saving of practically a thousand miles.

Apart from the abundant crops of grain and cereals for which Manitoba, Saskatchewan, and Alberta are renowned, there are numerous fields of exploitation in other directions in a region rich in natural resources of many kinds. Trapping for furs has long been an established feature, and the Hudson Bay Company, formed so long ago as the year 1670 under the governorship of Prince Rupert, nephew of King Charles I., has carried on a prosperous trade for more than two centuries. The rivers teem with fish. Water power is plentiful and invites conversion at numerous falls into electricity for adaptation to various industries. Forests in the southern areas provide an abundance of timber, with the promise of extensive supplies of pulpwood for paper manufacture, in addition to the considerable number of trees available for constructional and commercial purposes.

Not less remarkable is the scope for mining minerals and precious metals. The great pre-Cambrian area covering very nearly the whole of the Hudson Bay region, and known as the Canadian Shield, has given startling evidence of being one of the world's largest storehouses of mineral wealth. The famous Hollinger mine is third among the largest gold producers in both hemispheres. There are impressive copper-zinc ore deposits in northern Manitoba and massive bodies of ferriferous ore on the Belcher Islands in Hudson Bay.

The country is still largely in the exploratory stage, and much of its wealth yet remains to be discovered. From such evidence as has accumulated to date, it is clear that there is every ground for believing that the internal resources of the Hudson Bay region will prove highly remunerative and profitable to the capable prospector. The opening of the new route to Europe will afford a means of facilitating the initiation of further enterprise, and will doubtless lead to a great era of commercial, industrial, and agricultural development in the inland provinces of western Canada.

[1] "Report on the Selection of a Terminal Port for the Hudson Bay Railway", October 1927.

[2] "Report of the Hudson Strait Expedition, 1927–8." Ottawa, 1929.

Modern Whaling.

SO far as historical records show, whaling was first begun in the twelfth century by the Biscayans in the Bay of Biscay. From that time until the beginning of the present century, all whaling stations were situated on land.

Towards the end of the nineteenth century, Svend Foyn had tried to operate a floating factory, but the venture failed. The next attempt in this direction was made by Commander Christensen when, in 1903, he sent a wooden steamer fitted as a temporary factory and accompanied by two attendant catchers to Svalbard (Spitsbergen). So much success attended this expedition that Christensen afterwards bought the steel steamer *Admiralen* and fitted her out as the first fully equipped floating factory. This proved to be an epoch-making vessel. In 1925 she was sent to South Georgia, accompanied by two catchers, and from that date the great modern Antarctic whaling era may be said to have begun. There are now one Argentine, three British, and four Norwegian companies operating at South Georgia, and seven Norwegian companies at South Shetland, in addition to various other shore and pelagic factories working elsewhere in the Antarctic.

Prior to the outbreak of the War, some twenty-four steamers had been converted into whaling factories, but all worked in or near harbours, depending—in part at least—upon water and other supplies from the shore. Since the War about the same number of ships have been converted, but the majority of the latter are designed to work in open seas entirely independent of any shore base. The pioneer in this field of development was the renowned whaler, Capt. C. A. Larsen.

Until roughly five years ago, all the working up of whales was done in the water alongside the factory ships, the blanket of blubber and severed pieces of the carcass being hoisted on board by winches and derricks. To avoid the labour and discomfort involved in such a trying and uneconomical method, by means of some kind of slipway which would enable the entire carcass to be hauled on board, had long been the dream of many a whaleman. Numerous suggestions were put forward and a number of ships fitted with various types of slipway. These were located in different parts of the vessels—from bow to quarter—but not one proved satisfactory. Not until the introduction of a *straight* slipway through the *stern* was success eventually achieved. The great obstacle in the way of a straight slip was the profound respect with which all sailors regard the stern frame and rudder post of a ship.

In 1925 the "Globus" Company bought the s.s. *Flackwell* (now *Lancing*) for conversion into a pelagic whaler. Mr. Chr. Fred Christensen, in cooperation with Capt. H. G. Melsom, supervised the reconstruction of this ship. With commendable courage they decided to make drastic alterations and arranged a straight and permanent slipway down to the waterline *through the stern*—a process which necessitated the cutting away of about eleven feet of rudder stock and stern frame post.

This revolutionary design proved highly successful, and has formed the model for all subsequent slipways. Improvements quickly followed until what the designers consider full efficiency was attained in the *Vikingen*—a new ship designed and built specially as a pelagic whaling factory at Messrs. Swan, Hunter and Wigham Richardson's Wallsend shipyard in 1928.

In a very valuable and intensely interesting handbook* just published, Mr. Christensen describes this ship. Plans of the vessel are given, along with detailed information regarding the arrangement of the machinery and plant on board and the methods of working them. Photographs of the *Vikingen* and of her catchers at work are also included. To this are added a brief outline of the history of whaling and an account of various important modifications and improvements in whaling operations.

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* The Whaling Factory Ship *Vikingen*, with some Notes on Whaling. By Chr. Fred Christensen. (Newcastle-on-Tyne: North-East Coast Institution of Engineers and Shipbuilders, 1931.) Pp. 24 + 2 plates. n.p.

Mention is also made of the immense value of the whaling industry both to Norway and Great Britain. Since 1928, new factory ships totalling 140,000 tons and costing £2,500,000 have been built, excluding catchers. In addition to these new vessels, the whaling companies have bought in Great Britain about 250,000 tons of steamers for conversion into factories and transports. The approximate figures of expenditure in Great Britain during this period are:

Steamers converted into factories	£1,000,000
Floating factories (new buildings)	2,500,000
Transport ships for factories	950,000
Repairs to all types of vessels	550,000
Whale catchers (new buildings)	2,200,000
Total	£7,200,000

In addition to the above, the purchase of coal, oil, and equipment in Great Britain has amounted to millions of pounds, and the British Government derives a large income from licences and duties paid by the companies on the oil and guano they produce.

G. A. S.

Obituary.

DR. LOUIS DOLLO.

DR. LOUIS DOLLO, who died at Brussels on April 19, will always be remembered for his numerous and valuable contributions to our knowledge of extinct vertebrate animals. Early in 1882 he was appointed assistant-naturalist in the Royal Museum of Natural History, Brussels, where he afterwards became conservator, and was actively engaged in research until his retirement in November 1925. He arranged and labelled the unique collection of Belgian fossil vertebrates in the new museum which was opened in the Leopold Park in 1905, and he published preliminary descriptions especially of the fossil reptiles in a series of remarkable papers, besides preparing a general guide-book to the vertebrates, both living and fossil.

Dollo was born at Lille on Dec. 7, 1857, and completed his education in the university of that city, where he graduated as a civil engineer. He studied geology under Prof. J. Gosselet, and he also devoted much attention to the zoological sciences both at Lille and in the marine biological station at Wimereux, under the direction of Prof. A. Giard. His inclination was towards natural history, and he abandoned an engineering career as soon as the opportunity for biological research presented itself in the appointment at Brussels in 1882. His early training, however, influenced him throughout life, and nearly all his writings are in the peculiarly mathematical form of brief numbered statements and proofs.

In the Brussels Museum, Dollo began immediately to study the fossil reptiles, and his first paper, published in October 1882, was a description of *Mosasaurus* and a new allied genus, *Pterycollasaurus*. The finest specimens of Mosasaurians in Europe were found in the Upper Cretaceous rocks of Belgium, and Dollo in subsequent years made many contributions to our knowledge of these extinct sea reptiles. In 1882, however, much progress had already been made in extracting from the rock the wonderful skeletons of Iguanodon and other reptiles which had been discovered four years previously in the Wealden of Bernissart, near Mons. Dollo was then entrusted with the study of this collection, and he soon produced a series of "Notes" in the Museum bulletin which described whole skeletons of Iguanodon for the first time, made known many new facts, and discussed them in a brilliant manner. He also published notes on the associated crocodiles and turtles, and the oldest known newt. These papers were intended to be preliminary to an exhaustive monograph on the whole collection which he hoped to prepare, but difficulties arose which unfortunately prevented the accomplishment of the task. Dollo, indeed, was forbidden by the director of the Museum at the time to proceed with his researches on fossil reptiles, and was ordered to pay attention to the fishes. Thus originated his classic paper on the evolution of the Dipnoi, and many other suggestive papers on evolutionary problems which made fundamental advances in the methods of studying fossils. He established the general principle that during evolution "an organism never returns exactly to its former state even if it finds itself placed again in circumstances identical with those through which it has passed". He described this as the irreversibility of evolution, and it is sometimes termed Dollo's law. He also emphasised the importance of 'ethology', or the study of organisms in relation to their natural surroundings, and furnished many striking examples in his later papers. His last paper, on the carpus and tarsus, published in 1929, fully maintained his old standards, and was written in the characteristic logical form.

Dollo had many ardent admirers among contemporary biologists, and a distinguished group of his friends made contributions to the first volume of a new serial *Palæobiologica* which was published by Prof. O. Abel in Vienna in 1928 in honour of his seventieth birthday. He was a foreign member of the Linnean, Geological, and Zoological Societies of London, and was awarded the Murchison Medal of the Geological Society in 1912. He was also an honorary Sc.D. of Cambridge. He was professor in the University of Brussels, and member of the Royal Belgian Academy. He was also a corresponding member of the Academies of Science of Berlin, Munich, and New York. He was an acknowledged leader, with a devoted following in the new generation.

A. S. W.

LIEUT.-COL. H. T. MORSHEAD, D.S.O., R.E.

ON May 17, Col. Morshead, of the Survey of India, was shot dead while riding in the jungle near Maymyo, the hill-station of Burma. He was forty-eight years of age, and his death deprives the Government of India and its Survey Department of an officer whose special attainments and rare experience had proved of frequent advantage.

To the north of India lies the mountain mass of Tibet: its people belong to the Mongolian family, but they have been shut off by their mountains from the outer world for many centuries, and they have developed a language that differs from both Chinese and Burmese.

Col. Morshead was a skilled mountain surveyor and a Tibetan linguist; and his boyish, modest charm of manner won for him the friendly confidence of Himalayan hill-tribes. The value of such a man has been great, and the discoveries which he made have led to scientific advances in Himalayan geography.

In 1901, when he was nineteen years of age, Morshead passed out of Woolwich Academy and received a commission in the Royal Engineers. In 1904 he was ordered to India, and was posted to Dehra Dun: he was there employed on the designs and construction of new lines for the Gurkha Regiment. Dehra Dun is a cantonment situated in the outer Himalayas, and when Morshead found himself surrounded by mountain peaks, the instincts born in him were stirred. An office of the Survey of India is at Dehra Dun, and Morshead, though modestly doubtful of his own qualifications, began to envy his brother officers who were employed on the Survey. His inclinations were towards exploring, and the idea of taking theodolite observations from hill summits seemed to him a glorious prospect. He was posted to the Survey of India in 1906, and except for the three years 1915 to 1918, when he served in the trenches in France, his whole career from 1906 to 1931 was passed in the Survey.

In 1912 the Himalayan peak of Namcha Barwa was discovered by Captains Morshead and Oakes. This discovery was the most important advance that had been made in Himalayan geography since the height of the Kashmir peak Nanga Parbah was determined in 1855. No high snow peak had been found by the Survey in the Assam Himalaya east of Bhutan. In 1880 the Surveyor-General of India had come to the conclusion that the Assam Himalaya carried no peaks above 20,000 feet. The height of Namcha Barwa is 25,455 feet; like Mount Everest, it is not visible from the plains of India, being concealed by intervening hills. Its discovery has led to the prolongation of the Great Himalayan crest-line for 300 miles.

In 1913, Capt. Morshead and Capt. F. M. Bailey discovered the gorge where the Tsangpo river, of Tibet, escapes from the highland through the Himalayan range.

In 1921, the Mount Everest expedition was organised by the Royal Geographical Society and by the Alpine Club. Col. Howard Bury was in command of the expedition, and Morshead was attached to it as a surveyor. His knowledge of the Tibetan language proved of great service on this expedition. An authority on the Tibetan language had been led to believe that the six names for Mount Everest and its surrounding peaks were recorded in a book of Tibetan ritual, and he was confirmed in this view by Tibetans from the district. But Morshead when in the field with the Mount Everest expedition had learnt from local Tibetans the six Tibetan names of the peaks of Gaurisankar, which are thirty-six miles from Mount Everest. When the names from the book of ritual came to be compared with Morshead's names obtained by him from the people on the spot, it was found that the book of ritual had been incorrect in applying these names to Mount Everest.

When we are looking back upon an officer's career, we recall his scientific achievements. But now that Col. Morshead has been suddenly cut down in all the vigour and activity of middle age, the thoughts of his brother officers turn not to his successes, great as they were. The sorrow which they feel for his widow and children, to whom he was so devotedly attached, fills their minds, and leads them even to forget for the moment the services he rendered to geography. S. B.

MR. HERBERT TOMLINSON, F.R.S.

THE death on June 12 of Mr. Herbert Tomlinson will bring to the minds of many of our older physicists the kind of work that engaged the attention of the research workers of the late Victorian days. Mr. Tomlinson was born in 1845 and went to St. Peter's School, York, from which he gained a scholarship at Christ Church, Oxford, where he studied mathematics and physics, receiving the B.A. degree in 1868. This appears to have completed his connexion with Oxford, for he never took his M.A. degree.

Shortly after graduating, Mr. Tomlinson went as a demonstrator and lecturer under the late Prof. Grylls Adams at King's College, London. His work enabled him to devote much time to research, which he followed most assiduously until about 1890. The subjects that specially attracted him were the various properties of matter, and a reference to the *Proceedings of the Royal Society* shows that in 1886, for example, he investigated the viscosity of air, the internal friction of metals and the effects of temperature and magnetism on this friction, and the velocities of sound in wires. Such subjects formed the matter of many extensive papers in the Royal Society's *Transactions*, and for this work he was elected a fellow on June 6, 1889. Among the others elected at the same meeting were: John Aitken, Horace T. Brown, Latimer Clark, Prof. McKenny Hughes, and Prof. Sollas.

In 1894, Mr. Tomlinson gave up the work at King's College for the post of principal of the newly built South-Western Polytechnic at Chelsea, and this work in technical education absorbed his activity until 1904. Among the many classes that he instituted was a Saturday morning class for team work in research. He and a number of the more advanced students met for the purpose of a united attack on some problem in elasticity or magnetism. The results were difficult to utilise, for although an experienced research worker himself, his assistants could claim but little facility at practical work.

In 1904, Mr. Tomlinson gave up the principalship and retired to Bexhill, where he devoted much time to wireless telegraphy, then in its infancy. It was characteristic of him that when he left London he told the present writer that he would never revisit it; and so far as the writer knows, he kept his word. Unfortunate circumstances deprived him of his small fortune, and as he was ineligible for any educational pension, he received a Civil List pension for his scientific work. During the War he served for a time as a science teacher at Lancing College.

Mr. Tomlinson was a man of intense devotion to a task that interested him, but he had also the capacity of putting aside a subject and taking up another with equal intensity. He was a most pleasant and cordial principal and received the devotion of his staff and students. The late Prof. Reinold was one of his most intimate friends, but he was not known to many of the younger school of physicists. His work was of importance in tracing the changes in properties of matter under varying conditions, and he brought to general notice many of these properties, which at his time were little appreciated. S. S.

DR. KARL BĚLAŘ.

WE regret to announce that Dr. Karl Bělař, of the Kaiser Wilhelm Institut für Biologie, Berlin, was killed in a motoring accident near Victorville, California, on May 24. He was returning with friends from a collecting trip in the Mohave Desert. Dr. Bělař's death at the age of thirty-six years is a tragic loss to the science of cytology. He combined a zeal for experiment and observation with a quite remarkable gift for the artistic expression of their results. After he left his native country, Austria, he was chiefly occupied with studies on animal cytology at the Kaiser Wilhelm Institut and at the Zoological Station at Naples. He was privat-dozent in zoology at the University of Berlin and a secretary of the Genetical Congress held there in 1927. In 1928 he was invited to the John Innes Horticultural Institution, where he spent two months that were highly profitable to all with whom he came into contact. In 1929 he was invited to visit the newly equipped California Institute of Technology, where he has since collaborated with the Morgan school of geneticists. He was about to return to Europe at the time of his death.

Bělař will be chiefly remembered for his masterly review of the behaviour of the nucleus in the Protista, and for his text-book of genetical cytology. In both these works, by critical analysis of discordant observations, he went a long way in reducing confusion to order. He contributed the article on Protozoa to the present edition of the "Encyclopædia Britannica". He will also be remembered for his remarkable ability in handling living and fixed cells. His technique (and his untiring industry) enabled him to show most satisfactorily the relation between what we see in permanent preparations and what is present in the living cell.

Bělař's friends in Great Britain and abroad will not easily forget the zest he put into his studies and the charm with which he instructed those less skilful than himself. C. D. D.

MISS ANNE L. MASSY.

ON April 16, after a few days' illness, Miss Anne L. Massy died at Howth, Co. Dublin. Living in her earlier years in the neighbourhood of that classical collecting ground of the old conchologists, the Velvet strand near Malahide, she soon acquired a very thorough knowledge, for an amateur, of the Irish marine mollusca, and when, in 1901, she was employed by the Irish Fishery Department in connexion with its biological work under the late E. W. L. Holt, her field of research was widened and she rapidly put herself in touch with the most recent systematic work on the Mollusca, taking a special interest in the pteropods and cephalopods.

With great industry and with that unconscious appreciation of differences and resemblances indispensable to a systematic worker, Miss Massy worked steadily through the Irish fishery collections and published from time to time papers containing sound original work on Atlantic pteropods, deep-water and pelagic cephalopods, brachiopods, holothurians, and other groups. Later, as a more independent worker, she published several papers on collections from other parts, amongst which may be mentioned the *Terra Nova* Reports on Cephalopoda and Pteropoda; a very useful paper on the Cephalopoda of the Indian Museum (1916), useful papers on South African Cephalopoda, and an account, in collaboration with Mr. G. C. Robson, of the remarkable sexual dimorphism in *Doratosepion*.

Apart from marine studies, Miss Massy was keenly interested in birds, and for many years acted as honorary secretary to the Irish Bird Protection Society. Her death, unexpected and all too soon, takes away a careful, critical, and efficient though retiring zoologist with no ambition but to do her work thoroughly, and a valued friend to all who knew her.

WE regret to announce the following deaths:

Prof. S. W. Beyer, dean of the industrial science division of Iowa State College, known for his work in economic geology, on June 2, aged sixty-six years.

Prof. F. Wigglesworth Clarke, formerly chief chemist of the United States Geological Survey, honorary member of the Chemical Society and foreign member of the Geological Society, on May 23, aged eighty-four years.

News and Views.

IN his presidential address to the British Association at Oxford in 1926, and on many other occasions, the Prince of Wales has shown that he is fully aware of the part that scientific research and invention can play in promoting the welfare of the human race. He returned to the subject in the course of his presidential address to the Congress of the Universities of the Empire, delivered in Guildhall on July 3. "It is borne in upon us daily more clearly", he said, "that the material progress of mankind will depend in an ever-increasing degree on the application of modern science to modern industry". In our leading article this week (p. 45), we have dealt with the chemical industry of Great Britain, and it is shown that while it is suffering from the present world-wide economic depression, yet it has suffered less than other industries. It owes its position to the technical progress which has been made, and to appreciation of scientific methods in research, management, and salesmanship. Here is an immediate justification of the Prince of Wales's remarks, if such be needed. By his wide travels within and beyond the British Empire, the Prince has had unrivalled opportunities of acquiring broad views of men and affairs. This gives added weight to his words, which will, we hope, help towards a fuller recognition of the value of the scientific worker to the community. At the same time, the scientific worker must himself be prepared to take his share of civic responsibility, as indeed in most cases he is fully competent to do.

Two American aviators, Messrs. Post and Gatty, landed in New York on the night of July 1, having flown round the earth on a 'small circle' course in the northern hemisphere, in nine days. The approximate length of the flight was 16,000 miles, the longest single day's 'hop' being 2500 miles from Khabarovsk to Solomon, Alaska, crossing the Bering Strait. The machine used was an American-built Lockheed "Vega" specially prepared for fast long-distance flying. This has been hailed by the press generally as a flight round the world—a misnomer, in that a passage round the globe on a 'great circle' course would have needed a flight of approximately 24,000 miles. As a feat of physical endurance on the part of the crew this performance is probably unsurpassed, but it was carried out on a special machine and in such a manner that it does not prove that such flights are yet commercially possible, or that the repetition of such risks is even advisable. It is, however, a tribute to the steady technical improvement in aeroplane and aero engine design. The only previous occasion of a similar flight was in 1924, when it was attempted by four U.S. Army aeroplanes. Only two completed the journey, after considerable delay due to the necessity for many repairs and the substitution of several new engines *en route*.

ACCORDING to a dispatch from the Paris correspondent of the *Times* in the issue of June 29, the Public Prosecutor of Cusset has reported in favour of dropping the prosecution for fraud against M. Émile Fradin, who was responsible for the discovery of inscribed clay tablets and other alleged antiquities at Glozel. The Public Prosecutor finds that there is no evidence to show that M. Fradin was responsible for placing these objects in the ground, and further that, as he did not profit, it would not be possible to maintain an action for fraud, as it must be shown that the deceit was practised for profit. The report, which must of course be accepted as in accordance with the principles of French law, is, to say the least, unfortunate from the point of view of the archæologist, if, as it suggests, it means that anyone is at liberty to foist an impudent imposture on an unsuspecting public, provided care is exercised to avoid the appearance of direct financial gain. It must be obvious that many advantages might, and indeed did, accrue to the Fradins and those associated with them, even if up to the time the bubble burst they had not actually exploited financially any of their 'precious' finds.

CITRUS growing in Southern Rhodesia is yet in the early stages; the total export for the year 1930 was 170,000 cases, 91 per cent of which was grown on the British South Africa Company's estates. The directors of this Company, which owns more than one half of the present plantings in this Colony, have adopted the policy of basing the industry on scientific research. With this object in view, they have increased the research staff in Southern Rhodesia, and on April 1 created a citrus experimental station of their own, with headquarters on the Mazoe Citrus Estate. The director of this station is Dr. W. J. Hall, assisted by a staff consisting of a chemist, plant pathologist, entomologist, and research horticulturist. Adequate laboratories are nearing completion, and will be suitably equipped, and a large plot of land has been allotted for use as an experimental plot for all field experiments. The prime function of the station is research, and all work undertaken will be in accordance with the practical needs of the citrus industry in Southern Rhodesia. Some of the major lines of investigation will be to establish those varieties most suitable to local conditions; improvement of strains by continuous and intensive bud selection; investigation of stock and scion relationships; the entire manurial programme; breakdown and wastage in transit; study of plant diseases and insect pests with the view of devising control measures and reducing the losses from their causes to a minimum. It is hoped to print an annual report, and also to publish from time to time such results as may appear worthy of record.

DELESSERT, in his work "Voyages dans les Deux Océans", published in 1848, says on p. 94, when referring to parrots in Australia, that the budgerigar (*Melopsittacus undulatus*) is the rarest and most charming, and that it is most amusing to hear it speak, which it can easily be taught to do. Gould, eight years before, had taken to England what he believed were the first living specimens to be imported: abundant importations soon followed, but the bird has turned out to be so readily bred in captivity that for a good many years now, until the recent ban on the importation of parrots, owing to the fear of psittacosis, the market was chiefly supplied by French-bred specimens, which were finer than the Australian-caught birds. Yellow varieties have been recorded among the wild Australian stock, and this variation has long been fixed among the tame birds. A blue form had been heard of here, but passed almost into a legend among aviarists, having originated in Belgium so long ago as 1880. In 1910, it was exhibited in London, and aroused very keen interest, which was renewed by further introductions after the War. Blues were eagerly sought for and bred, either pure or crossed with greens, which dominated this colour as well as yellow. Cross-bred budgerigars, on the whole, conform to Mendelian expectation, but the main interest of the impetus given by the new colour and the ban on parrot importation is that the birds are now often taken when young and taught to talk, showing, according to accounts which have recently appeared in *Cage Birds*, as much proficiency as an average grey parrot. A thoroughly domesticated creature which can be taught to speak should be of interest to any laboratory of eugenics, and the budgerigar is as clean and frugal as it is attractive, so that it is ideal for experimental breeding.

THE Committee on Organisation of the Sixteenth International Geological Congress has decided to postpone the meeting of the Congress for a year, to the latter part of June 1933. It was felt that the generally adverse economic conditions throughout the world made this postponement desirable. The following topics for discussion have been tentatively adopted: Measurement of geological time by any method; batholiths and related intrusives; zonal relations of metalliferous deposits; major division of the Palæozoic system; geomorphogenic processes in arid regions and their resulting forms and products; fossil man and contemporary faunas; orogenesis. The routes of the excursions have been selected and work is well advanced on the preparation of the guide-books. A series of excursions before the Congress of from five to twelve days in length will cover the eastern and central States. These will, so far as is possible, be arranged to appeal to specialists in various branches of geology. There will also be a number of short excursions in the vicinity of New York. During the session of the Congress, which will last about a week, several short trips will be made to points of interest in the vicinity of Washington. The excursions after the Congress will include two in the north-central States—one for glaciologists in Illinois, Iowa, and Wisconsin, and the other for mining geologists in the Lake Superior iron and copper districts, each of about ten days duration—and two transcontinental trips, each of about thirty-five days. Further particulars can be obtained from the Secretary, Sixteenth International Geological Congress, U.S. Geological Survey, Washington, D.C.

"CRIMINAL STATISTICS", being the statistics relating to crime, criminal proceedings, and coroners' investigations for the year 1929 (London: H.M. Stationery Office, 1931. 3*s*. 6*d*. net) raises some interesting problems. It is impossible to follow up all the questions suggested, but one that must be of importance to everyone is the significant relation between crime and industrial depression. The report states that even in normal times there are certain differences between the incidence of crime in industrial areas and non-industrial areas. In 1921 the incidence of crimes against property and of sexual offences was higher in the north of England than in the south, although in crimes of violence against the person it was slightly lower. In 1929 the position in the north had become relatively worse; although the population had increased only by 4 per cent, while that of the south had increased by 5 per cent, yet the increase in the incidence of all classes of indictable offences was 34 per cent as against 24 per cent in the south. The report suggests that the reason is the state of industrial depression from which the north of England is suffering. Analysis of the ages of the offenders shows that the incidence of crime among men above thirty years of age has not increased, but that as regards boys under sixteen years of age, the number found guilty in the north of offences of dishonesty is much higher than in the south. Industrial depression introduces conditions particularly detrimental to the young in destroying the direct incentive of good prospects, quite apart from the bad effects of idleness or inadequate work. The hope is expressed in the report that, when trade and industry improve, this kind of crime will diminish.

IN the last number of the *Archives de l'Institut de Paléontologie Humaine*, Prof. Charles Fraipont, of Liège, has published a memoir on the "Cerebral Evolution of the Primates, with special reference to the Hominidæ", which he dedicates to the distinguished editor, Prof. Boule, whose anthropological views he, for the most part, adopts. Although references are made to the works of Dubois and Tilney, the author seems to be unacquainted with the significant researches on the distinctive attributes of the human brain and their biological significance which have been accomplished in Great Britain, the United States, Germany, Austria, and other countries, besides those in France and Belgium, during the last thirty years. If Prof. Fraipont had made himself acquainted with these works he would scarcely have made such surprising claims as he puts forward in this memoir. Among other bizarre arguments, he states that the refinement of the hand made possible the reduction of the muscles and bony parts of the face, and that the latter changes permitted the hypertrophy of the frontal lobes of the brain, and consequently the emergence of human intelligence. There are some excellent photographs and radiograms of the bones of the leg to illustrate the evolution of the lower limb in apes and men.

M. FERDINAND LOT in his Sir John Rhys Memorial Lecture for 1930 on "Bretons et Anglais aux V^{e} et VI^{e} siècles", which has recently been issued by the British Academy (London: Oxford University Press,

1931. 1*s*. 6*d*. net), refers to the sources of information on this period in terms which fully justify our recent comments in these columns on the suggestion put forward by the editor of *Antiquity* that a chair for the study of English archæology is badly needed. He points out that, with the exception of Gildas, there is no literary authority of weight for the invasion and early years of domination of the Saxons in England; and that study of archæological remains and their distribution alone, within certain limitations, will afford any basis for our knowledge of the relation of Saxon and Briton in this and the succeeding period. Yet, as M. Lot points out, the fact that the Saxons found a place of refuge in England where they were able to develop an independent political and economic life of their own undisturbed, while other migrant peoples on the Continent were unable to find any settled resting-place, constitutes the Saxon invasion of Britain as one of the most important events in the history of the world. This, which a moment's reflection will show is no exaggeration, makes it all the more remarkable that so little provision should be made for systematic study of the earlier stages of Anglo-Saxon and English culture.

FROM the fourth annual report of the Australian Council for Scientific and Industrial Research it is evident that important results of economic value have already been obtained, and that the necessity for further development along scientific lines, if prosperous conditions in the Commonwealth are to be restored, is fully recognised. Through the discovery of methods for controlling plant disease, notably in the cases of bitter-pit in apples and bunchy top in bananas, large savings have already been made. The eradication of weed pests such as St. John's wort and prickly pear, by means of the introduction of insects which feed upon these plants, continues to prove amazingly successful, the monetary value of this line of work amounting to millions of pounds. The outstanding achievement in connexion with animal research is the discovery of an effective vaccine against black-disease of sheep, and animal nutrition investigations, though but recently begun, are already yielding valuable results. Since the establishment of the Council's Viticultural Research Station at Merbein the yield of dried fruit per acre has been doubled and the quality considerably improved. Marked success has also attended the division of forest products research, satisfactory paper pulp being obtained from hardwoods previously regarded as entirely unsuitable for this purpose. Many other fundamentally important lines of research are being carried out, and, to quote from the report, " it is obvious that, despite its comparatively recent formation, the Council has already been responsible for large national savings many times greater than its annual cost, and that its possibilities in the not far distant future are even greater."

METEOROLOGISTS have not yet succeeded in giving a clear account of the general circulation of the earth's atmosphere, that is to say, of the distribution of the prevailing winds at various seasons. It is true that the main features of the surface circulation are known, and that attempts have been made to show the circulation at greater heights by deductions based on surface pressure and temperature and the known relationships between horizontal pressure gradient and wind. Such theoretical representations cannot be accepted indefinitely as a substitute for accounts based on actual observation. On land, owing partly to the stimulus received from the needs of aviation during the War, the gaps in our knowledge are gradually being filled by organised exploration with the aid of pilot balloons. One is glad to learn from an article by Commdr. L. G. Garbett, superintendent of the Royal Naval Meteorological Services, in a recent issue of the *Marine Observer* (No. 91), that our very scanty knowledge of upper winds over the oceans is being rapidly increased by systematic observations undertaken on a number of His Majesty's ships, according to a scheme initiated in 1925. During 1931 no fewer than 1500 observations are to be made in various parts of the world, and this year's programme is to be repeated during forthcoming years. The observations are being received at the Meteorological Office, Air Ministry, and are to be shown graphically on a network of 'squares' measuring 10° in latitude and longitude. The soundings frequently extend up to a height of 20,000 feet when clouds do not interfere, and one made in Australian waters reached 49,000 feet, that is to say, nearly the same level as that to which Prof. Piccard ascended recently. In some instances, measurements of temperature are made. The accumulated material will be available at the Air Ministry for consultation by aviators and for meteorological research.

ONE of the great advantages of an electrical supply is the ease with which it can be applied to provide labour-saving devices. The switches for electric fires are now frequently fixed so that without moving the armchair it is possible to turn it on, regulate the heat it gives out, and turn it off. There is no domestic drudgery involved. At first sight some of these labour-saving devices seem almost unnecessary. For example, when measuring the insulation resistance of a network a voltmeter reading has to be divided by an ammeter reading. The arithmetic involved is very simple, but there is a device in much demand which by placing the pointers of the instruments on opposite sides of the same dial tells the resistance by noticing their point of intersection and seeing the curve on which it lies. Similarly, on the dashboard of electric motor-cars the ammeter and voltmeter pointers by their point of intersection indicate the horse power expended on the car. Ingenious experimenters have recently invented devices for shutting and opening windows by pressing buttons, and devices for regulating and controlling their radio-receiving sets from a distance are coming into use in America. Many devices with this end in view are described in the *Wireless World* for June 17. It is well known that most set owners only listen in to a few stations. One device consists of a small metal box on the top of which is a set of six buttons. Two more buttons turn the receiver on or off, and a slight pressure on two other buttons varies the volume of the sound. A tiny lamp lights when the set is in operation, and indicates by its varying brilliancy whether a station is tuned in to its most sensitive point on the dial. In elaborate installations in large mansions a more complex dialling system is used. In Great Britain the commonest arrangement is a switch which allows the user to turn off his set the last thing at night without getting out of bed.

THE *Transactions* of the Institute of Marine Engineers are issued in monthly parts, and these include many articles from the technical press which are of interest and value to the members, who, owing to the nature of their calling, can seldom visit libraries. The inclusion of these notes has caused the volumes to become rather bulky, and so with the commencement of vol. 43 the size of the pages has been doubled. It is now 11 in. by 8½ in. and corresponds with the size of the *Transactions* of the Institution of Naval Architects. The alteration is a great improvement and will be appreciated by all who read the *Transactions*. Of the two monthly parts issued in the new form and size, that for February contains the paper on the "Electrical Equipment of a Modern Ship" read by Mr. J. E. Allan on Jan. 13, while that for March contains the paper on "Water Tube and/or Scotch Boilers" read by Mr. H. E. Yarrow and S. Hunter, jun., on Feb. 10. Both papers are accompanied by a full report of the discussions. The February issue also contains a portrait of the late Sir Charles Parsons, who was a past president of the Institute. The Institute took a foremost part in arranging the memorial service held on Mar. 22 in St. Botolph's, Aldgate, to commemorate the centenary of the death of William Symington, the father of marine engineering, whose death took place in a house in Burr Street not far from the spot now occupied by the headquarters of the Institute.

THE Engineering Experiment Station of the University of Illinois includes a locomotive laboratory in which tests of service locomotives can be made. Such a laboratory is urgently needed in Great Britain and has, for some time past, been under the consideration of a committee appointed by the Department of Scientific and Industrial Research and presided over by Sir Alfred Ewing. The laboratory at Urbana, Illinois, was described in *Bulletin* No. 82, of the University of Illinois Engineering Experiment Station, while a recently issued *Bulletin*, No. 220, describes the tests of a Mikado-type locomotive equipped with Nicholson thermic syphons, conducted in co-operation with the Illinois Central Railway Company and the Locomotive Firebox Company. A syphon is a supplementary water leg or circulating chamber riveted to the roof of the firebox and the bottom of the tube plate to stimulate the circulation of the boiler water and increase the transfer of heat. The results of the tests showed that the syphon-equipped locomotive possessed a definite and notable superiority over the non-syphon engine as regards both evaporation per pound of coal and boiler efficiency. Under identical conditions of operation, the weight of steam generated per pound of coal would be on the average 8·5 per cent greater with the syphons than without them. There are at the present time about 13,000 syphons in service on American and Canadian locomotives. Copies of *Bulletin* No. 220 can be obtained from the Engineering Experiment Station without charge.

A GREAT collecting expedition to Australia is announced by Science Service, of Washington, D.C. Harvard Museum of Comparative Zoology is determined that its collection of Australia's rare and strange animals shall be one of the largest and best-balanced collections in the world. To that end an expedition, led by Prof. W. M. Wheeler and having the advantage of the presence of Dr. Glover M. Allen, is to leave New York on July 25. The expedition is to be in the field for a year, and is to visit many isolated and little-explored faunal areas in Australia and Tasmania. In addition to mammals, birds, reptiles, insects, and other forms of animal life will be collected. We wonder how long the rare animals of the world will survive the tax of scientific collecting expeditions, and when the museum scientific worker will act on the principle that more is to be learned by studying creatures alive in their native haunts than by measuring their skins in a laboratory. We trust, in any case, that Australia will see to it that the 'bag' of the really rare creatures is strictly limited; for a bird in the bush, in such a case, is worth two in the hand.

IN continuation of its work for the good of mankind, the Institut International de Co-opération intellectuelle, Paris, has published an account of the organisation and activities of "Instituts Nationaux à l'Étranger". The brochure, of 124 pages, includes the names of two categories of institutions: research institutes established by any country in a foreign land, and institutes established in foreign lands to spread there a knowledge of the language and civilisation of the founder country. The objects of the institutes, their personnel, mode of subvention, date of origin, and publications are summarised—a first attempt to give a comprehensive survey of those scientific foundations in foreign lands, which not only make their contributions to scientific knowledge, but also, since they form centres of international scientific collaboration, add to the comity of the nations. Of the 87 research institutes, founded by 16 different countries in 25 other lands, Great Britain claims only 8, a poor figure compared with the 12 representing the United States, 17 representing Germany, and 24 representing France.

AN exhibition of the finds of Mr. Guy Brunton's expedition to middle Egypt during the past season opened in the Nimrud Gallery of the British Museum on July 2. A large number of objects from the earliest pre-dynastic periods, and from the sixth to twelfth, the nineteenth to twenty-sixth dynasties, and the Christian Coptic period of about A.D. 300–500 are shown. The 'Tasian' and 'Badarian' objects include a fine well-preserved black ripple bowl. An 'Amratian' bowl of red-painted ware has a crocodile and a number of small hippopotami moulded on the rim. Other Amratian objects include a number of anthropomorphic amulets of ivory and slate palettes of various forms, including birds and fishes. There is a large number of beads of various periods. The Coptic objects include a number of shoes, some of which had belonged to children.

THE New International Association for Testing Materials (N.I.A.T.M.), which was formed as a result of meetings in Amsterdam in September 1927, will hold its first congress in Zurich next September. The president is Prof. A. Mesnager. The work of the congress will be divided among four groups, namely, (a) metals, chairman, Dr. W. Rosenhain, of the National Physical Laboratory; (b) non-metallic inorganic materials, chairman, Prof. M. Roš, of Zurich; (c) organic materials, chairman, Prof. J. O. Roos, of Stockholm; and (d) questions of general importance, chairman, Prof. W. von Mollendorf, of the Staatliches Materialprüfungsamt, Germany. The proceedings will commence on Sunday evening, Sept. 6, with a reception in the Zurich Polytechnic and addresses by the president and others. The sections will meet each day in the Polytechnic, the plenary session taking place on Friday afternoon, Sept. 11. Visits to works, excursions to places of interest, and various entertainments are being arranged. Particulars of the travelling arrangements and hotel accommodation can be obtained by members affiliated to the British branch of the N.I.A.T.M. from Mr. G. C. Lloyd, 28 Victoria Street, London, S.W.1. The autumn meeting of the Institute of Metals will also take place in Zurich in the week commencing Sunday, Sept. 13—that is, immediately following the Congress of the N.I.A.T.M.

THE tenth annual conference of the Institut International de Bibliographie will be held on Aug. 25–29 at the Hague. In addition to the presidential address, by Prof. A. F. C. Pollard, and the reports of the secretaries, more than a score of papers will be presented. Although the activities of the Institut embrace all branches of knowledge, scientific and technological interests are very well represented, as is shown by the following selection from the papers: "Le rôle et l'Organisation de la Documentation de la *Revue Générale de l'Électricité*", by E. Beinet; "Probleme der bibliographischen Praxis", by Dr. Julius Hanauer, of the A.E.G.; "L'Organisation de la Documentation dentaire par la F.D.I.", by Dr. Émile Huet, delegate of the International Dental Federation; "Rapport sur le 'Repertorium Technicum'", by J. M. C. Muller, Bataafsche Petroleum Company; "International Abstracting and Indexing of Scientific and Technical Literature", by Sir Frederic Nathan; "Aufgaben und Organisation eines Referatenorgans", by Dr. Maximilian Pflücke, of the *Chemisches Zentralblatt*; "The Bibliography of Physiology and the Application thereto of the Decimal Classification", by Dr. J. G. Priestley (Oxford); "La Classification décimale dans le Domaine de la Médecine", by Dr. René Sand, Ligue des Soc. de la Croix Rouge. In addition to the more serious business of the Conference, a very interesting programme of receptions and visits has been arranged. Full particulars may be obtained from the Secretariat, Institut International de Bibliographie, Carel van Bylandtlaan 30, La Haye, Netherlands; or from the honorary secretary, British Society for International Bibliography, Science Library, South Kensington, S.W.7.

THE following have been elected foreign members of the Royal Society: Prof. Charles Fabry, of Paris, distinguished for his work in connexion with the modern interference methods in spectroscopy and the modern system of wave-length standards; Dr. Emmanual de Margerie, of Strasbourg, distinguished for his work on the tectonic geology of parts of France and especially of the Pyrenees; and Prof. Heinrich Wieland, of Munich, distinguished for his work on organic chemistry.

THE Right Hon. Sir Herbert Samuel, M.P., has accepted the presidency of the British Institute of Philosophy in succession to the late Lord Balfour. Distinguished lecturers during the forthcoming session will include: Sir James Jeans, Prof. S. Alexander, the Dean of St. Paul's, the Archbishop of Armagh, Prof. J. S. Haldane, and Dr. C. D. Broad.

WE regret that a misprint has appeared in the letter entitled "Ultra-Violet Absorption and Raman Effect for Hydrazine" by S. Imanishi in NATURE of May 23, p. 782. The line 1120 is attributed to the N-N (single bond) vibration in the hydrazine molecule and not to the N-H vibration as stated in line 34 of the communication.

IT is stated in a *Bulletin* of Science Service that Dr. L. O. Howard, formerly chief entomologist of the United States Department of Agriculture, will receive the Capper award for 1931. This award consists of a gold medal and a cash purse of five thousand dollars. It was founded by Senator Arthur Capper of Kansas, and is given each year to a scientific worker who has made notable contributions to the progress of agriculture.

AN addition must be made to the list of zoological journals, with the appearance in December 1930 of the first part of volume 1 of the *Journal of Science of the Hiroshima University*, Series B, Div. 1 (Zoology). The first portion contains three papers by Yoshio Abe; two of these deal with mammals, and to them further reference will be made in our "Research Items". The journal is beautifully printed, both as regards text and plates, and it is announced that reports are to be published as they are received, and that each volume is to contain about 200 pages. Two of the papers in the first part are in German and one is in English.

THE issue of the *Quarterly Journal of Microscopical Science* for April contains an article of eighteen pages by Prof. E. S. Goodrich on the work of the late Sir Ray Lankester, which gives an excellent review of the chief points in the long series of his published works. Lankester's first papers, on Gregarines and on Tubifex, appeared in 1863, and his subsequent publications ranged over almost all the principal classes of the animal kingdom. The article brings out clearly the great part Lankester played in the progress of zoological science, and incidentally indicates how many of the terms employed in modern zoology and embryology are due to him.

The first three numbers of a new publication which abstracts the current papers on plant genetics (with the exception of herbage crops) have now appeared. They are published from the Imperial Bureau of Plant Genetics (School of Agriculture, Cambridge) and are issued quarterly at a price of 5*s.* per annum, or 1*s.* 6*d.* for single copies. The three numbers contain respectively 23, 36, and 52 pages, and will be of much service to all workers in plant genetics. In the abstracts, particular attention is given to practical developments in plant breeding and to the genetics of economic plants, but papers of general or theoretic interest are included.

The Faculty of Medicine of the Egyptian University, Cairo, has published a volume of 506 pages entitled "The Bibliography of Schistosomiasis (Bilharziasis), Zoological, Clinical, and Prophylactic". It has been compiled by Mohamed Bey Khalil, professor of parasitology in the University, and is divided into an alphabetical index of authors (232 pages) and a classified index of subjects. The Schistosomes constitute a family of the Trematoda or flukes, of which three species attack man and others are met with in other animals. The history of schistosomiasis commenced with the discovery of *Distomum hæmatobium* as the cause of endemic hæmaturia (urinary hæmorrhage) in Egypt by Theodor Bilharz in 1851, a half-tone plate of whom forms a frontispiece to the volume. The bibliography is a monumental piece of work, creditable alike to the author, the University authorities, and the printers, Paul Barbey of Cairo.

The Ministry of Health has issued an eighth memorandum on cancer (*Circular* 1186). It deals with cancer of the lip, tongue, and skin, and an analysis of the recorded deaths by sexes shows that lip and tongue cancers are much more frequent in the male sex, but skin cancers are only slightly more prevalent among males if certain 'occupational' cancers (due to soot, tar, oils, etc.) be excluded. The curability and survival rate for lip and skin cancers are high, but for the tongue the results of treatment are much less favourable. With lip and tongue cancers, some irritative condition is a common antecedent, and syphilitic lesions of the tongue appear to predispose to cancer of this organ. There is nothing to incriminate ordinary tobacco smoking as a predisposing cause of cancer, provided the mouth and tongue are in a healthy condition. In the skin, warts, birthmarks, and scars are liable to develop cancer, but particular sources of irritation over a long period are the predominant cause of cancer, such as X-rays, tar and pitch, soot, certain mineral oils, arsenic, possibly heat rays, etc.

We have received from Messrs. Baird and Tatlo [illegible] (London), Ltd., a copy of a book entitled "Anal [illegible] Reagents, Standards and Tests", which [illegible] recently issued in conjunction with Mess [illegible] and Williams. The book [illegible] common reagents, in each [illegible] tion. The use of the book will enable the chemist to check for himself the purity of the materials he purchases, and should prove very useful in analytical laboratories. Several organic compounds are included.

Messrs. Henry Sotheran, Ltd., 43 Piccadilly, W.1, have sent us part 1 of their "Catalogue of Exact and Applied Science" dealing with periodical publications, general and collected works, and mathematics. Nearly 2000 works are included and (as is usual with Messrs. Sotheran's catalogues) many valuable bibliographic notes are appended. The catalogue is one that should not be missed. Two further parts are promised dealing with astronomy, physics, geology and meteorology, chemistry and chemical technology, and engineering.

Applications are invited for the following appointments, on or before the dates mentioned:—A junior laboratory and lecture assistant in the physics department of the University of Manchester—Prof. W. L. Bragg, University, Manchester (July 14). An assistant under the Ministry of Transport (Roads Department) for work in connexion with road traffic —The Establishment Officer, Ministry of Transport, Whitehall Gardens, S.W.1 (July 14). A probationary tutor in economics and allied subjects at University College, Nottingham, for extra-mural classes—The Registrar, University College, Nottingham (July 15). A lecturer in the Department of Chemical Engineering of University College, London—The Secretary, University College, London, Gower Street, W.C.1 (July 17). A chief librarian and clerk to the Library Committee of the County Borough of Ipswich—The Clerk to the Library Committee, Central Public Library, Ipswich (July 18). An assistant lecturer in mathematics in the University of Manchester—The Registrar, University, Manchester (July 20). An assistant superintendent of classes for instruction in the principles of boot and shoe manufacture, under the Northamptonshire County Council Education Committee—The Secretary for Education, County Education Offices, Northampton (July 20). A temporary assistant lecturer and demonstrator in botany at the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (July 23). A tutor of psychology and philosophy at Loughborough College—The Registrar, Loughborough College, Leicestershire (July 25). A temporary technical assistant under the Directorate of Ordnance Factories of the War Office—The Permanent Under-S [illegible] of State for War (C.4), War Office, Whit [illegible] ig. 1). *A head of the Depart-* m [illegible] nd Rubber Technology of the [illegible] —The Clerk, Northern Poly- [illegible] A woman senior assistant [illegible] information bureau of the [illegible] Flour Millers—The [illegible] ciation of British [illegible] Albans. Two [illegible] of Ballistic [illegible] ich—

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Influence of Hydrogen on Chemical Changes in Silica Vessels.

CHEMICAL literature has of late contained several references to the influence of adsorbed hydrogen on silica on chemical changes taking place in silica vessels. At the same time the fact that silica, at moderately high temperatures, takes up very large quantities of hydrogen is stressed, and it is assumed that this hydrogen is adsorbed, that is to say, exists as a film on the gas-glass interface. However, the following experiments seem to indicate that this is only a part of the story.

During the past year we have been studying the condensation of ethane at 600°, by heating the pure gas, generally at concentration of 0 025 gram molecules per litre, in sealed silica tubes for periods up to eight hours. During the first few minutes a part of the ethane is decomposed into ethylene and hydrogen; but when equilibrium conditions are approached this reaction slows down, so that the hydrogen content of the tube varies but little or not at all during the latter periods. Hydrogen plays no direct part in the secondary reaction, or reactions, which lead to the formation of methane and a condensate of aromatic compounds.

Now, though hydrogen plays no direct part in the secondary processes, it plays a very important indirect part; for if hydrogen is added to the ethane to increase the hydrogen content of the reaction mixture by a small amount, the rate of formation of condensate diminishes rapidly, and a relatively small increase in the hydrogen condensate inhibits the formation of condensate altogether. However, we will only refer to this point in passing.

Down to a few weeks ago we had carried out a large number of experiments, using about twenty different silica reaction tubes, and had come only to the conclusion that the hydrogen played some part in the reactions, which we were absolutely unable to understand or to control. We were unable to reproduce experimental results, though in two series of experiments an apparent regularity nearly misled us to the conclusion that the condensation of ethane was primarily a *unimolecular* process.

Reasons which we cannot set forth in detail led us, however, to adopt a method of experiment which gave results which we believe to be both new and interesting. We observed that the results were more erratic when we used thin silica tubing than when moderately thick walled tubing was used, suggesting that, since hydrogen can pass fairly rapidly through silica at 600°, the solubility of th [illegible] in the silica was a factor which must b [illegible] since the hydrogen in the adsorbed la [illegible] be in equilibrium with the hydro [illegible] d gaseous phases. We therefor [illegible] of experiments. In one, we [illegible] reaction tube, and heat [illegible] hydrogen to the reac [illegible] ing, cooling, and [illegible] The other was a [illegible] an outer tu [illegible] filled [illegible]

We suggest that the idea which led us to carry out these experiments is a correct one, and that in dealing with such materials as silica and palladium, through which hydrogen passes readily, the equilibrium system is rather a complex one, and consists of:

Glassy phase :: Glass-gas interface :: Gas-glass interface :: Gas phase

It is possible that in the solid or glassy phase the hydrogen may be more highly dissociated than in the gaseous phase, so that we have to consider the equilibria:

Glassy phase :: Glass-gas interface :: Gas-glass interface :: Gas phase

$$H_2 \rightleftharpoons 2H \quad \boxed{H_2 \rightleftharpoons 2H} \quad H_2 \rightleftharpoons 2H \quad \boxed{H_2 \rightleftharpoons H_2} \quad H_2 \quad \boxed{H_2 \rightleftharpoons H_2} \quad H_2$$

The hydrogen atoms in equilibrium in the gas-glass interface and in the gas phase may be so small as to be negligible; however, the life of hydrogen atoms passing out from the glass-gas interface into the gas-glass interface may be long enough to effect those processes which are commonly attributed to atomic hydrogen in the adsorbed layer (gas-glass) on the silica.

Now that we have been able to stabilise the silica-gas system, and to obtain reproducible results, we have been able to study another phenomenon, which is rather striking. The process of condensation of ethane with formation of methane and condensate appears to be catalysed and accelerated, so that, representing the amounts of product obtained as ordinates and time as abscissæ, the curve representing the change, in either case, has an upward tendency. Now over a range between 570° and 610° C., and at concentrations between 0·025 and 0·0125, and whether in the thick-walled tube or in the double-walled tube, the rate of formation of condensate or of methane undergoes so sudden a change after a period which is always almost exactly 2½ hours from the commencement of the experiment, that one is inclined to connect the phenomenon with some change of an *explosive* character such as all forms of silica undergo when changing from the α to the β form, or vice versa. What the nature of the change is we do not know, but we suggest that it may be a chemical change, facilitated by the fact that the silica surface, like the interior surface of all tubes, is in tension, when, as we now know, reactions can take place which general thermodynamic data would indicate to be impossible.

These matters are the subject of further investigations.

MORRIS W. TRAVERS.
LESLIE E. HOCKIN.
THOMAS J. P. PEARCE.

Department of Chemistry,
University of Bristol,
June 24.

The Composition of the Blood of Aquatic Animals and its Bearings upon the Possible Conditions of Origin of the Vertebrates.

FORTY years ago a suggestion was made (Bunge)[1] that the sodium chloride in the human tissues might be a relic, an inherited feature of some aquatic marine ancestor. The same idea was expressed in certain papers by Quinton,[2] who stated that so far as salinity [illegible] concerned the blood of most animals is an altered [illegible] water. In 1903,[3] Macallum, then unaware of the [illegible] stions of Bunge and Quinton, advanced the [illegible] that the blood plasma of vertebrates and [illegible] tes with a closed circulatory system is, in [illegible] a reproduction of the sea water [illegible] riod in which the prototypic present-day ocean as due to changes in the composition of the sea water since palæozoic or mesozoic times. Macallum followed up his first statement by more detailed papers, and made some valuable analyses of blood to support his thesis. He is now generally credited with being the originator of this interesting conception. In 1912 I discussed the matter[4] from the point of view of certain experiments and observations on marine and fresh-water invertebrates, and came to the conclusion that whilst one might accept the well-regulated saline composition of the blood of teleost fishes, amphibia, and the higher groups as being to a certain extent an heirloom of an ocean environment, there was no reason whatever to believe that the favoured salinity associated with independence represented the composition of any particular primeval ocean. At that time I stated that the investigations of osmotic regulation did not preclude the idea that the early vertebrates with an independence in blood salinity had evolved in fresh water.

Recent researches have gone far to confirm this view. It is now fairly well known that the blood of marine invertebrates resembles very closely in saline contents the sea water in which they live, and the concentration and composition is very dependent upon this medium. It is, however, becoming clear that these conditions only hold good in the sea. Marine invertebrates which have invaded brackish and fresh waters often present an independence of the blood which is not at all unlike that of the vertebrates. For example, in both the fresh-water crayfish and a frog immersed in water, there is a constant and controlled diffusion inwards of water and a regulated output from the excretory organs. A new fresh-water crab (from a river of New South Wales) with which we have been experimenting retains a constancy of blood salinity which is less than half that of the ocean from which it has undoubtedly wandered, yet its sojourn in fresh water cannot have been of long duration. During recent years, oceanographers and geologists have been more inclined to be conservative with their conceptions of increase in the salinity of the ocean since mesozoic or palæozoic times, and palæontologists are well disposed to the origin of the early vertebrates in fresh or brackish water. It does not really matter, however, from the present point of view, whether the ocean has become more saline or not. Comparative and experimental physiology gives little support to the view that the regulated blood salinities of the vertebrates represent the salinity of the media in which their ancestors evolved that constancy.

We can only accept the universal saline composition of the blood of *metazoa*—with its variations—as a possible reflection of a long-continued existence and probable origin in a saline medium.

W. J. DAKIN.

University of Sydney, May 16.

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[1] Bunge, "Lehrbuch der physiologischen und pathologischen Chemie". Leipzig, 1889.

[2] Quinton, "L'eau de mer, milieu organique". XIIIe Congrès intern. de Méd. de Paris Paris: Masson, 1900.

[3] Macallum, "Palæochemistry of the Ocean", *Trans. Canad Inst.*, 1904.

[4] Dakin, William J., "Aquatic Animals and the Constitution of the External Medium", *Internat. Revue d. ges. Hydrobiologie.* Leipzig, 1912.

Effect of Light on Urediniospores of Black Stem Rust of Wheat, *Puccinia graminis tritici*.

AT the Dominion Rust Research Laboratory, Winnipeg, the effect of ultra-violet light on the development of the rust organism has been studied by me. As a result of certain experiments, evidence was obtained that the pigment in the epispore of a normal urediniospore protected it from injury by ultra-violet light. The experiments in which this evidence was obtained were carried out in the laboratory, and the source of light was a mercury vapour sun lamp. These experiments were concluded and others were commenced out of doors, the source of light then being the sun.

As these experiments progressed, an interesting phenomenon was observed. Urediniospores of black stem rust, when dusted lightly on the surface of distilled water and exposed either to direct sunlight or very strong diffuse light, did not germinate, whereas similar spores kept under the same conditions in the dark germinated very readily.

On bright days during April and May experiments of this nature have been carried out and spores have been exposed for varying periods, generally from 9 A.M. until 4 or 5 P.M. The results have always been the same—the spores have not germinated until the light intensity was low.

At first it was thought that the spores had been killed by the ultra-violet light emanating from the sun. When, however, the dishes containing the spores were covered by ordinary glass, and also by a glass transmitting the ultra-violet rays, the same phenomenon was observed.

Other experiments were carried out to see if this inability to germinate was due to existing temperature or humidity conditions. When, however, the spores in the dark and the spores in the sunlight were under approximately similar conditions with respect to temperature and humidity, those in the sunlight did not germinate.

In no case when urediniospores have been dusted on the surface of distilled water has germination been observed to take place in strong sunlight. In the dark these spores germinated readily, and germination was well advanced within two hours. Moreover, when spores exposed out of doors were taken into the laboratory they germinated in a normal manner. In controlled experiments in the laboratory dark room, using ten hundred-watt lamps, it was noted that germination was higher the farther the spores were placed from the source of light.

It seemed clear, therefore, that the reason these spores did not germinate was due in some way to visible white light and the intensity of it.

Standard Wratten light filters were then used, and the spores were covered by these and exposed to sunlight. It was observed that the spores germinated abundantly under the green and blue filters, but that only occasionally did any spores germinate under the red, scarlet, orange, yellow, or purple filters. When the light intensities were low, however, germination took place.

To confirm this observation a prism was used to split the sunlight into its component parts, which were allowed to fall on spores contained in ring chambers. No germination took place at the red end of the spectrum. To confirm this, spores were dusted lightly on to the surface of different dyes, and it was observed that they failed to germinate on Congo Red when exposed to sunlight; but on Light Green germination took place. In both cases, in darkness, on solutions of the same concentrations they germinated normally.

Pursuing these observations, other filters were tried, chiefly of different greens and blues. It was noted then that germination decreased when certain green and certain blue filters were used. The more yellow in the green and the more light blue in the green the more pronounced was the inhibition.

In addition to spores of different physiologic forms of *P. graminis tritici* this same phenomenon—that is, the inability to germinate in sunlight or under red, orange, yellow, and purple filters when exposed to strong sunlight—has been observed with different physiologic forms of *P. graminis avenæ* and, at the present time, other fungal spores are being investigated. If it may be assumed that the mycelia react in the same way as the spore and its germ tube to light of different wave-lengths, then these observations suggest some very interesting possibilities.

In a letter such as this it is not possible fully to outline the complete observations of these preliminary investigations; in consequence the results so far obtained with certain of these physiologic forms of rust and with other fungi, will be communicated elsewhere, and the work will be continued.

W. A. R. DILLON WESTON.

Dominion Rust Research Laboratory,
Winnipeg, Man., June 1.

Ultra-Violet Rays and Mosquito Larvæ.

RECENT work which I have been conducting at this laboratory on the possible effect ultra-violet rays may have on the activation of ovarian function in female mosquitoes, has disclosed the fact that mosquito larvæ are highly susceptible to a remarkable form of injury by radiations from the unshielded mercury-arc generated by the ordinary Cooper-Hewitt vacuum type of quartz lamp.

Larvæ in water contained in open watch-glasses when exposed to the rays at 12 inches from the lamp immediately exhibit an intense irritation. After an irradiation of 3 minutes' duration there is evidence of partial paralysis, in that the larvæ show signs of slight ventral curvature while resting at the water surface; otherwise, they are apparently normal in their responses and swimming movements. However, if such larvæ are kept under close observation, the rapid development of a progressive type of injury is made evident within a few hours. The paralysis increases, the ventral curvature becomes more and more pronounced, and usually by 6 hours after irradiation severe injury to the internal tissues is distinct. The injury takes the form of a progressive histolysis of the connective tissue, muscles, fat-body, etc., first along the dorsal region of the thorax and abdomen, then gradually extending to the underlying tissues, until ultimately the larvæ, bereft of a large mass of tissues, present an astonishing appearance. The chitinous integument is itself unaltered, and consequently extensive internal spaces are formed where tissue histolysis has taken place. These spaces, filled with the fluid product of histolysis, are perfectly transparent except for the ramifications of the tracheæ, and finally, the still living larvæ are reduced to a condition where only a comparatively narrow band of tissues remain along the ventral region of the body. The larvæ are then practically immobile, lying at the bottom of the water-container, but the action of the heart continues feebly for some length of time, even after the respiratory system has completely collapsed by paralysis of the constrictor-dilator nerve-muscle mechanism.

Under the rays of a lamp which has not operated for more than a total of 150 hours, the minimum duration of exposure necessary to produce fatal injury of this nature in the larvæ of both *Aëdes* (*Stegomyia*) *ægypti* L. and *Culex* (*Culex*) *pipiens* L. has been found to be a period of 45 seconds. The rate of the induction of these tissue changes is directly proportional to the duration of irradiation over fairly wide intervals, while the period occupied by the progress of the process, and before the ultimate death of the larvæ occurs, is inversely proportional to the duration of the irradiation.

Two distinct types of injury have been revealed. (1) A direct injury to the motor nervous system indicated by immediate partial paralysis of certain muscles, and the inhibition of the pulse-rate and tone of the heart. The heart is one of the first organs to suffer injury, but, strangely enough, is the last to be put entirely out of action. (2) An indirect injury leading to the progressive dissolution of many tissues, though principally affecting the fat-body.

The radiations responsible for these remarkable effects have been traced by the use of filters and subsequent spectrographic analysis to the band 2150-2850 A., the most effective radiations being apparently below 2500 A. A possible cause of the tissue histolysis and other injury would seem to be the disturbance of the normal electrostatic conditions within the living cell by absorption of the quanta of the lethal rays.

A full account of my investigations and the results of various experiments to determine the histological nature of the injury will be published in due course.

MALCOLM E. MACGREGOR.

Wellcome Field Laboratory
(Wellcome Bureau of Scientific Research),
Wisley, Surrey.

The Form of Fæcal Pellets and Specific Identification.

WHILE at Oslo, Norway, in 1927, I devised a bottom sampler capable of withdrawing a core of mud from the sea bottom, and at the same time preserving, as *in situ*, the surface layer. My object was to examine this upper layer of flocculent detritus with reference to its possibilities in providing potential food for bottom-living organisms. A description of this instrument with slight modifications was published by Moore in the *Jour. Marine Biol. Assoc.* (vol. 16, No. 2, pp. 589-594). When examining samples which I collected in the Clyde Estuary, I was struck by the characteristic form and sculpturing of fæcal pellets found in them, and, by keeping various members of the bottom fauna in captivity, was able to determine from which particular organism these fæcal pellets were derived.

Doubtless Mr. Moore[1] will remember my discussing the matter with him at Millport Marine Laboratory in 1929 before he commenced his investigations on marine muds.

I may mention here that a distinct stratification in the core extracted from the bottom was noticeable, and my examination showed that successive layers were characterised by fæcal pellets derived from different species, and in some cases different groups, of organisms. A history of the nature of the population in a specific area over a period was thus possible.

Not only were these layers characterised by the fæcal pellets of different organisms, but also they registered more or less faithfully the amount of land drainage in the particular neighbourhood.

I was therefore interested to read in Mr. Moore's letter that he has been so successful in his investigations, which in part confirm my observations. The detailed published results of his work should be valuable.

RODERICK MACDONALD.

Marine Laboratory, Egypt,
June 18.

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[1] NATURE, May 30, p 818

The Theoretical Magneton Numbers in Weiss Units.

As in several cases the experimental ionic magneton numbers may be regarded as established to within a few hundredths of a Weiss magneton, and as, on the other hand, the theoretical values given by Hund,[1] Laporte-Sommerfeld,[2] and Bose-Stoner[3] are accurate only to a few tenths of a magneton, it may be useful to tabulate the more exactly calculated magneton numbers expected from the different theories.

For the magnitude of the Bohr magneton $\left(N\frac{he}{4\pi m}\right)$, 5564 erg gauss^{-1} mol^{-1} has been accepted,[4] where the spectroscopic value of e/m has been used.[5]

The experimental Weiss magneton, in terms of which the measurements are usually described, has the value 1123·5 erg gauss^{-1} mol^{-1}. The ratio of the two units is 4·952.

Hund's theory leads to the formula $p = 4{\cdot}952\, g\sqrt{j(j+1)}$; the theory of Bose and Stoner to $p = 4{\cdot}952\sqrt{4s(s+1)}$.

The values of p for the group of rare earths (following Hund), and for the iron group, are tabulated next to the numbers, as given by the authors themselves.

RARE EARTHS.

Number Electrons.	Ion.	Basic Level.	p_H.	p_H foll. Hund.
55	Ce'''	$^2F_{5/2}$	12·56	12·5
56	Pr'''	$^3H_4$	17·72	17·8
57	Nd'''	$^4J_{9/2}$	17·92	17·8
58	Il'''	$^5J_4$	13·29	13·4
59	Sa'''	$^6H_{5/2}$	4·19	4·2
60	Eu'''	$^7F_0$	0	0
61	Gd'''	$^8S_{7/2}$	39·31	39·4
62	Tb'''	$^7F_6$	48·14	48·3
63	Dy'''	$^6H_{15/2}$	52·72	52·8
64	Ho'''	$^5J_8$	52·53	52·8
65	Er'''	$^4J_{15/2}$	47·45	47·7
66	Tu'''	$^3H_6$	37·44	37·6
67	Yb'''	$^2F_{7/2}$	22·46	22·5

IRON GROUP.

Number Electrons.	Ions.	Basic Level.	p_H.	p_H foll. L.-S.	$p_{B.-St.}$	$p_{B.-St.}$ foll. St.
19	V'''', Ti'''	$^2D_{3/2}$	7·67	7·7	8·58	8·6
20	V''', Ti''	$^3F_2$	8·09	8·1	14·01	14·1
21	Cr''', V''	$^4F_{3/2}$	3·84	3·9	19·18	19·3
22	Mn''', Cr''	$^5D_0$	0	0	24·26	24·4
23	Fe''', Mn''	$^6S_{5/2}$	29·30	29·6	29·30	29·4
24	Fe''	$^5D_4$	33·22	33·6	24·26	24·4
25	Co''	$^4F_{9/2}$	32·85	33·2	19·18	19·3
26	Ni''	$^3F_4$	27·68	28·0	14·01	14·1
27	Cu''	$^2D_{5/2}$	17·58	17·7	8·58	8·6

C. J. GORTER.

Natuurk. Laborat. der Rijks-universiteit,
Leyden, June 4.

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[1] F. Hund, *Zeit. f. Phys.*, **33**, 855; 1925.

[2] O. Laporte und A. Sommerfeld, *Zeit. f. Phys.*, **40**, 333; 1926.

[3] D. M. Bose, *Zeit. f. Phys.*, **43**, 864; 1927. E. C. Stoner, *Phil. Mag.*, **8**, 250; 1929.

[4] R. T. Birge, *Phys. Rev.* Suppl., vol. i.; 1929.

[5] Even the last deflection measurements point to the 'spectroscopic' value. C. T. Perry and E. L. Chafféé, *Phys. Rev.*, **36**, 904; 1930.

Measurement of the Electricity Liberated during the Downgrade Reactions of Organic Compounds.

THE possibility of deriving electrical energy from an organic reaction proceeding irreversibly in one half-element of a cell seems so unlikely on general grounds that an attempt has been made to repeat the observations recorded by Prof. Potter under the above title in NATURE of April 11. Briefly, Prof. Potter found that if the cell

carbon (or stainless steel)	dilute HCl	porous pot	CuSO4 solution	copper

is short-circuited, no current passes; if, however, zinc is placed in the acid out of contact with the electrode, copper is deposited on the right-hand electrode so long as the zinc continues to dissolve. He further found that, if the acid is replaced by 15 per cent sugar solution and the cell is short-circuited, copper is deposited on the electrode as soon as yeast is added to the sugar solution, but not before. Prof. Potter also found that a primary cell (capable of electrolysing copper sulphate solution) is obtained from the combination

carbon	15 per cent sugar solution	porous pot	15 per cent sugar solution and yeast	carbon

the electrode in the fermenting half of the cell being negative. Observations were further recorded in which the decay of lawn mowings and other organic matter was made to produce electrolysis.

When I repeated Prof. Potter's experiments with the first type of cell, I found small random changes in weight of the copper electrodes which, however, were affected neither by the addition of zinc to the acid nor by the addition of yeast to the sugar solution. Furthermore, control copper electrodes, immersed in the copper sulphate solution but unconnected to the other electrode of the combination, showed exactly similar changes in weight.

To explore the matter further, the cell

carbon	$\frac{N}{5}$ HCl	saturated KCl	$\frac{N}{5}$ CuSO4	Cu

was set up and its E.M.F. was measured on a potentiometer. The cell was found to give a substantial but variable E.M.F. ranging from 0·1 to 0·3 volt; the carbon electrode was usually positive, so that if the cell had been short-circuited, copper would not have deposited but would have dissolved. When zinc was placed in the acid, its solution caused no substantial change in the sign or magnitude of the E.M.F.

The replacement of the acid by 15 per cent sugar solution yielded a cell in which the carbon was positive to about the same extent. The addition of yeast and subsequent fermentation produced none but random variations in the E.M.F. of the combination.

The cell

carbon	15 per cent sugar solution	porous pot	15 per cent sugar solution and yeast	carbon

was set up several times. It yielded an initial E.M.F. entirely fortuitous in sign and upon which the subsequent fermentation produced no systematic effect. Like all the other combinations measured, this cell polarised with great readiness.

In none of my observations is there any evidence, therefore, of a continuous supply of electrical energy from a chemical reaction proceeding irreversibly. Neither the solution of the zinc nor the fermentation of the sugar had any effect on the E.M.F. of the cell beyond the random effects to be anticipated during the liberation of gases in the neighbourhood of an indeterminate and readily polarisable electrode such as carbon.

Since making these observations I have been in correspondence with Prof. Potter. We have not succeeded in discovering any significant discrepancy in the two sets of experimental conditions beyond the fact that I used pure sucrose while Prof. Potter used unrefined sugar. Apart from their effect on the internal resistance of the cell, it seems unlikely that the impurities could play a decisive part.

J. H. WOLFENDEN.

Balliol College and Trinity College Laboratory,
Oxford, June 18.

X-Ray Fibre Photography.

We have recently brought to a successful termination an investigation which was carried out to determine a combination of an X-ray generating plant and tube which would enable fibre photographs to be taken with exposures so low as to enhance the value of X-rays as a testing medium in the silk, wool, and allied industries. Fig. 1 is an X-ray photograph of ramie fibre of fifteen minutes' exposure. This exposure, however, greatly under-estimates the efficiency of the plant, since later photographs were produced with exposures of only thirty seconds' duration. This was repeated for wool and artificial silk.

A Laue spectrographic arrangement was used, and the fibres were subjected to copper radiation emanating from a Muller type water-cooled hot filament tube working at 10 m.amp. at 40 k.v. peak. The tube was fed by a D.C. generating plant consisting of a valve rectifier plant with smoothing condensers, arranged for an output of 30 m.amp. at 60,000 volts D.C. maximum.

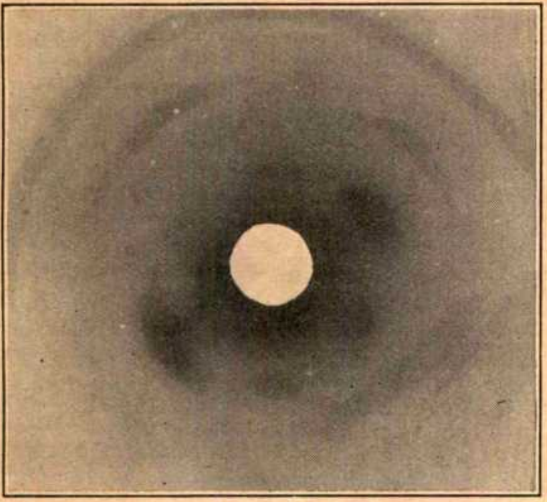

Fig. 1.—X-ray photograph of ramie fibre. The outer ring is due to brass of collimating tube.

We intend in the future to use a helium-filled Muller chrome iron tube with flat copper anode and fitted with four Lindemann windows. This tube will carry continuously, on rectified current, loads of 25 m.A. at 60 k.v. peak or 30 m.A. at 40 k.v. peak. This results in a treble output of that initially used, and in addition the tube is so designed that the anode to fibre distance is reduced by half. Thus we confidently expect to obtain X-ray fibre photographs with exposures of five seconds and even less.

S. Zeidenfeld.

Adam Hilger, Ltd. (Research Laboratories),
24 Rochester Place,
Camden Road, N.W.1.

"The World List of Scientific Periodicals."

"The World List", of which the first edition was published a few years ago, was an attempt to issue a complete alphabetical list of all the periodicals in all countries publishing the results of scientific research, in existence between 1900 and 1920, with standard abbreviations for the titles of each. The List contained the titles of approximately 24,000 periodicals. It was impossible that a work so costly to compile and to print could be self-supporting, and the publication of the first edition was made possible only by grants from the Carnegie United Kingdom Trust and from private individuals.

The Royal Society of London, recognising the value to science of "The World List", has made a grant sufficient to enable us to undertake the preparation of a new edition. This is to be complete, so far as we can make it, up to the end of 1931. I shall be very grateful if librarians and others who have the first edition will send to the editor, Mr. W. A. Smith, Department of Printed Books, British Museum, Bloomsbury, London, W.C., a note of any errors they may have observed in the first edition, any omissions from it, and the titles of any existing periodicals containing the results of scientific research, in actual existence from 1900 up to the present, and omitted from the original edition.

P. Chalmers Mitchell
(Chairman, "The World List").

July 2.

'All or None': a Question of Nomenclature.

The 'all or nothing' hypothesis represents such a clear-cut principle in elementary physiology that it seems a pity that the ambiguous phrase, 'all or none', should so often be used instead. We have been accustomed to suppose that a given physiological unit, or set of units, shows either 'all or nothing' of the response it can make under given conditions; also that additions to this response, under the same conditions but with greater stimulus, can be made only by co-operation (or, in a special context, 'recruitment') of additional units. This meaning is actually excluded by the nickname 'all or none', because we have supposed that 'some' units, few or many, fill in intervening stages of intensity of the response.

Moreover, recent and well-known work (such as the experiments at Oxford and at Cambridge on the spinal flexion reflex and on variation of electrical rhythm in sensory and motor units) demonstrates that 'all or none' of the active units can together modify their response. The alternative phrases now suggest two different principles, separately demonstrable in certain experiments—variability in number of units, each contributing its own 'all or nothing', and secondly, variability of contribution from 'all or none' of them.

W. W. Waller.

Physiological Laboratory,
University of Liverpool.

Polarisation of Raman Scattering by Hydrogen Gas.

The theoretical work of Hill and Kemble, Manneback, and others, indicates that in the spectrum of the light scattered transversely by diatomic molecules, the rotational lines should be very imperfectly polarised. The Raman spectrum of hydrogen offers a particularly favourable case for an experimental test of this point, as the individual rotational lines are well separated from the exciting line. Working at a pressure of 50 atm. I have observed that the Raman lines representing the rotational transitions $0\rightarrow 2$ and $1\rightarrow 3$ in hydrogen gas are only weakly polarised, that is, to the extent of about 25 per cent; and that, on the other hand, the polarisation of the vibration lines appears to be sensibly complete.

By improving the experimental arrangements it has been found possible to eliminate stray light, and thus ensure that the light entering the spectrograph is exclusively that scattered by the molecules of the gas. Experiments are in progress to determine directly from the spectrograms the relative intensities of the Rayleigh and Raman scattering by various gases.

S. Bhagavantam.

210 Bow Bazar Street, Calcutta, June 1.

Research Items.

Yaksas.—In '*Yaksas*', pt. 2, published by the Smithsonian Institution, Freer Gallery of Art, Dr. Ananda Coomaraswamy continues his study of the Yaksas cults of India. All Yaksas, great or small, are vegetation spirits directly controlling, or bestowing on their *bhaktas*, fertility and wealth. All Yaksas are intimately connected with the waters; for example, Kubera's inexhaustible treasuries are a lotus and a conch; innumerable Yaksas have a makara or other fish-tailed animal as their vehicle; Kamadeva has the makara as his cognisance; the greater tutelary Yaksas control the rains essential to prosperity. In the decorative art, vegetation is shown either springing from the mouth or navel of a Yaksa, from the open jaws of a makara, or other fish-tailed animal, or from a conch, but never directly from a symbol representing the earth. But the Yaksas do not so much control the waters as water, as the essence in the water, which is at one with the sap in trees, the elixir of the Devas, especially Agni, with the soma, and the seed in the living being. They are a far greater and mysterious power, and far more significant than the Nagas or dragons. who are also water deities. The importance of the Yaksas in what has been called the Life cult is to suggest that this cult, which is connected with the worship of the Great Mother, may have been the primitive religion of India. A belief in the origin of life in the water was common to many ancient cultures, and must have arisen very naturally in the case of peoples, like those of the valleys of the Euphrates, Tigris, or the Indus, among whom water, whether of the seasonal rains or the overflowing river, was the most serious prerequisite for vegetal increase.

Hand-Spinning in Egypt and the Sudan.—The Bankfield Museum, Halifax, has published as No. 12 of the second series of its *Museum Notes*, a study of hand-spinning in Egypt and the Sudan, by Mrs. Grace M. Crowfoot. In this area a number of different types is found, from the most primitive and simple by hand alone to the highest type of suspended spindle-spinning reached before the invention of the wheel. Six types are recognised: (1) Hand-spinning alone, the simplest method known, in which the hand alone is used or with the assistance of the thigh. There is no example in modern Egypt, but it is represented in ancient Egypt. In the Sudan it occurs far to the south among the primitive Nuer. (2) Spinning by twisting a hooked stick, a simple and primitive method found among the conservative nomads, such as the 'Beit Awad' of the Beni Amer. (3) Spinning by rotation of the spindle in the hand, a surprising and beautiful method found among the Sudanese Arab tribes and the Hadendoa of the Red Sea coast. The stick is sometimes plain, and sometimes has a whorl at the tip. Its special value lies in its command over short-stapled wool. (4) Grasped spindle, in which a prepared rove is passed through a ring over a forked stick or other support and is spun on a large spindle suspended in both hands, known only from ancient Egypt. (5) Supported spindle: (*a*) spindle rests lengthwise on the right thigh and is spun on a large spindle grasped in both hands; (*b*) spindle spun while standing erect on the ground or in a shell or bowl; 5 (*a*) is used chiefly for cotton—the only modern example is in Dongola Province; 5 (*b*), the chief way of spinning cotton in many parts of the world, is used in the Sudan only by immigrants from Sokoto and Bornu. The flax-spinning of modern Egypt shows the influence of ancient Egypt and Europe, cotton-spinning in the Sudan shows strong resemblances to the flax-spinning of ancient Egypt.

The Wolf of Corea.—In Corea a considerable amount of damage is still caused by wolves, and the Tyosen (Corean) Government reports show that rewards are paid annually for the slaughter of more than a hundred individuals. On three occasions, Yoshio Abe visited Corea for material to study the wolves of the region, and these he now describes as belonging to a geographical race of the common wolf, *Canis lupus coreanus*. From the races of the common wolf which inhabit various areas of Asia, the Corean form is distinguishable by the relative slenderness of the muzzle, a character in which it approaches the North American *Canis occidentalis*. In colour, the Corean wolf, which, like other wolves, shows distinct variation in individuals, falls between the common wolf and the pale *Canis laniger* (*Jour. Sci., Hiroshima Univ.*, Ser. B, Zoo.; Dec. 1930.)

New North and South American Ascidians.—Dr. Willard G. Van Name in the *Bulletin* of the American Museum of Natural History, vol. 61, art. vi. pp. 207-225, describes four species of ascidians new to science, and a fifth from Tortugas, Florida, appears to be identical with a Japanese form, *Botryllus primigenus* (Oka), described by Prof. Oka in 1928. This species is noteworthy in that the branchial sac has but 4 rows of stigmata, unlike all other known American and European forms, which have 8 or more such rows—8 or 9 in the common *B. schlosseri*, typical of British waters. In addition the atrial orifices of some of the zooids of *B. primigenus* open directly on to the surface of the colony without the intervention of common cloacal cavities. Of the four species new to science, all are members of well-known families and genera: *Clavelina huntsmani* from the west coast of N. America; *Stolonica zorritensis* from Zorritos, Peru, peculiar in having a small number of gonads all apparently hermaphroditic; *Pyura bradleyi*, also from Zorritos; and *Polyandrocarpa gravei*, a compound styelid of flat encrusting form from Tortugas. As is usual with Dr. Van Name's publications, the descriptions of the species are accompanied by numerous helpful illustrations.

Antarctic Alcyonaria, Madreporaria, and Antipatharia.—Sir J. Arthur Thomson and Miss Nita Rennet describe these cœlenterates of the Australasian Antarctic Expedition, 1911–14, under the leadership of Sir Douglas Mawson (*Scientific Reports*. Series C, Zoology and Botany. Vol. 9, part 3, January 1931). The collection includes 31 species of Alcyonaria, of which 7 are new, 5 species of Madreporaria, and 2 species of Antipatharia. The most important find is that unique type of alcyonarian *Ainigmaptilon haswelli* Dean, placed provisionally in the Pennatulacea and already described in the *Proceedings* of the Linnean Society (Zoology, vol. 36; 1926) by Miss Isobel Dean. From a narrow main stem, without an axis, numerous short side-branches are given off which subdivide irregularly into twigs bearing many small autozooids. There are four longitudinal septa in the main stem—the most striking pennatulid feature—and the side branches are most nearly comparable, though not identical in structure, with the pinnæ of the pennatulids *Virgularia gustaviana* and *V. halisceptrum*. However, there is no satisfactory evidence of siphonozooids; also a definite axial canal and an axis are missing. It is, however, possible, although not probable, that the axis was separated from the colony in the dredging, as the septa are torn. *Ascolepsis splendens*, a new genus, is a beautiful alcyonarian belonging to the Primnoidæ in the order Axifera. This has a new type of sclerite, chalice-like in shape. Another species belonging to this genus. *A. spinosa*, is also described, and a form intermediate between these two. The plates are excellent, especially those which are delicately coloured.

Chromosome Multiples in *Chrysanthemum* and *Potentilla*.—IN a paper just received, N. Shimotomai (*Jour. Sci., Hiroshima Univ.*, Botany, vol. 1, p. 37) describes three species-hybrids of *Chrysanthemum* and the behaviour of their chromosomes. In *Ch. Decaisneanum* ($n=36$) × *Ch. indicum* ($n=18$) the F_1 hybrid has 54 chromosomes, which form 27 pairs in meiosis, and the pollen grains receive 27 chromosomes. This is presumably because 18 of the chromosomes from the octoploid *Ch. Decaisneanum* pair with each other. Similarly, in *Ch. marginatum* ($n=45$) × *Ch. morifolium* ($n=27$) the hybrid has 72 chromosomes which form 36 pairs. Again, 18 chromosomes of the higher polyploid parent mate with each other. In *Ch. marginatum* × *Ch. indicum*, however, the 63 chromosomes of the hybrid form 18 bivalents and 27 univalents. These hybrids are all intermediate between the parents, but nearer that one with the higher chromosome number. Another paper in the same journal (p. 1) gives chromosome counts in a number of further species of *Potentilla*, and discusses the phylogeny of the genus in the light of the chromosome numbers. It appears that primitive species and subsections have the basal number ($2n=14$) or low multiples; while in the Hæmatochroæ, regarded as recent in origin and arising in part through hybridisation, the numbers range from 42 in *P. nepalensis* to 112 ($16n$) in *P. hæmatochrus*. It is believed that the originals of *Potentilla* were diploid species with a circumpolar distribution in the Tertiary, whence they afterwards moved southwards, intercrossed, and gave rise to various polyploid species and groups.

The Classification of Carbonaceous Minerals.—In 1927 Prof. G. Hickling plotted the percentages of carbon and oxygen recorded in more than a thousand analyses of American and British coals, and found that the points lay on a well-defined and continuous belt covering the whole range from lignite to anthracite, thus demonstrating that these coals are members of a natural, unbroken series. Prof. H. Briggs has now plotted the corresponding data for other carbonaceous materials and recorded the results in the *Proc. Roy. Soc. Edinburgh*, **51**, 1931, pp. 54-63. It appears that there are two kinds of cannel coals, the analyses of which fall on distinct 'development' lines. In order of increasing hydrogen, the series recognised are (*a*) sub-cannels, (*b*) cannels, (*c*) paraffin shales, and (*d*) torbanites. These give lines nearly parallel to the coal belt, and beyond them fall two groups of crude petroleums, heavy and light oils respectively, on lines having a very different slope. It is noteworthy that the further from the coal belt an analysis is situated (in the direction of increasing hydrogen) the more suitable is the mineral as a source of oil. The graphs therefore serve a useful purpose as a standard of reference for distinguishing suitable materials for distillation.

High Vacua.—In the June issue of the *Journal of the Franklin Institute*, Dr. S. Dushman, of the research laboratory of the General Electric Company, reviews the advances in the production and measurement of high vacua which have taken place since the issue of his own and of other books on the subject, published five or six years ago. The chief advances are in the introduction of vapour pumps of much higher speeds, the use of what are known as 'getters' to improve the vacuum, and in the more careful investigation of the behaviour of the metal parts of the apparatus towards the vacuum. The usual method of measuring the speed of exhaust depends on Knudsen's expression for the resistance a tube offers to the flow of gas through it. Condensation pumps are the rule, and the Payne two-stage pump used by the Company is described. It requires a force pump giving a pressure of 2 mm. of mercury, and its speed is given as 60,000 c.c. per second. Pumps using organic liquids instead of mercury, as used in the Eastman Kodak Laboratories, are also described. Magnesium and calcium are the usual 'getters' for oxygen, but for hydrogen and nitrogen, cæsium and sodium are more active. Pressure gauges are generally either of the ionisation type, depending on the ionisation produced in the residual gas by accelerated electrons from an oxide-coated filament, or they utilise the temperature or resistance of a thin wire electrically heated in the residual gas. The author collects a considerable amount of information recently obtained on the constitution and amount of the gases in metals and in glass.

Reflection of Water Molecules at the Liquid Surface.—Whilst it is relatively easy to investigate experimentally problems connected with the emission and reception of charged particles, the study of the corresponding processes for neutral atoms and molecules often presents considerable difficulty and has received less attention. Prof. T. Alty has contributed a paper to the June issue of the *Proceedings of the Royal Society* in which he describes a determination of the reflection coefficient of water molecules when they are incident on a liquid water surface. The method employed was to measure the rate of evaporation from a water surface of known area as a function of the vapour pressure over the evaporating surface, whence by extrapolation to zero pressure the rate of evaporation into a vacuum could be deduced. The last quantity was then compared with the rate at which molecules struck the surface from the saturated vapour, calculated by the usual kinetic theory relations. The two quantities were of a different order of magnitude, and to reconcile them it is necessary to assume that the large majority of the molecules are reflected from the surface when they strike it, and pass back into the vapour phase. Under the conditions used by Prof. Alty, it appears that only about one per cent of the incident molecules are able to enter the liquid. The average time which a molecule spends in the surface is not greater than about 10^{-5} sec.

Photochemical Decomposition of Hydrogen Iodide.—The decomposition of hydrogen iodide gas on exposure to light, first studied by Lemoine in 1877, has been investigated several times, and it has been considered that the gas exhibited continuous absorption to a wave-length of 3600 A. In the May number of the *Journal of the American Chemical Society*, Rollefson and Booher show that the absorption extends as far as 4000 A. The absorption on the long wave-length tide of 3120 A. is interpreted as due to dissociation of the molecule into normal atoms (a type of reaction not very common), that on the shorter wave-length side giving an excited iodine atom. Salant and Sandow have reported decomposition with the 4047 A. line of the mercury arc. The conclusions are based on the value 69,000 gm.cal., or 3 volts, for the heat of dissociation into normal atoms, and the energy 0·95 volt to raise the iodine atom to the first stage of excitation. This gives the corresponding wave-lengths 4120 A. and 3120 A. The results are interpreted in terms of potential energy curves. It is concluded that in the zero and first vibrational levels the molecule may be considered as an example of ionic binding.

Estimation of Bromine in Organic Compounds.—By substituting butyl alcohol for ethyl alcohol in Stepanoff's method for the determination of halogens in organic compounds, Dr. F. Schultz claims to have made the method more accurate and even applicable to the determination of bromine in highly brominated hydrocarbons. Stepanoff's method (*Ber.*, 1906, 39, 49) of estimating halogens by treating the substance in alcoholic solution with sodium, thereby converting the chlorine, bromine, or iodine present into the sodium salt, possesses obvious advantages over the Carius tube method. Various modifications have been suggested from time to time, but the method has not hitherto been considered accurate for highly brominated hydrocarbons. In his paper in the May number of the *Collection of Czechoslovak Chemical Communications*, Dr. Schultz describes how he carried out the reaction by gradually adding sodium to the boiling butyl alcohol solution of the bromine compound. Hexabromobenzene, pentabromotoluene and hexabromonaphthalene were examined. After the sodium had all been introduced, boiling under a reflux condenser was continued for an hour. Water was then added before filtration and the acidified solution was precipitated with silver nitrate and 'back-titrated' with ammonium sulphocyanide. The results were in very good agreement with the theoretical values.

Oxidation-Reduction Potentials in Bacteriology.—It is now well known that living cells require a constant hydrogen ion concentration in their environment if they are to live and function normally, and in higher animals mechanisms have been developed to maintain this concentration in the tissue fluids constant at a point close to neutrality. The reducing power of the environment is probably similarly regulated, a balance being struck between the reducing and oxidising tendencies just as there is a balance between the hydrogen and hydroxyl ions. The oxidation-reduction potential can be measured by suitable indicators or potentiometrically. L. F. Hewitt, in a publication, "Oxidation-Reduction Potentials in Bacteriology and Biochemistry", recently issued by the London County Council (pp. 70. Price 2*s*.), describes a series of investigations on the oxidation-reduction conditions produced by bacteria in the medium by which they are surrounded, and has found striking differences of behaviour between different micro-organisms. Thus aerobes are in general able to reduce ordinary aerobic culture media until a moderately intense reducing level is reached; anaerobes, on the other hand, cannot effect any reduction in ordinary aerobic cultures, but if the medium is partially reduced to begin with, for example, by exclusion of the oxidising effect of air, they are able to establish very much more intense reducing conditions than the majority of aerobes. Pneumococci, again, do not maintain the level of reducing intensity after the logarithmic phase of growth, highly oxidising conditions being gradually established owing to the formation of peroxide. The virulence of hæmolytic streptococci is maintained in culture by opposing the reducing effects of the organisms, through increasing their oxygen supply. It seems possible that a systematic classification of organisms will result from studies of the oxidation-reduction potentials in bacterial cultures.

Astronomical Topics.

Distance of the Great Nebula in Orion.—A *Bulletin* dated June 11, from Science Service, Washington, D.C., gives a summary of a new determination of the distance of this nebula, made by Dr. R. J. Trumpler at the Lick Observatory, and reported by him to the Astronomical Society of the Pacific at Pasadena. He states that three different methods give the distance as 1800 light-years, which is about three times as great as the value generally given; thus Kapteyn gave the parallax of the nebula as 0·0055″, implying a distance of 590 light-years. As there is evidence of association between the nebula and many of the bright stars in Orion, their distance is generally taken to be about the same; if the new distance applies to Rigel, it must be of extraordinary brilliance. The table in Russell, Dugan, and Stewart's standard work gives its absolute magnitude as − 5·8 with a parallax of 0·006″; at three times the distance it would have absolute magnitude about − 8·2. The new value gives the diameter of the nebula, neglecting its faint extensions, as 26 light-years. Dr. Trumpler has also investigated the colour of the stars in the nebula; he finds that they are slightly redder than stars of the same type elsewhere, which he ascribes to the absorptive effect of the nebula on their light.

The Cape Observatory.—The report of the Cape Observatory for 1930, which has just come to hand, states that the transit circle observations include the sun, Mercury, Venus, and Vesta (which is used to check the equator point), zodiacal stars, and stars south of − 30° Decl. down to mag. 7·5. There is the welcome news that the heliometer observations of the outer planets since 1897 will shortly be published. They are likely to help in the determination of Pluto's mass.

Proper motions of stars in the Cape astrographic zone are being deduced by comparing recent photographs, taken through the glass, with those taken several years ago.

The relative trigonometrical parallax of Nova Pictoris came out as − 0·013″. Another determination was made by co-ordinating the increase of brightness with the expansion indicated by the spectroscope. The value 0·0015″ was obtained, which makes the absolute magnitude at maximum − 7·9.

The report shows that even before the end of 1930 the Eros programme was in full swing; the most important southern observations would be those made in January and February.

1930 was the driest year at the Cape since 1841, the rainfall being 16·46 in. The extremes of temperature were 104·0° and 35·8°. the annual mean being 63·7°.

New List of Astronomers and Observatories.—Prof. P. Stroobant and the other members of the staff of Uccle Observatory have just published a new edition of their useful list. The first edition appeared in 1907 and is now out of date; the new one is brought out under the auspices of the International Astronomical Union, which has assisted in the cost of publication. Very full particulars are given of the observatories; the names of all members of the staff, the department that they are attached to; details about the instruments, and the work for which they are used. The list of astronomers has references to all the pages on which they are mentioned. Full details are also given of the astronomical societies, with a description of their special objects, their dates of meeting, their publications, etc. They are arranged in order of their dates of foundation, the Royal Astronomical Society coming first. Finally, there is a list of astronomical periodicals, with particulars about their special fields of work, dates of publication, and subscription prices. Altogether the volume is one which all astronomers will find most useful; it is printed and edited by Messrs. Casterman, Tournai; the price is not stated.

National Physical Laboratory, Teddington.

INSPECTION BY THE GENERAL BOARD.

ON Tuesday, June 23, the General Board of the National Physical Laboratory made its annual inspection of the laboratory. As is customary, a large number of visitors, including members of scientific and technical institutions, government departments and industrial organisations, were present and were received by Sir Gowland Hopkins, president of the Royal Society, chairman of the General Board, Sir Richard Glazebrook, chairman of the Executive Committee, and Sir Joseph Petavel, director of the Laboratory.

A comprehensive range of experiments and apparatus, illustrating the various activities of the Laboratory, was shown.

In the Aerodynamics Department, the compressed air wind tunnel, a model of which was shown in 1928, has nearly reached completion and was thrown open for inspection. This tunnel, which consists of a main steel shell 50 ft. in length and 17 ft. in diameter, enclosing the working tunnel of 6 ft. diameter, is constructed of rolled steel rings closed by hemispherical end castings, both made at the works of Messrs. John Brown, Ltd., Sheffield. The tunnel is of the open jet, return flow type and is capable of withstanding pressures up to 25 atmospheres. Three 400 h.p. compressors are housed in an adjoining room and can raise the pressure to its full value in about 80 minutes. The propeller for circulating the air is driven by an external 400 h.p. motor, the shaft passing through a stuffing box. It is anticipated that an air speed of about 90 ft. per sec. will be possible at the highest working pressure, corresponding to a speed of about 150 miles per hour in the case of an average aeroplane under normal atmospheric conditions.

In one of the four-foot wind tunnels demonstrations were given of the buffeting of aeroplane tails, a phenomenon revealed by tests subsequent to the Meopham accident. This phenomenon is due to the character of the airflow behind an aerofoil, when the latter approaches stalling incidence, particularly at high speeds. Under these conditions the airflow becomes periodic, and the eddies so formed may impinge on the tail, and in special circumstances may set up serious vibration. To demonstrate the phenomenon, an aerofoil was mounted in the tunnel at stalling incidence and means were provided of setting the tail in any desired position relative to it. The tail was provided with suitable flat springs to allow vibration to take place, the oscillations being projected by appropriate mirrors on to photographic paper. The investigation is directed to the study of the limits of the eddying wake produced by different wing sections at various angles of incidence, and to the buffeting effects on a tail placed at various positions inside and outside the wake.

Apparatus for the precise reproduction of the spinning motion of an aeroplane has been constructed in the Department. Hitherto, in wind tunnel tests relating to spinning problems, the model has been rotated about an axis through the centre of gravity. This does not take account of the fact that the latter moves in a helix. The new apparatus allows for this factor. The model is offset at any desired distance from the rotating axle by means of a radius arm, the rotation being effected by means of a motor and epicyclic gearing. The rolling moment is determined by measurement of the mechanical reaction on the gear system due to the model.

Of interest also was a method of rendering visible the airflow round a body placed in an airstream. Fine platinum wires, half an inch apart, are mounted on two vertical supports situated in front of the body and heated to redness by means of an electric current. Each wire gives rise to a band of heated air which persists for some distance downstream. These bands, owing to their decreased refractivity, cast a shadow on a screen when suitably illuminated and thus give a direct picture of the streamlines. These can be examined by means of a stroboscope if necessary. Such phenomena as the behaviour of an aerofoil at stalling incidence and of the Handley Page slot are clearly brought out.

In the Engineering Department an investigation was in progress for the Roads Department of the Ministry of Transport on the forces due to wheel impacts on a road. To determine such forces it is necessary to know the corresponding spring load and the linear accelerations of two points on the axle. To measure the latter, special accelerometers have been designed and constructed in the Department. These instruments depend on the variation of a mutual inductance by the impact. Alternating current of definite frequency is supplied to the primary coil and the secondary current, after rectification, is recorded by an oscillograph. The load on the springs is determined by mounting the normal suspension springs on stiff springs, the deflection of one end of which is determined by a method similar to that utilised in the accelerometers. The whole equipment is mounted on a special trailer, which is provided with a dark room for development of the records on the road. The effects of different types of tyre and sizes of wheel are being investigated.

In connexion with the investigation of the mechanical properties of materials at high temperatures, creep tests have been made on a variety of materials—cast and forged steels, alloy steels, and non-ferrous alloys—and the effects of an atmosphere of steam and of a hot air blast have been investigated. To obtain greater refinement in such tests, very accurate control of the temperature of the specimens has been found necessary. For this purpose a further batch of creep units has been constructed. These are controlled by a thermionic valve bridge and suitable relays, and the temperature can be maintained constant within ± 0·5° C. The extension of the specimen is measured by means of Marten's mirror extensometers, capable of measuring to one millionth of an inch on a five-inch length. A new 25-ton testing machine to accommodate the new creep units has been installed. With this machine low rates of creep can be obtained.

Attention has been given to a method of testing the hardness of thin coatings of electrolytically desposited metals such as chromium. Some success has been obtained with a diamond scratch method, using suitable loads.

Experiments have also been made to determine the minimum dimensions for correct results of a test piece suitable for use in ball indentation tests. Sample test pieces of various shapes and thicknesses which have been used in the investigation were on view.

Of interest also was apparatus for determining the hardness of white-metal bearings at temperatures up to 350° F. The tests are made on the metal in actual half bearings ready for service. A Vickers loading machine is used, the bearing being immersed in an oil bath mounted on the machine and maintained at the required temperature. The apparatus was shown in use for tests on a big-end bearing.

Attention has also been given to the problem of corrosion fatigue, which is being dealt with under two aspects. In one case experiments have been made on a single crystal of aluminium stressed while immersed in a slow stream of tap water. Corrosion was found to occur preferentially on the site of previously formed slip bands, and to this corrosion the ultimate failure of the crystal was mainly due. Specimen test pieces showing the corrosion product (aluminium hydroxide) were on view. In the second case the relative strengths of aircraft steels and alloys have been determined when tested *in vacuo*, in various gases, in a salt spray, and with and without protective coatings. The specimens are subjected to reversed bending and to reversed direct stresses under these conditions.

Research work has been carried out to determine the causes of failure of wrought iron chains. The investigation has shown that failure may be caused by the occurrence of burnt iron, which is due to an excess of phosphorus and silicon, and dates back to the puddling stage of manufacture. A test has been devised to reveal the presence of such defective material. Work is also in hand to determine the effects of service conditions and of subsequent heat treatment, such as annealing, upon the threaded parts of shackles and upon the pitch of chains. Special machines have been devised in which service conditions are reproduced.

The Department has been responsible for the design of standard forms of crane hooks. Sample hooks have been prepared and tested for strength and have been found extremely satisfactory. The designs have been adopted by the British Engineering Standards Association. Specimen hooks both before and after test were on view.

An investigation was in progress to study the velocity of travel and the wave-length of waves set up on the surface of water by the action of wind. The waves are produced in a 12 in. by 12 in. rectangular tunnel 50 ft. in length. By observation with a stroboscope it is possible to determine the frequency and wave-length at the same time. From photographs of the wave motion, scale models of the actual waves can be constructed and the distribution of wind pressure over them determined in a wind tunnel. The relation between the wave-length and the velocity approximates very closely to that calculated on the basis of the irrotational motion of a frictionless wind.

Of interest also was a liquid gauge used for simultaneous measurements of the wind pressure at a number of points on a building. The tubes contain benzyl alcohol and a solution of calcium chloride; these liquids give a clear surface of separation and the difference of their densities is small. A sensitivity five times that of the ordinary water gauge is attained. A flashlight photograph is taken of the gauge, and the pressures corresponding to different points of the building are read off from the print.

In the Metallurgy Department, research work was in progress in connexion with the effect of various aqueous solutions of salts, such as may be present in boilers, on the behaviour of boiler steels when stressed. Steel specimens which have been subjected to the action of various solutions are bent in alternate directions at intervals of 24 hours. It has been shown that the effect of continuous immersion in tap water is to reduce the survival of the specimens (expressed as the number of bends before fracture) by 30 per cent as compared with the endurance in air. Concentrated solutions of sodium chloride have a similar but less severe effect.

The investigation of the effect of flue gases, mentioned last year, has been continued, and has now reached the stage when a batch of a dozen wires can be tested simultaneously for the corrosive action of flue gases. Improved apparatus has been installed, permitting the tests to be carried out at 400° C., 500° C., and 600° C.

An investigation has been undertaken on behalf of the Aeronautical Research Committee in connexion with the constitution and structure of magnesium alloys. The work is directed towards improvements of mechanical properties by the discovery of new alloys in which there is a considerable solubility of the added element, or a change of solubility with temperature sufficient to permit age hardening. Samples of such alloys were on view.

Beryllium is usually prepared by electrolysis of its fused chloride at white heat. A method has, however, been developed in the Department for the electrodeposition of the metal from its fused salts at a much lower temperature. Coherent deposits on copper have been obtained in this way and specimens were exhibited.

Research work has been undertaken for the British Non-Ferrous Metals Association to determine the effects on the strength of copper of such impurities as bismuth, arsenic, antimony, and oxygen. Prepared specimens in the form of strips are subjected to bending in alternate directions in a special machine.

One of the difficulties encountered in the determination of the melting points of some alloys is the presence of vapour, which prevents the use of an optical pyrometer and may contaminate thermocouples. To avoid this difficulty, work is in progress to produce special refractories which are impervious to such vapour. It has been possible to make small tubes of glazed alumina which are satisfactory in this respect, and work is in progress to apply the technique to the production of larger tubes. To avoid glow discharge, and hence error in the thermocouples due to local heating when these are used in the induction furnace, a special furnace of this type has been evolved. This is coreless and is fitted with a water cooled electrostatic screen round the melting chamber.

A demonstration was given in the rolling mill of a special type of failure which can occur in the rolling of ingots of aluminium alloys if the conditions of cooling are not correct. These alloys are rolled while hot. Accurate control of the temperature and the conditions of working previous to rolling—such as casting and forging—are essential.

In the Metrology Department a new clock has been installed depending for its action on the mechanical vibrations of a metal bar held at its centre. The primary vibrating element is a rod of elinvar, an alloy with a low-temperature coefficient of elasticity. This is maintained in a state of self-vibration by the application to one end of electrostatic forces obtained after amplification by a valve amplifier from similar feeble forces taken from the other end. A phonic motor operated by the amplifier drives a clock train, one spindle of which rotates once per second. Suitable means are provided for the recording of these seconds on a chronograph. To ensure constancy of frequency, the bar is enclosed in a special housing, the temperature and pressure in which can be controlled by immersion in a vessel of circulating water, the temperature of which is regulated by a toluene thermostat.

Of interest also was a new method of testing surface plates. The plate to be tested is supported on a somewhat larger one provided with levelling screws, and resting on a large flat plate forming the base of the apparatus and carrying a 'Hirth' minimeter as an indicator. The specimen is first set approximately parallel to the base plate by means of the minimeter and then explored by the same instrument. If a standard plate, of which the departures from flatness are known, is substituted for the test plate and the same procedure is adopted, the errors in the latter can be readily determined.

In the Physics Department the investigation on the heat transfer from moving air to cold pipes has been continued, and extended to include banks of pipes such as are used industrially for air cooling in refrigerators.

Experiments were in progress to determine the heat transmission through wall materials. A specimen plate of the material is laid on an electrically heated plate, backed with cork, and is surmounted by a water plate. The electrical input, after correction for the heat conducted through the cork, together with the temperatures of the two faces, gives the necessary data for calculating the conductivity of the material.

The thermal conductivities of heat-insulating materials at high and low temperatures were also under investigation. In the case of the low temperature measurements, the method adopted is similar to that used for the wall materials, a refrigerating plant being utilised for the maintenance of the low temperature. For the measurements at high temperature a water-flow calorimeter is used. The rate of flow, and the rise of temperature of the water when steady conditions have been attained, give the data for the calculation of the thermal conductivity.

An investigation is being carried out, for the Atmospheric Pollution Research Committee, in connexion with the determination of the water in fogs, and a dew point method has been developed for the purpose. A stream of fog-laden air is drawn through a heated tube to vaporise suspended water droplets, and the dew point of the resultant fog-free air is then determined. For the production of artificial fogs a special equipment has been devised consisting of a small chamber provided with air-circulating apparatus which is supplied with steam from an external generator.

A study has also been made of the basic laws of the wet and dry bulb hygrometer over the temperature range 40° C.–100° C. As standards of reference the dew point and gravimetric methods of determining humidity have been used. Apparatus has been designed to give a stream of air at any desired temperature and humidity flowing past the wet bulb thermometer, with velocities exceeding three metres per second. A number of novel features have been incorporated in the apparatus.

In the Sound Division attention is being devoted to the increasingly important subject of noise measurement. The laboratory has co-operated with the Royal Aircraft Establishment in connexion with measurements of the noise of airscrews and exhausts. In the case of the former, the effects of tip speed of rotation, blade diameter and blade shape have been studied and have yielded interesting results. An investigation has also been undertaken for the Ministry of Transport on the noisiness and stridency of motor horns. The loudness was measured by means of an audiometer of the Barkhausen type. By means of a portable microphone amplifier arrangement and cathode ray oscillograph, measurements were also made of the spectral distribution of the sound intensities emitted by the horns. The results indicated that some of the factors affecting the stridency might be the occurrence of strong high frequency components and the presence of inharmonic series of frequencies.

In the Radiology Division the depth below the surface of the cathode at which X-rays originate is being explored. A special hot-cathode X-ray tube is used, the target consisting of thin foil of the material to be investigated. The nature of the X-ray output is analysed by comparative measurements of the absorption in an ionisation chamber.

A number of investigations are being undertaken in connexion with the application of X-rays to industrial problems. These include a study of tungsten steels and tungsten steel residues, the effect of rolling on the crystal orientation in aluminium, and of drawing on that in constantan wire, problems of electrodeposition, paints, and artificial teeth. In the case of constantan wire, the temperature coefficient was found to change as the wire was drawn, and the effect on this phenomenon of changes in crystal orientation is being studied.

In the Electrical Standards Division considerable attention has been devoted to the development of a standard of radio-frequency of high accuracy. The requisite precision has been attained by the use of a valve-maintained tuning fork operating in an airtight enclosure in which the pressure and temperature can be maintained constant. The six walls of the enclosure are provided with heating mats, temperature control being effected by means of a toluene thermoregulator. The tuning fork controls a phonic motor and chronograph, on which are recorded hourly the differences of the fork and the standard Shortt clock. The electrical and mechanical arrangements are such as to permit the determination of the frequency of the fork at any time to an accuracy of two parts in ten millions.

A method has been evolved for the measurement of the small anode-grid capacity of screen grid valves. Use has been made of the amplification of the valve itself. A tuned circuit, the coil of which is loosely coupled to a radio frequency generator, is inserted between the grid and the filament, resonance being indicated by a valve voltmeter. Readings of the condenser in the tuned circuit with no impedance, and with high impedance in the plate circuit, enable the anode-grid capacity to be determined.

An investigation has been commenced in connexion with the magnetic susceptibility of various rocks on behalf of the Geological Survey of Great Britain. An instrument of the type used by Prof. E. B. Wilson has been designed for the purpose. The specimen, in the form of a cylinder, is suspended at the end of a torsion arm in the gap of a large ring electromagnet. The instrument is capable of measuring susceptibilities one hundred million times less than that of iron.

For the precision measurement of the resistance and inductance of four-terminal resistances at power frequencies, a substitution method which avoids the necessity of taking current from the voltage terminals has been evolved in the Electrotechnics Division. The resistance under test is connected in series with a known standard resistance of nearly the same value and with the primary of a nickel-iron transformer. In series with the secondary is a resistance the value of which is so adjusted with reference to the transformer ratio that the voltage drop across it is approximately equal to, and may be opposed in turn to, that across each of the standard and test resistances. A vibration galvanometer is included in the apparatus and its deflection can be reduced to zero by suitable shunts incorporated in the secondary circuit. The resistance and inductance of the unknown resistance can then be determined.

Another exhibit showed arrangements for the measurement of the current rating of power cables. The modern trend in building construction has led to a more extensive use of electric power, and it is becoming standard practice to employ single core lead or rubber covered conductors to carry the current. Owing to sheath losses and skin effect, the current carrying capacity of a cable for a given temperature rise is less with alternating current than with direct current, and is determined by the maximum temperature rise that can be allowed in any given set of circumstances, having regard to the deleterious effect of high temperature on the properties of the insulating material. The object of the investigation is to determine the current carrying capacity of standard cables of various types and sizes under different conditions of laying, both for alternating and direct current.

For work in connexion with the testing of fuses, the laboratory facilities have been extended to cover the latest specification of the British Engineering Standards Association for domestic fuses up to 250 volts and 100 amperes. The specification requires that the tests be made at 260 volts and at suitable short circuit currents up to a maximum of 6500 amperes. With the new equipment, the short circuit is made from a distance by means of a solenoid controlled switch, the cut-out being observed through a wired glass panel in the door of the test enclosure. An auxiliary circuit incorporating a neon lamp indicates whether iron-clad cut-outs show any tendency to arc to their cases.

In the Wireless Division a new type of dynatron oscillator has been developed by the use of the negative resistance characteristic of the screen grid valve. By coupling the anode to the control grid through a small capacity and including a resistance of the order of a megohm in the filament-control grid circuit, higher frequencies than are possible with normal dynatron circuits have been obtained. The exhibit shown can be used for the generation of oscillations of wave-length as small as 6 metres.

The same principle can be applied to the problem of selective amplification. With the usual triode valve the presence of the positive shunt resistance of the valve decreases the selectivity of the tuning circuit through damping. If the negative resistance characteristic of the screen grid valve be utilised, the selectivity of the amplifying stage can be made greater than that of the tuned circuit alone. A demonstration of this was given by means of a circuit incorporating a valve of this type.

The investigation on behalf of the Radio Research Board in connexion with the development of transmitting and receiving apparatus for very short wave-lengths has been continued, and equipment capable of transmitting and receiving oscillations of wave-length as small as 1·5 metres was shown. The apparatus has been used for the study of the propagation characteristics of very short waves.

The apparatus for testing the performance characteristics of wireless receivers has now been extended to cover the shortest wave-lengths in commercial use. Improved apparatus has been installed capable of carrying out comprehensive tests at wave-lengths from 7 metres to 2000 metres. The tests comprise over-all sensitivity, radio-frequency, selectivity, and fidelity in the reproduction of radio-frequencies. The last-named test is carried out by the use of an input modulation free from harmonics. Any harmonics present in the output constitute a measure of the distortion produced.

In the High Voltage Building, equipment for the measurement of the dielectric loss of high voltage porcelain insulators was exhibited. Demonstrations were given of flashover tests to determine the maximum voltage withstood by a 132-kilovolt porcelain insulator string.

In the Photometry Division an investigation was in progress in connexion with the light-diffusing properties of diffusing glassware. These properties are governed by the size and concentration of the particles, and apparatus has been developed in the division for the measurement of these two quantities by the use of a powerful microscope. Half-silvered interferometer plates are fitted to the fixed and movable stages of this instrument, enabling the movement of the latter to be obtained directly in terms of light wave-lengths. The diameter of a particle can be determined by observation of the interference fringe system, as the particle is made to traverse a fixed cross wire, or alternatively by attaching the cross wire to a travelling microscope, the scale of which can be calibrated by means of the interferometer. To determine the concentration, the field is limited by an aperture of known diameter. The microscope is focused through the particles by a slow-motion device, the distance traversed being measured by a second interferometer.

The fundamental work on glare has been extended to cover the glare effect of coloured light sources with white and coloured backgrounds. Practical application has also been made of the results already obtained with normal light sources by the design of an instrument for the determination of the glare effect due to an actual lighting system. Two measurements of the brightness difference threshold, one with the glare sources exposed to the observer's eyes, and the other with the glare sources screened, give a ratio which is a measure of the glare effect.

In the William Froude Laboratory a model of a single-screw vessel was being tested to compare its behaviour in shoal and deep water. There are reasons for supposing that there is a scale effect leading to differences between the model and the full-sized ship. The model under test was equipped with its own inboard motor and propeller and apparatus for determining its resistance through the water. A model twin-screw vessel fitted with its own propelling and recording gear and utilised for research work on the backing qualities of propellers was exhibited. The tests are designed to show the thrust capacities of propellers of various shapes and diameters to destroy and reverse the motion of the model.

The International Congress of the History of Science and Technology.

THE Second International Congress of the History of Science and Technology, which assembled in London on June 29–July 4, has achieved a notable success, thanks to the untiring efforts of its distinguished president, Dr. Charles Singer, and the executive committee, and thanks also to the active interest it has aroused among scientific workers and historians throughout the world. The Congress, which was really the first of its kind, originated with the Comité International d'Histoire des Sciences, which was founded at Oslo on Aug. 17, 1928. It has, however, been fortunate in enlisting the co-operation of the Comité International des Sciences Historiques, of the American History of Science Society, and the Newcomen Society for the Study of the History of Engineering and Technology, of London. It has thus been possible to show, in its widest extent, the important part played by the sciences in historical and technical research. The papers and discussions of the Congress, and the large attendance of official representatives, who came not only from most of the universities of Great Britain and the Empire, but also from the Continent, North and South America, Asia, and Africa, bear witness to this fact.

At the inaugural session of the Congress, which was opened by the President of the Board of Education, the Right Hon. H. B. Lees-Smith, M.P., in the Great Hall of the Royal Geographical Society, Dr. C. Singer read some paragraphs of his inspiring presidential address on "The Beginnings of Science", which was published in full in NATURE of July 4. He emphasised the dynamic rôle of science, which is best illustrated by its history, and pleaded for the introduction into school-teaching of the broad lines of scientific history.

The work of the Congress itself was divided into four main sections, which met most fittingly in the lecture hall of the Science Museum. The first section, with Prof. G. Loria (Genoa) as chairman, dealt with "The Sciences as an Integral Part of General Historical Study". In his opening paper, Prof. G. N. Clark (Oxford) showed the complexity of the relations between the history of science and general history, and claimed that science has more truly a history than have other human activities, owing to the fact that the history of science is distinguished by more definite achievements and a more orderly development. This point was further emphasised by Sir William Dampier-Whetham (Cambridge), who proposed that the teaching of history should follow the natural order of its development, moving onward from primitive emotions to law, economics, and science. In support of these views, Dr. T. Greenwood (London) maintained in his paper that even the development of mathematics is a necessary constituent of both philosophy and technology, and illustrated the point that a critical history of mathematics should help in getting a deeper knowledge of the various philosophical systems which, in turn, provide the fundamental causes of the periodical and progressive changes in the mental and material outlook of the human race. Some stimulating remarks were made in this connexion by Prof. A. V. Hill (London), who submitted that if history is to deal with human greatness, with things which have given man control of himself and his surroundings, that have relieved him of superstition, ignorance, ill-health, and incompetence in the face of natural forces, then the great figures of science and their discoveries deserve a more worthy place even in children's history-books. For after all, the forces that move us are forces of our own making, which cannot be of less importance than the results they produce.

To this individualistic interpretation of history and to the paramountcy of the history of science, the representatives of the U.S.S.R. took exception, and proposed instead a communistic explanation of scientific development, in which the integrative work of the masses is exalted at the expense of the glorification of genius. Prof. B. Zawadovsky (Moscow), for example, does not conceive history as the history of personality, but rather as the process of development of mankind conforming to certain laws, as a social whole in all the multiformity of its class structure. From this angle, the history of science begins only from the moment when we discern the particular conditions of material culture and the economic requirements of production which determine the direction of the interests of the scientific workers concerned, and the readiness of society to utilise their discoveries. In seconding this opinion, Prof. E. Colman (Moscow) was able to illustrate the influence of the spiritual atmosphere of his time on Darwin himself by means of a letter written by the great naturalist to Karl Marx, in which Darwin admits having refrained from writing on religion in order to avoid surprising his contemporaries and his relatives, although he was all the same an advocate of free thought on all subjects. Prof. M. Rubenstein (Moscow) shared the views of his colleagues, suggesting that history has not been made by great men, but by the economic and social forces of which they have been the expression. It might be said here that the attitude of the Soviet delegates can scarcely explain any history, however stimulating their message and their endeavours to put it into practice in their own educational institutions.

The second section of the Congress, with Prof. W. H. Welch (United States) in the chair, discussed the important problem of "The Teaching of the History of Science". M. Aldo Mieli, the active permanent secretary of the Comité International d'Histoire des Sciences and editor of *Archeion*, told the Congress how this body is directing an inquiry into the teaching of scientific history, which will be completed in time for the Congress of History to be held at Warsaw in 1933. Going into the heart of the debate, Prof. A. E. Heath (Swansea) tried to show that our social and cultural disharmonies are largely due to our failure to acclimatise ourselves to modern cosmologies; and proposed, as a solution of this difficulty, the creation of a scientific history more in accord with the facts of the modern world. On the other hand, in advocating the development of special courses in the history of science in secondary schools and colleges, Prof. F. S. Marvin (University of Cairo) outlined, in his paper, the advantages to be gained by introducing the historical side into scientific work: such a method would present science as a growing thing; it would show the link with the other aspects of our knowledge; it would present the mass of scientific facts in a more human form; and finally it would illustrate the collective work of the human mind, building up an increasingly coherent framework of the universe. One may add, too, that the history of science can suggest new lines of research, and thus lead to unexpected discoveries.

Prof. A. Wolf (London) outlined the teaching of the history of science in the University of London, which owes so much to his own efforts, pointing out as one of the difficulties of the organisation of such courses the existing hostility towards new subjects, which are wrongly imagined by many to be side lines to something else. Prof. P. Diepgen (Berlin), Prof. H. Dannemann (Bonn), Prof. Q. Vetter (Prague), Prof. M. Stephanides (Athens), and Prof. D. E. Smith (United States) gave some interesting details about the teaching of the history of science in their respective countries; while Prof. Laignel-Lavastine, the new holder of the chair of the History of Medicine in the University of Paris, expressed the feeling of the whole Congress when he urged the necessity of university chairs of the history of science in the principal universities of the world.

The third section of the Congress was devoted to the "Historical and Contemporary Inter-relationship of the Physical and Biological Sciences", and was presided over by Prof. W. Ritter (United States). It developed into a lively debate between 'organicists', represented by Prof. J. S. Haldane, Prof. D'Arcy Thompson, Dr. E. S. Russell, and Mr. L. L. Whyte, and the 'mechanists', represented by Dr. J. Needham, Dr. J. H. Woodger, Prof. L. Hogben, and Prof. Baas-Becking (Holland). The case for organicism was put forward forcibly by Prof. J. S. Haldane (Oxford), who claimed the independence of biology from physics, while admitting that the advances of physics during the present century have made it much easier to realise the true relations between these sciences. The discovery that atoms are not mere inert elastic bodies, but centres of intense specific and persistent internal activity, and that on this internal activity their physical and chemical properties depend, has upset the physical conceptions which we inherited from Galileo and Newton. Atoms seem now as if they had properties similar to those which the vitalists attributed to living organisms. Yet, on the other hand, biology deals with parts and events which are manifestations of the co-ordinated whole which we call the life of the organism. Hence, it looks as if, while we shall retain the old physical and mathematical conceptions for practical purposes, the more fundamental physical and mathematical conceptions are assuming characters similar to those of biology. This fundamental attitude was further explained by Mr. L. L. Whyte, who showed how the study of the structure of material bodies and of radiation is beginning to influence biology. The adequate description of ordered structures, which was impossible by classical methods, is now expressed by ' quantum conditions ' which refer to systems as a whole, each part having in it definite positions and motions. Thus the conflict between the analytical methods of classical physics and the organic concepts of biology is thinned down to such a point that it may be hoped to see the study of biology leading ultimately to the discovery of exact biological laws defining the structural characteristics of living systems.

Dr. Needham's cry for an increase in the use of the style of physics in biology, and Dr. Russell's slogan, 'Back to Aristotle', alike strengthened the resistance of the mechanists, who, like Prof. L. Hogben (London), emphasise that there was never a time when biologists entertained more confidence in the usefulness of classical physico-chemical methods as instruments for arriving at predictable conclusions about how organisms behave. The ecclesiastical origins of modern culture and the contemporary social unrest were quoted as causes for the public distrust of the mechanist conception of life, at a time when the materialistic tradition appears to be entrenched in the laboratory more strongly than ever before. Dr. J. H. Woodger (London) went a step further by proposing to apply to the study of biological questions, not only physical methods, but also an appropriate notation of mathematical logic derived from the method of Russell and Whitehead. He was thus led to predict a gradual displacement of the notion of 'stuff' by that of 'system'; so that the notion of 'protoplasm' or 'living matter' would have to go the way of 'hereditary substance', when the scientific worker will learn to think of cells more in term of systems, and less in terms of stuff. A mechanist conception of biology seemed to linger also in the mind of Prof. A. Joffe (Moscow), though he admitted that physicists have to use biological methods for the finest measurements. He quoted the experiments of Prof. Gurtwitsch, who claims to have discovered ' biological rays ', in support of the closer relationship between physics and biology, which will lead in time, he hoped, to the disappearance of the ' mysterious ' vitalistic conceptions.

The fourth section of the Congress, presided over by Sir Henry Lyons, Director of the Science Museum, dealt with "The Interdependence of Pure and Applied Science". Sir Napier Shaw, Prof. C. H. Desch, Prof. F. G. Donnan, Dr. G. Windred, Mr. R. V. Vernon, Dr. Marie Stopes, and Prof. W. Mitkewich illustrated the various aspects of the problem, and seemed to agree that a study of scientific history makes it evident that there can be no independence between pure research and experiment on one hand, and the practical application of scientific principles on the other hand. Further, it appears that the present tendency of intense specialisation makes the progress of science more than ever dependent upon the co-ordination of pure and applied science.

At a meeting of the Committee on July 5, the following were elected members of the International Council for the period 1931–34: Prof. Karl Sudhoff, of Leipzig (*President*); Prof. Gino Loria (Genoa), Dr. Charles Singer (London), Prof. Paul Diepgen (Berlin), Prof. Julian Ribera (Madrid), Prof. George Sarton (Harvard); Mme. Hélène Metzger, of Paris (*Treasurer*), and M. Aldo Mieli, of Paris (*Secretary*). The next Congress will be held in Berlin in 1934.

Such was the general trend of the labours of the Second International Congress of the History of Science and Technology. As Dr. Singer has long been claiming, the history of science can take its place not only among the departments of high scholarship, but also as an integral part of training and discipline in the general study of history. Science cannot assume her just position in education until the educator himself recognises the part that science has taken in shaping the social and intellectual environment in which we live. If the scientific process come to be recognised as a great part of our great inheritance, the Congress will have gone a good way towards achieving its objective. THOMAS GREENWOOD.

The British Australian New Zealand Antarctic Research Expedition.

THE second cruise of the *Discovery*, under the title of the British Australian New Zealand Antarctic Research Expedition, ended on March 27 with the arrival of the ship and party at Melbourne. The health of Sir Douglas Mawson and his men has been excellent, and they have added greatly to our scientific knowledge of the Antarctic continent.

It has been definitely established that the coast-line is continuous through a great arc from Cape Adare to Enderby Land, which is nowhere far removed from the Antarctic Circle. New land totalling 16° of longitude has been discovered, and further detailed charting has been carried out of the 13° discovered on the first cruise last year. The field work extended through one-third of the circuit of the Antarctic region, beginning at the new 180th meridian and ranging west to long. 60° E. Additional features have been added to the coast lines of Adelie Land and Wilkes Land. It has been shown that there is no land in the latitudes assigned for North's Highland, Totten's Highland, or Budd's Land. The name Banzare Land (from the initials of the Expedition's title) has been given to a stretch of territory running from a well-defined cape near the juncture of the 66th parallel and the 127th meridian. It is proposed to maintain the title Sabrina Land for an area observed from the aeroplane between the 115th and 116th meridians at about the 66th parallel. At the end of Wilkes Land is an ice land about 1300 ft. high, which has been charted as Bowman Iceland, in honour of the Director of the American Geological Society. Princess Elizabeth Land is a newly discovered region commencing at the 80th meridian on the 76th parallel and extending south and west in a great sweep to Cape Amery. All the salient features of the MacRobertson Land coast have been charted and named. It is a most interesting region, diversified with mountains, peaks, and islands.

Apart from the geographical work, an immense mass of scientific data has been accumulated by the Expedition. Considerable delineation of the sea floor has been possible with an echo sounder, and many examinations of vertical marine stations were carried out. Daily nettings for marine life and chemical examination of waters have been made, as well as investigations on bacteria in sea water and their rôle as denitrifiers. A two-hourly meteorological record was maintained, and the pilot balloon work was very successful. An interesting fact established is that the violent winds of certain parts of the Antarctic are mainly confined to the surface, seldom extending more than 500 ft. or 1000 ft. above ground-level. Useful observations in magnetics, solar radiation, and cosmic penetration have been made, while, of course, a rich harvest has been reaped in glaciology, geology, and ornithology.

The *Discovery* sailed from Melbourne about the middle of April and, if not delayed, may be expected in London shortly.

A New Heat Engine.

At the Royal Society of Arts on June 4, Mr. J. F. J. Malone, in a paper entitled "A New Prime Mover", gave a description of a form of heat engine, invented by himself, in which the working medium is a liquid instead of a gas. In the course of his paper he stated that though mercury and oil have been tried, water has been found to be the most suitable medium, and in the engines to which reference was made only water has been used.

The main parts of the new form of engine consist of one or more working cylinders, a large number of long thick steel tubes in each of which is a movable displacer or regenerator, and a furnace. The tubes the author calls the thermodynamic tubes or 'T.D. tubes', and the regenerators, the thermodynamic piles or 'T.D. piles'. The tubes are closed at one end and at the other end are connected by pipes to the working cylinders. They are set in groups with their closed ends in the furnace, while the other ends are surrounded by water for cooling. The T.D. piles are built up of thin plates or tubes very closely spaced. The interior of the T.D. tubes, the very narrow spaces in the piles, the connecting pipes, and the working cylinders form a closed system completely full of water, which, when the engine is prepared ready for starting, is under an initial pressure of 1·4 tons per sq. in.

The engine depends for its action on the alternate expansion and contraction of the water in the system, due to the heating and cooling of the water in the T.D. tubes and piles, as the latter are moved to and fro in the tubes. For all practical purposes, the moving of the piles, which is done automatically by the engine, is equivalent to the alternate application and removal of the source of heat. Under these conditions the moving of the piles causes the pressure to rise to about 5·3 tons in one part of the stroke and then to fall to 1·4 tons per sq. in. Much ingenuity has been shown in the construction of the piles, which at first sight might appear likely to give trouble, but which have proved reliable on service.

Unfortunately, though the paper gave a few details of the several engines which have been built and run, these were by no means sufficient to form an estimate of the place the engine is likely to fill. One experimental engine was said to have run over 30,000,000 revolutions, and on three brake tests by three different independent engineers an indicated efficiency of 27 per cent was obtained. It was also stated that allowing for furnace and mechanical losses, it was anticipated with a 100 h.p. engine an over-all efficiency of 20 per cent can be obtained, and this on a weight of about 330 lb. per indicated horse power. In the conclusion of his paper Mr. Malone claimed that the new engine possesses features which make it suitable both for locomotives and for ships.

University and Educational Intelligence.

Birmingham.—The degree of D.Sc. has been awarded to the following: Jonquei Su-Kwang Lee, for published work on "The Fusulinidæ of North China" (*Palæontologia Sinica*, series B, vol. 4), "Some Characteristic Structural Types in Eastern Asia and their Bearing upon the Problem of Continental Movement", "Geology of the Gorge District of the Yang-tse with special Reference to the Development of the Gorge", and other papers; Harry W. Webb, for published work on "Absorption of Nitrous Gases", "Limitation of the Capacity of Platinum Catalyst in Ammonia Oxidation", and other papers.

Dr. A. Stanley Barnes has been appointed Dean of the Faculty of Medicine, in succession to Prof. Brash.

The following appointments have been made: Dr. R. H. Hopkins, lecturer and head of the Department of Brewing in the Heriot-Watt College, Edinburgh, to the Adrian Brown chair of brewing; Mr. R. D. Lockhart, lecturer in anatomy, University of Aberdeen, to the chair of anatomy; Mr. P. Gray and Mr. D. Richards, to be resident staff tutors for adult education under the Joint Committee of the University and the W.E.A.

Prof. A. M. Carr-Saunders has accepted an invitation to hold the Muirhead Lectureship for a further year.

Cambridge.—The Harkness scholarship for proficiency in geology, of value £117, has been awarded to Miss F. E. S. Caldwell, of Newnham College.

The Frank Smart prizes have been awarded to P. W. Richards, of Trinity College, for botany, and P. Ullyett, of Trinity College, for zoology.

Edinburgh.—At the graduation ceremony on July 2 the honorary degree of doctor of laws was conferred on the following, among others: Dr. E. J. Allen, Director of the Marine Biological Laboratory, Plymouth; Sir George Andreas Berry, M.P. for the Scottish Universities, formerly lecturer in ophthalmology in the University of Edinburgh; and Sir Walter Morley Fletcher, secretary of the Medical Research Council.

The degree of doctor of science was conferred on Lucy Boyd, for a thesis on "Studies in the Post-Seminal Development of the Monocotyledonous Embryo"; A. Cunningham, for a thesis on "Studies on Soil Micro-Organisms"; Esmé Mary Gilroy, for a thesis on "The Influence of Arginine upon Growth and Tissue Repair"; Dr. M. Young, for a thesis on "A Contribution to the Study of the Growth of the Face in Childhood".

Leeds.—At a graduation ceremony in connexion with the hundredth anniversary of the Leeds School of Medicine, the following honorary degrees were conferred, among others: Degree of doctor of laws—Prof. A. G. Barrs, emeritus professor of medicine at Leeds and for more than fifty years connected with the School of Medicine; Sir John Bland-Sutton, consulting surgeon at the Middlesex Hospital; Lord Dawson of Penn, president of the Royal College of Physicians; and Sir George Newman, Chief Medical Officer, Ministry of Health. Degree of doctor of science—Sir Walter Morley Fletcher, secretary of the Medical Research Council; and Sir Frederick Gowland Hopkins, president of the Royal Society

London.—The late Mr. J. F. H. Knight has bequeathed to the University a moiety of his residuary estate for the furtherance of teaching and research in the University. The bequest is expected to amount to about £25,000.

NOTTINGHAM.—Dr. Henry L. Brose, at present reader in atomic physics, formerly Rhodes Scholar at Christ Church, Oxford, has been appointed to the chair of physics, which is about to become vacant owing to the retirement of Prof. P. E. Shaw.

ST. ANDREWS.—At a meeting of the University Court on June 23, Dr. F. L. Arnot, of Trinity College, Cambridge, was appointed lecturer in natural philosophy in the United College, St. Andrews, as from Oct. 1. Dr. George L. Montgomery was appointed lecturer in clinical pathology in the University.

The Court confirmed the acceptance of contracts for the erection of a new building for the botany and geology departments, a new lecture theatre for the zoology department, and a new laboratory for the anatomy department, to form part of the group of Bute Medical and Bell-Pettigrew Museum Buildings at St. Andrews.

DR. J. D. STIRLING has recently been appointed to the staff of the Hannah Dairy Research Institute, Kirkhill, Auchincruive, Ayr. For the past three years Dr. Stirling has been doing research work in biochemistry at the University of Glasgow under the direction of Prof. E. P. Cathcart, and later at Tübingen in Germany and Graz in Austria.

THE second year's awards of the Sir James Caird Travelling Scholarships have recently been announced. The scholarships were instituted by the will of the late Mrs. Emma Grace Marryat, who was a sister of the late Sir James Caird, Bart., of Dundee. A sum of £200,000 was appointed to be held in trust for the foundation of the scholarships in engineering, electricity, aeronautics, and music. Only natives of Scotland, of either sex, who are not already holders of scholarships similar in nature to those offered, are eligible for these scholarships. Two classes, junior and senior, are offered. The value of the junior varies from £50 to £150 and the senior from £250 to £600 per annum. Each scholarship is tenable for one year; but may be extended yearly to a maximum of three years. Among the scholarships awarded for this year were the following: Engineering (junior of the maximum of £150), T. C. Inglis, W. A. Sangster; (senior of the normal amount of £400), J. Jamieson. Electricity (junior of the maximum of £150), J. C. M. Sanders, H. C. Thompson; (senior of the normal amount of £400), M. D. Kippen, J. M. Dodds. Aeronautics (senior scholarship of £300), J. A. J. Bennet.

THE Medical Research Council has made the ollowing awards of travelling Fellowships for the academic year 1931–32 on behalf of the Rockefeller Foundation: Mr. E. T. Conybeare, Guy's Hospital, London; Mr. G. M. Dean, Department of Surgery, University of Aberdeen; Mr. M. H. Finkelstein, Department of Bacteriology, University of Edinburgh; Prof. O. S. Gibbs, formerly professor of pharmacology, Dalhousie University, Canada; Mr. E. M. Lourie, Liverpool School of Tropical Medicine; Mr. A. W. Spence, St. Bartholomew's Hospital, London; Mr. C. H. Waddington, Strangeways Research Laboratory, Cambridge; M. K. H. Watkins, Royal Infirmary, Manchester. The Fellowships awarded to Prof. Gibbs and Mr. Waddington are tenable in Europe, the others at centres in the United States. These Fellowships are awarded to graduates who have had some training in research work either in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a chosen centre in the United States or, in special cases, in Europe, before taking up positions for higher teaching or research in the British Isles.

Societies and Academies.

EDINBURGH.

Royal Society, June 15.—A. H. Reginald Buller: (An address) Recent advances in our knowledge of the higher fungi. A mushroom is the reproductive part of the mushroom plant and is produced at the expense of the mycelium or spawn. A large mushroom may develop and liberate upwards of 10,000,000,000 spores. The basidiospores of all Hymenomycetes, all Uredineæ, the smut-genus *Tilletia*, and the yeast-genus *Sporobolomyces* are shot away by a drop-excretion mechanism, but exactly how this mechanism works is still a profound mystery. The terminal rate of fall of spores in still air varies with the size of the spores from about 0·5 to 4·0 mm. per sec. Spores are discharged from the under side of the caps of mushrooms and toadstools in a continuous stream for days or weeks. The clouds of spores escaping from a fruit-body can be made visible in a darkened room by means of a beam of light. Nocturnal excursions with an electric lamp may be made to observe spore-discharge from fruit-bodies attached to tree-trunks, etc. The organisation of the hymenium which covers the gills of mushrooms and toadstools has been worked out, and the time and space relations of the basidia which produce the spores and of the sterile elements called paraphyses are now known. The basidia come to maturity in a series of successive generations. The sexual process in mushrooms and toadstools is initiated in the mycelium with nuclear association, is continued there with conjugate nuclear divisions, and is completed in the fruit-body by nuclear fusion in every basidium.—**J. Thomson**: The ionising efficiency of electronic impacts in air: Experiments are described, the aim of which is the determination of the average energy required to produce one pair of ions in air by electronic impact, the initial energy of the electron being defined. The results show that the total number of ions produced is a linear function of the initial electronic energy. Hence it is shown by extrapolation that for fast-moving electrons (such as β-rays) the energy per ion-pair is 37 ± 2 electron-volts. This result is discussed in relation to other investigations, and the extrapolation is thereby justified.

PARIS.

Academy of Sciences, May 18.—A. Lacroix: The nepheline and leucite phonolites of the island of Ua-Pou (Marquesas Archipelago).—**A. Cotton**: Comparison of the magnetic rotations of crystallised quartz and fused quartz. The specific magnetic rotation of fused quartz was found to be greater than that of crystallised quartz.—**L. Cayeux**: The petrographic characters of the magnesian irregularities in the chalk of the Paris basin.—**Charles Richet**: The reflexes of acquisition (Pavloff's conditional reflexes). A claim for priority as regards the work of Pavloff.—**Charles Nicolle and Ugo Lumbroso**: The *Bacterium granulosa* of Noguchi in its relations with the etiology of trachoma. Two strains of this bacillus (Noguchi, Olitski) proved to be devoid of pathogenic power. It is mentioned as possible that there might have been an attenuation of the virulence due to the age of the culture.—**S. Finikoff**: Congruences of which the two sheets of the focal surface are projectively applicable one on the other by the corresponding focal points.—**Marcel Vasseur**: A geometrical interpretation of Moutard's transformation.—**J. Leray**: A system of partial differential equations which governs the permanent flow of viscous fluids.—**Mlle. Nina Bary**: The representation of continued functions by means of functions with limited variation.—**R. Gosse**: The investigation of a category of equations of the first class.—**Stefan Kempisty**: The integral (A) of Denjoy.—**A. Rauch**: The generalisation of theorems of Valiron on meromorph functions of positive order.—**Jean Brille**: A property of functions presenting a certain complex character of resolvability.—**F. E. Myard**: Closed chains with four rotoid non-concurrent couples, deformable at the first degree of freedom. Toric isogram.—**Henri Poncin**: Cavitations (in fluids) of permanent form.—**A. Lafay**: The deviations of the push of the wind on a cylinder produced by very small superficial projections on the latter.—**Mme. G. Camille Flammarion**: Photographs of the planet Mercury. A detailed description of the markings observed is given, with a drawing. It is the first time that details of the surface of this planet have been obtained by photography.—**Ž. Horák**: The space-time line of a material point in classical mechanics.—**G. Ribaud**: The distribution of the temperatures in the cross-section of a flat incandescent filament.—**R. Jouaust and N. Stoyko**: The propagation of short radio-electric waves. For some time in 1930 and 1931 radiotelegraphic transmissions on 18·5-metre waves between Indo-China and France were bad; for each signal sent more than one was received. The difference of time between the two signals received has been measured on a Blondel oscillograph and found to be 0·0681 second. In the light of this figure, two hypotheses regarding the paths of the waves are discussed.—**P. David**: A valve generator with very stable frequency. Instead of controlling the frequency of an emitting valve with a quartz oscillator or tuning fork, the author proposes the use of a valve with two grids, and describes the arrangement of the circuit found to be most suitable. For variations in the voltages of 15 per cent the variations in the frequency do not exceed five millionths.—**F. Esclangon**. The theory of the discharge without electrodes. According to the theory of Sir J. J. Thomson, the electrodeless discharge in a rarefied gas placed inside a solenoid carrying a high-frequency current is to be attributed to the electric field induced by the alternating magnetic field of the solenoid. Townsend and Donaldson showed that the electrostatic changes on the turns of the solenoid produce an additional and more intense field. Experiments are described by the author by which these two effects can be separated.—**Mlle. Paule Collet and G. Foex**: The influence of the field on the magnetic states of platinum. In these experiments the magnetic fields varied from 14,000 gauss to less than 3000 gauss, and the temperature from − 180° C. to 200° or 400° C. The results are summarised in two diagrams.—**P. Lainé**: The errors introduced by inexactitude of the half-wave plates in the analysis of slightly elliptical vibrations, and on the standardisation of half-wave and quarter-wave plates.—**C. Salceanu**: The natural and magnetic rotary polarisation of some organic compounds studied in the liquid state. Wiedemann's rule, that the ratio of the magnetic to the natural rotation is independent of the wave-length, holds for menthol, but not for fused camphor or carvone.—**S. Takvorian**: Investigation on element 61 by means of the X-rays. Starting with 14 kilograms of cerium earths, after a preliminary treatment increasing the proportions of neodymium and samarium oxides, the method of fractional crystallisation of the double magnesium nitrates was used. The fractions examined, which were those in which element 61 ought to be concentrated, and which only represented 1/200th of the weight of the initial oxides, gave no evidence of the presence of element 61, at least in a proportion higher than 1 in 10,000.—**M. Schérer**: The magnetic double refraction of liquid hydrocarbons.—**A. Sanfourche**: The electrometric titration of phosphoric acid. The results obtained with hydrogen and quinhydrone electrodes using soda, lime, strontia, and baryta as alkalis are shown graphically.—**Mlles. C. Chamié and A. Korvezee**: The centrifugation of solutions of polonium in the presence of various electrolytes. A solution of polonium, filtered before the experiment, gives a precipitation of 40 per cent of the polonium. This proportion is increased by the addition of electrolytes ranging from 50 per cent for sodium nitrate to 99·6 for silver nitrate.—**H. Colin and Mlle. A. Chaudun**: The hydrolysis of sugar by strong acids in the presence of their salts.—**Barbière and Desmaroux**: The solvent power of the alcohols for the nitrocelluloses.—**F. Bourion and Mlle. O. Hun-**: The boiling point determination of the molecular equilibria of pyrocatechol in lithium chloride solutions.—**A. Damiens**: A new porcelain without silica, based on pure fluorspar. Starting with mixtures of finely divided fluorspar and precipitated calcium fluoride, it has been found possible to prepare a material resembling porcelain, and which is unattacked by fluorine or by hydrofluoric acid.—**G. Arrivaut**: The action of arsenic chloride upon nickel. The first product of the reaction between finely divided nickel and an acid solution of arsenious chloride was the compound Ni_3As_2.—**J. Bougault and G. Schuster**: A new triglyceride obtained from cocoa butter: a palmitostearoazelain.—**Tseou Héou-Féo**: The condensation of an amine and of formaldehyde with quinaldine and picoline.—**J. Wyart**: Study of chabase.—**A. Rivière**: Remarks on the stratigraphy of the base of the Eocene in central Elbourz.—**Jean Lacoste**: Tectonic observations on the southern Rif (Moulay Bou Chta region).—**Joseph Blayac and Marcel Thoral**: The discovery of Georgian Trilobites in the Montagne Noire (Hérault).—**J. Thoulet**: Deep submarine volcanoes.—**H. Arsandaux**: The morphological evolution of the dome of Montagne Pelée.—**F. Roman and J. Dareste de la Chavanne**: The presence of an elk (*Alces latifrons*) in the upper Pliocene of Senèze (Haute-Loire).—**A. Duparque**: The microscopic structure and origin of anthracite.—**Alfred Carpentier**: Some imprints of seeds of Pteridosperms.—**Mlle. G. Py**: The evolution of the cytoplasmic constituents of the nutritive layer of the pollen in *Vincetoxicum officinale*.—**A. Guillaumin**: The transformation of the lower portion of the axis of inflorescence into a hook in the Uncaria.—**Paul Becquerel**: The development of the male fern in a pure aseptic culture starting from the spore.—**J. Chaze**: Experimental proofs of the excretion of nicotine from the aerial parts of the tobacco plant. A direct proof is given that nicotine is excreted by the tobacco plant and evaporated into the surrounding air.—**M. Bridel and C. Charaux**: The purgative complex of elder buckthorn bark, soluble in water and hydrolysable by rhamnodiastase.—**Henri Perrin**: Indices of aridity and types of forest vegetation.—**Charles Pérez**: Statistics of infestation of hermit crabs by *Chorogaster*.—**Mme. Lucie Randoin and Mlle. Andrée Michaux**: Variations in the proportion of globulin and serum in blood serum under the influence of a diet thrown out of equilibrium by the complete absence of antiscorbutic vitamine.—**J. Vellard**: Poison of the ray (*Tœniura*) from the Rio Araguaya (Brazil).—**Emile Haas**: The extent to which the central visual acuteness is altered when a very bright object is near the test to be defined. A study of the effects of dazzle.—**A. Leulier and B. Drevon**: Action of the blood on morphine chlorhydrate.—**H. Bierry**: Specificity and chemical structure.—**Bunzô Hayata**: The dynamic system of plants based on the theory of participation.—**J. Laurin**: The hypoglycæmic action of the bulbs of *Allium cepa*.—**Raymond-Hamet**: The mechanism of the action of the sympathomimetic amines.

Geneva.

Society of Physics and Natural History, Feb. 19.—**G. Dejardin**: (1) The utilisation of ultra-violet light in photoelectric cells with glass bulbs. The author exhibits photoelectric cells in which the quartz, as transparent material, is replaced by an extremely thin glass window (some hundredths of a millimetre). For ordinary cells, without the thin wall, the spectrum range can be extended considerably by depositing on the window a thin layer of a fluorescent substance such as mineral oil, vaseline, or esculin incorporated in gelatine.—(2) The extension of the spectrum sensibility of photoelectric cells under the action of oxygen. The spectrum sensibility of very thin films of the alkali metals increases considerably when the surface of the metal serving as the support (copper, silver, magnesium) is oxidised. In the case of potassium, the presence of the oxygen produces a displacement of the whole spectrum towards the red of the sensibility curve. The author shows that by this method films can be obtained with potassium which can in many cases replace those of cæsium.—**E. Briner** and **B. Susz**: The maximum concentration of endothermic compounds at high temperatures (calculated in collaboration with E. Rod). Following on earlier researches, the authors establish by calculation the existence of a maximum concentration for endothermic compounds such as ozone and nitric oxide. For ozone the maximum concentration is very low. For nitric oxide it amounts to 3·6 per cent at 4000° Abs. in an equimolecular mixture of nitrogen and oxygen at atmospheric pressure.—**P. Balavoine**: The analytical characters of caramel regarded as a colouring matter for food. A close study of certain analytical characters of this colouring matter compared with artificial colouring matters. A new reaction is described suitable for detecting caramel in the presence of other natural colouring matters.—**G. Ladame**: The central Rhodopes and the Balkans. Geological and mining outline. After some brief geological data based on the work of Stephan Bončev, the author gives five analyses of selected specimens of sulphide ores of zinc, lead, and copper, the latter containing more or less silver. Fairly numerous researches have not resulted in extensive mining operations. There are important deposits of tertiary lignites, and mining for these is more probable.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 1, Jan. 15).—**Matilda Moldenhauer Brooks**: The penetration of 1-naphthol-2-sulphonate indophenol, *o*-chloro phenol indophenol, and *o*-cresol indophenol into *Valonia*. As with indigo sulphonates, the first does not penetrate into the sap, suggesting that the sulphonate radicle is responsible. The other dyes penetrate in a colourless form.—**Henry Borsook** and **Howard M. Winegarden**: (1) The work of the kidney in the production of urine. The minimum work performed by the kidney in man in the production of urine, analysed by the second law of thermodynamics, is of the order of 0·7 gm. cal. per c.c. of urine or 70 gm. cal. per gm. of nitrogen excreted.—(2) The energy cost of the excretion of urine. Production of hyper- or hypotonic urine entails work by the kidney. The energy consumed by the normal healthy kidney in man is 6-11 kgm. cal. per gm. nitrogen excreted, an efficiency of only 1-2 per cent. The healthy kidney has a great capacity for work, which is much reduced by disease, drugs, etc. The paper contains an extensive review of work on the subject.—**J. H. Hodges** and **E. F. Linhorst**: The thermal decomposition of nitrogen pentoxide. At 35° C., the reaction appears to be unimolecular at partial pressures of 0·12 mm. to 0·06 mm.; below 0·06 mm. pressure, specific reaction rate decreases with pressure, and below 0·004 mm. pressure it appears to be bimolecular.—**Oscar Knefler Rice**: On the transfer of energy between atoms at collision. A theoretical discussion. A modification of Born's method is outlined, taking into account the mutual kinetic energy of the particles. The method gives an upper limit to the radius of action.—**G. A. Miller**: Groups which admit five-eighths automorphisms.—**M. S. Knebelman**: Multivectorial curvature.—**Tracy Yerkes Thomas**: On the unified field theory (3). A general existence theorem is derived and the characteristic surfaces of the four-dimensional world are determined.—**E. H. Kennard**: Quantum mechanical motion of free electrons in electromagnetic fields. Formulæ are obtained by Ehrenfest's method for the motion of the centroid of a wave-packet; only the non-relativistic case is considered, based on Schrodinger's equation. The general result is that in a uniform electric or magnetic field the packet-centroid moves as an electron should according to classical theory, and in non-uniform fields its acceleration is a kind of average of the classical value.—**Carl Størmer**: Remarks on a paper: Note on the nature of cosmic rays, by Paul S. Epstein. The results for the motion of electrons in the field of an elementary magnet obtained by Epstein (*Proc. Nat. Acad. Sci.*, Oct. 1930) were derived by Størmer in 1904.—**Ernest O. Lawrence** and **David H. Sloan**: The production of high-speed canal rays without the use of high voltages. A series of metal tubes in line are attached alternately to the inductance of a high frequency oscillatory circuit. An ion between the first and second tubes is accelerated into the second tube, and if the length of this tube is such that the time taken to pass through it is equal to the half-period of the oscillator, the ion will be further accelerated into the third tube and so on. An apparatus containing twenty-one accelerators has been made and with it mercury ions of kinetic energies of more than 200,000 volts have been obtained with a maximum applied voltage of about 10,000 volts. The method is capable of further development.—**G. Breit**: On the interpretation of Dirac's α-matrices.

Official Publications Received.

British.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1362 (E. 44—I.C.E. 782): Detonation, Mineral Lubricating Oils and Blended Fuels By R. O King and Dr. H. Moss. Pp. 11+7 plates. 9*d*. net. No. 1367 (Ae. 494—T. 3022): Longitudinal Control and Stability when Stalled. By E. T. Jones and R P. Alston. Pp. 8+11 plates. 9*d*. net. No. 1366 (Ae. 493—T. 3021). Drag and Heat Dissipation of Three Radiator Systems. By E. T. Jones. Pp. 14+9 plates. 1*s*. net. No 1368 (Ae. 495—T. 3049): Flow of Air adjacent to the Surface of a Rotating Cylinder in a Stream. By E. G. Richardson. Pp. 12+12 plates. 1*s*. net. No. 1359 (Ae. 490—T. 3017): Heat Transmission between Surfaces and Fluids flowing over Them. (1) The Case of Two-Dimensional Flow. By W. F. Cope. Pp. 8+2 plates. 6*d*. net. No. 1365 (E. 45—I.C.E. 787): The Limits of Compression Ratio in Diesel Engines By D. R. Pye. Pp. 9+3 plates. 9*d*. net. No. 1373 (Ae. 500—T. 3037): Eddies behind a Circular Cylinder. By Dr. A. Thom Pp. 8+4 plates. 6*d*. net. No 1370 (Ae. 497—T. 2961): Drag of Circular Cylinders and Spheres. By A. Fage. Pp. 6 + 2 plates. 6*d*. net. (London: H.M. Stationery Office.)

Department of Public Instruction, Technical Education Branch: New South Wales. Technological Museum: Curator's Annual Report for Year ended 31st December 1930. Pp. 6. (Sydney, N.S.W.)

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1930. Pp. 131. (Calcutta: Bengal Government Press.)

Hull Museum Publications. No. 167: Record of Additions. Edited by T. Sheppard. Pp. 43. No 168: Record of Additions. Compiled by T. Sheppard. Pp. 43. No. 169: Bronze-Age Remains, including Beaker, Bracer, Jet Ornaments, Spear Head, and Clay Moulds for Implements, etc. Edited by T. Sheppard. Pp. 33. (Hull.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1344 (Ae. 476: T. 2988): The Influence of a Fuselage on the Lift of a Monoplane. By A. S. Hartshorn. Pp. 14+8 plates. (London: H.M. Stationery Office.) 9*d*. net.

The Himalayan Journal: Records of the Himalayan Club. Edited by Kenneth Mason. Vol. 3, April. Pp. vi+172+11 plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co) 5 rupees; 8*s*.

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1930. Pp. 18. (Pretoria: Government Printing Office.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 414, June. Pp. 673-804+xxvi. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 3, No. 31: The British and Belgian Carboniferous Bellerophontidae. By Dr. John Weir. Pp. 767-861+9 plates. 16*s.* 6*d.* Vol. 57, Part 1, No. 1: An Analysis of the Vegetative Organs of Selaginella grandis Moore, together with some Observations on Abnormalities and Experimental Results. By Dr. S. Williams. Pp. 24+2 plates. 3*s.* 6*d.* (Edinburgh: Robert Grant and Son, London: Williams and Norgate, Ltd.)

University of Birmingham. Executive Board of Mining Research. Report on the Work of the Mining Research Laboratory during the Year 1930. Pp. 19. (Birmingham.)

Foreign.

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University (Publications de la Faculte des Sciences de l'Université Masaryk). Čis. 128: Generis Trigonella L. revisio critica, III. Scripsit G. Sirjaev. Pp. 31. Čis. 129: Příspěvek k analytickému studiu reakcí oximů (Contribution à l'étude analytique des réactions des oximes). Napsali J. V. Dubský, Fr. Brychta a M. Kuraš. Pp. 26. Čis. 130: Contribution à la theorie des séries trigonométriques généralisées et des séries à fonctions orthogonales. Par Dr. F. Wolf. Pp. 34. Čis. 131: Několik poznámek o Markovových řetězech (Quelques remarques sur les chaines de Markoff). Napsal Jos. Kauchy. Pp. 22. Čis. 132: O vlivu kysličníku dusicitého na světélkovaní fosforu (Influence of nitrogen peroxyde on the glow of phosphorus). Napsal Dr. Fr. Schacherl. Pp. 29. Čis. 133: Hydrolysa soli beryllnatých a hlinitych, odvozených od silných kyselin, Část 2 (Hydrolysis of beryllium and aluminium salts derived from strong acids, Part 2). Napsal Václav Čupr. Pp. 50. Čis. 134: Měreni hydrolysy siranu zinečnateho a kademnatého vodíkovou a chinhydronovou elektrodou (Measurement of hydrolysis of zinc and cadmium sulphates by means of the hydrogen and quinhydrone electrodes) Napsali V. Čupr a O. Viktorin. Pp. 18. (Brno: A. Píša.)

Sborník vysoké Školy Zemědělské v Brně (Bulletin de l'Ecole Supérieure d'Agronomie, Brno). Sign. D17: Příspěvek ke studiu degradace humusokarbonátových půd v oblasti Moravskeho Krasu (The Contribution to the study of degradation of rendzina soils in the Moravian Karst). Napsal Dr. Ivan A. Zvorykin. Pp. 48. Sign. D18: Addenda ad floram Čechoslovakiae mycologicam, V. Scripsit Dr. Richard Picbauer. Pp. 30. (Brno: A. Píša.)

Svenska Sallskapet for Antropologi och Geografi. Geografiska Annaler 1930, Heft 4: The Tidal Force, a Study in Geophysics. By Otto Pettersson. Pp. 261-322. (Stockholm.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 5, Mai. Pp. 241-284. (Prague: Regia Societas Scientiarum Bohemica.)

Bulletin of the Imperial Agricultural Experiment Station of Japan. Vol. 3, No. 2, November 1928. Pp 77-160. Journal of the Imperial Agricultural Experiment Station, Nishigahara, Tokyo. Vol. 1, No. 1, March 1929. Pp. 106+9 plates. Vol. 1, No. 2, October 1929. Pp. 107-182+plates 10-16. (Tokyo.)

Svenska Linné-Sallskapets Årsskrift. Årgång 14, 1931. Pp. vi+196. (Uppsala.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 302: On the Catalytic Oxidation of Non-Benzenoid Hydrocarbons and Mineral Oils in their Vapour. By Rinta Shimose. Pp. 251-276. 30 sen. No. 303: On the Hydrosol of Silicic Acid. 3: On the Stability of the Hydrosol and the Influence of Electrolyte on it. By Kenkyo Inaba. Pp. 277-287. 20 sen. No. 304: On the Separation and Determination of Gallium. 3: The Separation of Gallium from Bivalent Elements and those of the Rare Earths, and the Determination of all these Elements. By Sunao Ato. Pp. 289-301. 40 sen. (Tōkyō: Iwanami Shoten.)

Proceedings of the California Academy of Science. Fourth Series, Vol. 19, Nos. 13 and 14: Report of the President of the Academy for the Year 1930, by C. E. Grunsky; Report of the Director of the Museum and of the Aquarium for the Year 1930, by Barton Warren Evermann. Pp 399-482. (San Francisco.)

University of California Publications in Zoology. Vol. 32, No. 8: Adaptive Modifications in the Woodpeckers. By William Henry Burt. Pp. 455-524. 1 dollar. Vol. 37, No. 1: Critical Comments on Mammals from Utah, with Descriptions of New Forms from Utah, Nevada and Washington. By E. Raymond Hall. Pp. 13 25 cents. (Berkeley, Calif.)

Catalogues.

A Catalogue of Book Bargains. (No. 528) Pp. 16. (London. William Glaisher, Ltd.)

Catalogue de livres anciens et modernes, rares ou curieux, relatifs à l'Orient. (No. 17) Pp 126. (Paris: Librairie Adrien-Maisonneuve.)

Philips X-Ray Tubes, for Structure Research. Pp 9. (London: Philips Lamps, Ltd.)

Autograph Letters, Documents and Manuscripts. (Catalogue 540.) Pp. 52. (London: Francis Edwards, Ltd)

Diary of Societies.

TUESDAY, July 14.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.

THURSDAY, July 16

Genetical Society (at Entomological Society of London, 41 Queen's Gate, S.W.7), at 3.—Exhibits and Demonstrations by Prof. E. B. Poulton, Dr. A. D. Imms, J. C. F. Fryer, and others.—At 5.—Annual General Meeting.

National Smoke Abatement Society (at 71 Eccleston Square, S.W.1), at 3.15.—W. Prescott: Smoke Abatement from the Manufacturers' Point of View (Address).

CONGRESSES.

July 6 to 11 (in Edinburgh).

Congress of Universities of the Empire.

Friday, July 10, at 10.30 a.m.—Address by Sir Donald Macalister, Bart.
At 11 a.m.—Dr. H. L. Eason and others: Discussion on Post-graduate Study in Medicine and Surgery in Great Britain.
Sir Thomas H. Holland and others: Discussion on Facilities for Overseas Students in British Universities.

Saturday, July 11.—Visits.

July 9 and 10.

Ophthalmological Congress (at Oxford).

Friday, June 10.—Dr. Baillart: Tonometry.
P Adams: An Ophthalmological Mélange (Doyne Memorial Lecture).
J. Craig and Prof. Schuller: Discussion on Penetrating Wounds of the Eye.

July 10 and 11.

Society for Experimental Biology (at Rothamsted Experimental Station, Harpenden).

Friday, July 10 (In Chair: Dr. W. B. Brierley).
At 11.30 a.m.—W. H. Pearsall: The Effects of Calcium on the Metabolism of *Chlorella*.
J. H. Priestley: Growth as a Factor in Food-transport in Plants.
M. A. H. Tincker: Some Factors Affecting Tuber Formation.
At 2.—Address by Sir John Russell.
At 5 (In Chair: Dr. A. D Imms).—V. B. Wigglesworth: The Physiology of Excretion in a Blood-sucking Insect, *Rhodnius prolixus*.
R. P. Hobson. Digestion in Blow-fly Larvæ.
At 6.—Business Meeting.

Saturday, July 11 (In Chair: Dr. D. Ward Cutler).
At 10.30 a.m.—N. N. Murti: The Artificial Production of Double-pored Larvæ in *Asterias glacialis*
S. Zuckerman: The Reproductive Mechanism in Primates.
J. S. Huxley: Recent Work on Differential Growth.
Boris Zavadovsky: Research Work at the Institute of Neuro-humeral Physiology, Moscow.
A. T. Yoffe. Recent Work on Mitogenetic Rays.

July 13 and 14.

International Union for Biological Sciences (at Brussels).

July 20 to 23.

British Pharmaceutical Conference (at Manchester)

Monday, July 20, at 8 p.m.—Civic Reception by the Lord Mayor and Corporation.

Tuesday, July 21, at 10 a.m.—Chairman's Address.
At 11.15 a.m. and 2.15 p.m.—Science Meetings.
At 2.15 p.m.—Delegates' Meeting.

Wednesday, July 22, at 10 a.m. and 2 p.m.—Science Meetings.
At 10 a.m.—Delegates' Meeting

Thursday, July 23, at 10 a.m.—Closing Session.

JUBILEE CELEBRATION AND ANNUAL MEETING.

July 13 to 19.

Society of Chemical Industry (in London).

Monday, July 13 (at Central Hall, Westminster), at 11.30 a.m.—Opening of Chemical Plant and Research Instruments Exhibition.

Tuesday, July 14 (at Royal Academy of Music), at 10 30 a.m.—Annual General Meeting.
Sir Harry McGowan: Presidential Address.
(At Salters' Hall, St. Swithin's Lane), at 7 p.m.—Dr. G. Engi: Recent Developments of the Society of Chemical Industry in Basle.
Dr. H. Schicht: Address.
(At Home Office Industrial Museum, Horseferry Road), at 9 p.m—Prof. R. V. Wheeler: Dust Explosions.

Wednesday, July 15 (at Royal Academy of Music), at 10.30 a.m.—Presentation of Society's Medal to Dr. H. Levinstein and Address by the Medallist.

Thursday, July 16 (at Leathersellers' Hall, St Helen's Place), at 10.30 a.m.—Dr. H. Sorensen: Hydrogen Ion Concentration
(At Great Central Hotel), at 10.30 a.m.—Reading and Discussion of Papers.

Friday, Saturday, and *Sunday, July* 17, 18, and 19.—Visits.

SUMMER MEETINGS.

July 13 to 17.

Institution of Mechanical Engineers (at Cambridge)

Tuesday, July 14, at 10 30 a.m.—Prof. C. E. Inglis: Cambridge as a Place of Education (Address).
At 11 a.m.—H. N. Gresley: Locomotive Experimental Stations.

Wednesday, Thursday, and *Friday, July* 15, 16, and 17.—Visits.

July 18 to 23.

Institution of Electrical Engineers (in Northern Italy and Western Switzerland).

NATURE

SATURDAY, JULY 18, 1931.

CONTENTS.

PAGE
Against Foreign Pests . . . 85
Anthropology and Native Administration . . . 86
African Settlement and the Origin of Rift Valleys. By Prof. J. W. Gregory, F.R.S. . . . 87
Human Monstrosities . . . 90
Biochemistry in America. By E. F. A. . . . 90
Short Reviews . . . 91
Deep Oil-Well Drilling . . . 93
The German Bunsen Society in Vienna. By Prof. Fritz Paneth . . . 94
Obituary:
  Sir Hugh Bell, Bart., C.B. By Prof. Henry Louis 96
  Prof. H. Wildon Carr. By Sir Percy Nunn; Prof. S. Alexander, O.M. . . . 98
  Mr. Ernest Noel. By T. E. J. . . . 100
News and Views . . . 100
Letters to the Editor:
  The Excitation Potentials of Metallic Lithium.—Dr. H. W. B. Skinner . . . 114
  Evidence for the Spin of the Photon from Light-Scattering.—Sir C. V. Raman, F.R.S. and S. Bhagavantam . . . 114
  Absolute Rates of Heterogeneous Gas Reactions.—B. Topley . . . 115
  Excretion of Uric Acid.—Dr. V. B. Wigglesworth 116
  The Peroxidation of Hydrocarbons during Combustion in Air.—Dr. E. Mardles . . . 116
  Velocity of Sound in Tubes: Ultrasonic Method.—Geo. S. Field . . . 117
  Control of Prickly Pear by the Cochineal Insect.—C. T. Jacob . . . 117
  The late Sir Francis Ogilvie.—J. Cameron Smail, O.B.E. . . . 118
  Alchemical Apparatus.—Prof. J. R. Partington, M.B.E. . . . 118
  Forestry Research in Great Britain.—F. T. Brooks, F.R.S.; J. Ramsbottom, O.B.E. . . . 118
  The London Skull.—C. N. Bromehead . . . 118
Research Items . . . 119
Astronomical Topics . . . 121
Research in Industry . . . 122
The Flying Fox in Australia. By A. C. D. R. . . . 122
Young's Theory of Colour Vision . . . 123
Taste and Chemical Constitution . . . 124
University and Educational Intelligence . . . 124
Birthdays and Research Centres . . . 125
Societies and Academies . . . 125
Official Publications Received . . . 128
Diary of Societies . . . 128
SUPPLEMENT.
  The Annihilation of Matter. By Sir James Jeans, F.R.S. . . . 103

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Against Foreign Pests.

THE history of agricultural pests suggests that there is a strong tendency for any creature imported from a foreign country, so long as conditions of food and climate favour its survival, to outrival native pests and to become a real burden in the land of its adoption. So often has this happened that many nations have taken the warning to heart and have adopted laws forbidding, without permit from the proper authorities, the importation of foreign creatures. Great Britain, always a little slow in admitting that science can teach it, has been content to place a ban upon certain insect pests which are liable to come unawares with food materials or other vegetation, but has made no provision against the open and deliberate importation of animals which harbour the possibility of much damage.

Such is the case of the musk-rat or musquash, to the importation and breeding of which in Scotland, for the sake of its fur, attention has already been directed in these pages. Indeed, we believe that the appearance of several notes in NATURE discussing the inordinate spread and the damage caused by the musk-rat in central and southern Europe, led to the investigation which has resulted in the first attempt in Great Britain to control the importation of the larger potential pests.

The musk-rat (*Fiber zibethicus* or *Ondatra zibethica*) is an American rodent somewhat resembling a small beaver, which, imported to Europe to be bred for its fur, has within the last twenty years spread enormously along the valley of the Upper Danube and has penetrated and colonised adjacent river systems, causing damage to flood-embankments and river-banks by burrowing, and to agricultural produce, especially green crops and roots. Bavaria and other States employ men trained and specially detailed to trap musquash, and in Bavaria alone as many as 33,000 have been destroyed in a year. Much controversy has arisen in Europe concerning the need or otherwise of prohibiting the musk-rat from countries yet free from its presence; for although central Europe has suffered heavily and has made many unsuccessful attempts to rid itself of the pest, in other parts—Finland is an example—breeding has been carried on successfully without, it is said, any untoward results. The difference seems to depend upon modifications in the rate of breeding and increase of numbers due to climatic differences; but it cannot be forgotten that success in the breeding of fur animals depends upon rapid multiplication, and that the very countries which claim the musk-rat to be harmless are by that indicating that its commercial exploitation there is less likely to be an outstanding success.

In Scotland, musquash were imported for breeding purposes only in 1927, and at first all were bred in captivity. But by accident or otherwise various pairs have escaped, so that in three areas they are known to be at large, and in one Scottish district in 1929 as many as sixteen musquash 'huts' were seen at a time, an indication that conditions there seemed to favour that rapid multiplication of the animal which leads to plague conditions.

A few months ago, the Ministry of Agriculture and Fisheries, following upon an investigation made regarding the presence of musk-rats in wild conditions in Scotland, issued a notice requesting any person keeping and breeding musk-rats to inform the Ministry of the fact and of the number of the animals. Speedy action has followed the issue of that notice, for the Parliamentary Secretary to the Ministry, Earl de la Warr, has now introduced a "Destructive Foreign Animals Bill" to the House of Lords, where it was given a first reading. The text of the Bill, issued on June 24, indicates that power would be given to the Minister of Agriculture and the Secretary of State for Scotland, acting jointly, to prohibit by order, either absolutely or except under a licence, the importation into and the keeping within Great Britain of any animal of the species.

The occupier of any land who knows that musk-rats not kept by him under licence are to be found upon it, is required to give notice to the appropriate department, which may take all the steps necessary for their destruction. Anyone importing or attempting to import musk-rats without a licence at a time when this is prohibited, or failing to comply with the terms of his licence, or who turns loose or wilfully allows a musk-rat to escape, would be liable to various penalties. On the other hand, compensation would be paid to persons keeping musk-rats for profit in respect of loss caused by their being compelled to destroy the animals under an order. Special licences may be granted to persons wishing to keep musk-rats for exhibition or scientific research; but the granting of such special licences would have to be accompanied by special precautions, since musk-rats kept for exhibition or research which have escaped, are just as dangerous fellows as escapes from breeding-pens.

The Bill contains a section which adds enormously to its significance: power is given to extend its provisions to other destructive animals "of any foreign mammalian species".

We trust that this Bill, to which the House of Lords has granted a first reading, will make rapid progress through both Houses. Whether the musk-rat would ever become such a plague in Great Britain as the alien rabbit has turned out to be, none can tell; but where there is so great a risk it is wise to err on the safe side. Moreover, we should be but following the examples of Norway and Germany, both of which have deemed it necessary to prohibit the importation of this foreign pest.

As an Act, the new measure would signify an important progressive step in the laws relating to animals in Great Britain—a tardy recognition of the fact, from which we as well as other nations are suffering, that more may be involved in the thoughtless importation of strange animals than the importer can possibly conceive.

Anthropology and Native Administration.

IN a review entitled "The Anthropology of Africa" in NATURE of May 2, p. 655, Prof. B. Malinowski pleaded for a fuller acknowledgment of the science of man as a force in colonial affairs, as well as for its academic recognition in the more important universities of Great Britain. The subject, as a matter of fact, is only taught at three universities—Oxford, Cambridge, and London—and neither of the older universities has an established chair of anthropology, in spite of the glorious tradition of Tylor at Oxford and of Haddon and Rivers at Cambridge. The present organisation of the anthropological departments, with such teachers as Dr. R. R. Marett, Mr. Henry Balfour, and Mr. Dudley Buxton at Oxford and Col. T. C. Hodson at Cambridge, would well warrant a full chair at each university.

We are informed that at Oxford the amount of teaching in social anthropology exceeds the twenty hours mentioned by Prof. Malinowski. The course includes lectures in social anthropology by the Rector of Exeter (Dr. Marett), in colonial history by Prof. Coupland, in African economics by Mr. Henry Balfour, and in racial problems by Mr. Buxton—all subjects which come within the range of anthropological studies.

Col. Hodson writes that, so far as Cambridge is concerned, "Prof. Malinowski's statement that the

Colonial Probationers receive only twenty hours' tuition and that anthropology is not obligatory, needs correction. They receive forty hours' tuition, given by lecturers who have African administrative experience, and they are required to attend these lectures. It is hoped to increase and improve this in the immediate future."

These additional facts give further support to Prof. Malinowski's argument in favour of a general strengthening of anthropology in all the universities of Great Britain and of a greater interest being paid to it by administrative authorities. The difference between twenty, thirty, or even forty hours is not material. It is universally acknowledged that anthropology is necessary, and it is not a contentious point that two or even three score hours will remain a superficial smattering. On the other hand, it seems better that specialising should not begin so early as it does on the Continent, and that young men should take up a colonial career only after they have gone through the ordinary university course; and after this they cannot be asked to spend some five more years on a special colonial course.

There is one practicable method of getting over this difficulty which has already in part been adopted by the colonial authorities, and is receiving the serious consideration of the International Institute of African Languages and Cultures, which has its main seat in London. This is, that officers with a special interest in the application of anthropology to problems of native administration should be given study leave after their first or second term abroad. This involves the creation of refresher courses, and private tuition can be arranged at any of the three universities. Colonial Governments have been working on this system, though only to a limited extent, for some years, and it has given excellent results; it might well be more fully developed. It is important that all the universities where teaching in the subject is given should cooperate in the organising of such teaching and that here the University of London should not be passed over.

The combination of a brief anthropological training, such as is now given at Oxford and Cambridge, with refresher courses of a fuller nature, would provide a solution to a problem which becomes more and more urgent in colonial administration, namely, the problem of not over-burdening the young man eager to go out to the Colonies, and yet making it possible for him to gain, later on, the theoretical knowledge which is admittedly essential to his work.

African Settlement and the Origin of Rift Valleys.

(1) *Africa View.* By Julian Huxley. Pp. viii + 455 + 32 plates. (London: Chatto and Windus, 1931.) 15*s.* net.

(2) *Living Africa: a Geologist's Wanderings through the Rift Valleys.* By Bailey Willis. Pp. xv + 320 + 21 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 20*s.* net.

THESE two books have much in common. They state the impressions formed during tours in East Africa by two highly trained scientific observers. The first is by a brilliant British biologist; the other by one of the most distinguished American geologists. Both authors have the philosopher's respect for first principles, high literary skill, keen insight on a wide range of subjects, and a sympathy which enables them to come to a friendly understanding with all sorts of men. Prof. Bailey Willis during an eight months' tour through East Africa travelled 8000 miles, from Pretoria to Baringo, through Rhodesia, Tanganyika Territory, Uganda, and Kenya, and down the Nile, to study the nature and origin of rift valleys. Prof. Julian Huxley's tour of four months in Tanganyika Territory, Uganda, and Kenya Colony was made on the invitation of a Colonial Office Committee to advise on native education.

Both books are highly complimentary to British administration; and the repeated testimony to its efficiency is especially gratifying from the American author, for he can be a candid critic, for example, upon the inferiority of the motor car that he used to its American equivalent. Both authors have returned deeply impressed by the superiority of indirect rule, as shown by the comparison between the results in Tanganyika Territory and in Kenya Colony; and the testimony of two such competent and different observers should be of special value at a time when the issues are being considered by the Joint Committee on East Africa of the two Houses of Parliament. Prof. Bailey Willis quotes with approval the passage in the Duke of Devonshire's dispatch of 1923 which introduced the phrase "the paramountcy of native interests".

(1) The larger part of Prof. Huxley's book is a lucid and suggestive discussion of the fundamental principles of East African administration. He is a warm champion of the system developed by Lord Lugard in Nigeria, which has been applied by Sir Donald Cameron in Tanganyika Territory and

by Sir William Gowers in Uganda, but is opposed by the Settlers' Association in Kenya Colony. The section of "Africa View" that carries most weight is that on education, on which Prof. Huxley writes with expert authority. He regards education as "the great adventure" and the most important and influential of all branches of public service in Africa. He visited many schools and all the chief educational institutions, including Amani, the biological research station, which has been re-established and is now under the directorship of Dr. Nowell. The position of Amani he regards as highly inconvenient, but he deprecates the current criticism that it has not yet been of help to East African agriculture and should therefore either be reduced or discontinued. He thinks that it should be left at work for five years and overhauled then if it has not begun to justify its existence. Both authors visited Mr. Swynnerton and are eulogistic of his anti-tsetse fly researches.

The question of education involves the problem of the missionaries, with whom Prof. Huxley is, in general, sympathetic. He recognises that they are the one section of the European population which is concerned primarily with the welfare of the natives and are therefore an invaluable check on any settlers who may look on the natives as mere 'labour-fodder'. He recognises that the position of the missionaries is strong owing to the generous financial and public support given to them from Europe, and that they represent a 'third estate' in the local realm. He deplores, however, the narrow outlook of some of them and suggests, in view of their political influence and the mischief done by some, that no missionary should be admitted without a sound training in social anthropology. The missions are especially important for their share in education; but some of the mission schools are so defective that he estimates that "only 30 to 40 per cent of the children put down as attending mission schools in East Africa were getting an education worth calling an education". Missionary co-operation in education there is indispensable, but needs control. The Colonial Office Education Committee for East Africa was established with an unduly high clerical bias. Prof. Huxley is emphatic that the natives must be allowed an education of which the basis is a knowledge of reading and writing; for the core of African primary education he recommends biology and geography. On the controverted issue of the language to be used in the schools, he adopts the conclusion, which Indian experience suggests as sound, that the elementary teaching should be in the local vernacular, followed by use of a lingua franca in the higher classes: the second language at present used is Suahili. Prof. Huxley regards that choice as justified in present circumstances; but he is anxious that it should not be permanently engrafted on to the system, and that it should be declared from the outset that English is to be adopted as the second language and Suahili either ousted or reduced to a very secondary position as soon as adequate teachers in English are available.

Prof. Huxley holds that the African can profit by ordinary education. He repudiates the assumption that the Negro is mentally much below the European. He rejects the helpless orphan conception of the Negro and all the policies based on it. He is prepared to believe that the races of Africa are "slightly below the races of Europe in pure intelligence and probably certain other important qualities"; but he is "perfectly certain" that, if so, the difference between the racial averages is small and that the great majority of Negroes and Europeans "overlap as regards their innate intellectual capacities". He is opposed to the implications of the report by the American Phelps-Stokes Commission on African education, which laid great stress on "community adaptation" and approved the settler policy that the education adopted should be designed to fit the natives for their subordinate status, and, as Prof. Huxley puts it, "in fact, to increase their docility and their output in the God-appointed *status quo*".

Prof. Huxley, though warm in his praise of many of the settlers, represents others as reactionary and as anxious to maintain a relation between Negroes and Europeans which is shown by the experience of West Africa and India to be obsolete and impracticable. He devotes one chapter to a criticism of the policy advocated in General Smuts's Rhodes Lectures, which, however, represent a compromise between the two extreme views. For General Smuts upholds the principle that the interests of natives must come first; he favours the segregation of the two races, the whites being given preference in the highlands and the natives in the lower land, the political independence of the native areas under a High Commissioner, and the appointment of an advisory council to act as intermediary between the East African Government and the Colonial Office.

(2) The most important section of Prof. Bailey Willis's book, which happens to be the least satisfactory in Prof. Huxley's, is his consideration of the nature of rift valleys. The investigation of that

problem was the purpose of Prof. Willis's journey and his results will be published in a future monograph, which will be of high value, as it will deal with the question more fully than any previous work on the subject. The main object of the writer's contributions was to establish the tectonic origin of the valleys, the possibility of which was denied by some British geologists. Their tectonic nature being now accepted, the exact mode of their formation is their main problem of current interest.

Prof. Bailey Willis is the leading champion of the theory that the valleys are due to the uplift of their sides owing to the horizontal compression of the crust, instead of to the subsidence of their floor owing to lack of support in consequence of the shrinkage of the internal mass of the earth. Prof. Willis therefore called them 'ramp valleys' instead of 'rift valleys'. He advocated this theory for the section of the Great Rift Valley in Palestine and went to Africa to see how far the explanation is applicable there. He found that the subsidence view is correct for the part of the Rift Valley for which it was expounded; but he holds that the rift valley along the Albert Nyanza was formed by the uplift of the walls along overthrust faults. The same action, to some extent, was suggested by Dr. Wayland (*Geog. Jour.*, **74**, p. 133), whose description of the local rift valleys as "fracture valleys running along the crests of linear upwarps" combined with the "more or less continuous sinking of the rift valley floor" agrees with the view that the essential processes were, in order, upwarp, rupture, and subsidence. The existence of overthrust faults beside Lake Tanganyika is well known; but they are possibly far too old to have produced the rift valley. As the floor of Tanganyika is 1600 ft. below sea-level, Prof. Willis admits that it must have reached its position by subsidence. Prof. Huxley accepts the ramp-valley theory for the area for which its author has abandoned it, and adopts the existence there of a great high-level lake. The evidence for that lake is considered by Prof. Willis, who has had exceptional opportunities for the study of old lake terraces, and he denies its existence.

It would be premature to discuss Prof. Willis's theory of the origin of these valleys until the issue of his full work on the subject. He attributes the valleys to the expansion of vast subterranean discs by re-crystallisation of the constituents under the rise in internal heat. One such disc he believes to underlie the Victoria Nyanza, and its expansion has forced up the land along its margins and thus formed high ramps. The alternative view is that the rift valleys were caused by movements of the crust due to extensive subsidences, of which the largest formed the basin of the Indian Ocean and broke across the former continent of Gondwanaland.

Prof. Bailey Willis is the leading adherent of the permanence of oceans and continents. He thinks that the continents have been connected by isthmus-lands, like Central America, but that the main ocean basins have existed throughout geological time. He therefore denies the existence of Gondwanaland and, in reference to the rift valley in Palestine, the formation of the Levant by the foundering of its floor. In his discussion of the problem, he appears to consider that the supporters of the subsidence theory of rift valleys deny any uplift along their course or of their edges. But the subsidence of a band below a rift valley would have pushed the underlying material sideways; and this movement would have upraised the edges. Suess called this effect the *Aufwulstung* of the edges. Ruwenzori may have undergone some such uplift, though its topography, so far as can be judged from the maps, seems in favour of its having remained a high massif for a very long period.

Prof. Willis wonders how the gentle slopes up which the Uganda railway climbs on to the Mau plateau can be reconciled with the ordinary rift valley theory; but the features of that part of the margin of the rift valley appear due to the Oligocene faulting, and the scarp was not renewed by later faulting. Prof. Willis represents, on the tension and subsidence theory, that there must have been a line of super-Himalayan mountains along the Rift Valley in Kenya Colony, and says that there is no trace of any such mountain chain; but on the view that the subsidence of the Indian Ocean was accompanied by a widespread uplift in East Africa, the highest part need not have been more than a few thousand feet above the present margins. The irregularities in level of the margins of the rift valley appear all that need be expected as the relics of its drainage channels.

Amongst the many interesting contributions in Prof. Willis's volume is a record of an egregious failure of water divining, and the welcome term 'island-mounts' instead of *inselbergs*. But his statement that those who "said that Paul du Chaillu lied were wrong" repeats a widespread misunderstanding; they who said that the skins, which du Chaillu sold as those of gorillas that he had shot at close range when in deadly peril, had been caught in native traps, were unquestionably right.

J. W. GREGORY.

Human Monstrosities.

The Mystery and Lore of Monsters: with Accounts of some Giants, Dwarfs and Prodigies. By C. J. S. Thompson. Pp. iv + 256 + 32 plates. (London: Williams and Norgate, Ltd., 1930.) 15*s*. net.

MR. C. J. S. THOMPSON, who is known to medical men because of contributions made to the history of their art, has published, in bookform, gleanings he has gathered concerning the ancient lore of human monsters. His book will make a wide appeal, not only to those who are interested in the 'lore of monsters', but also to embryologists who are in search of the rarer aberrations undergone by the human body in the course of development. His text is clear and easy, and is enriched by many illustrations of 'prodigious births' which have adorned the records published by writers in former centuries.

Down to the end of the seventeenth century, it is difficult to know whether the abnormalities which are described had actually been seen by authors or only imagined. Lycosthenes, who wrote "Prodigiorum ac Ostentorum Chronicon" in 1557, illustrated by 1500 woodcuts, gives the following account of the 'terrible child' who was "born in Craconia of noble parents. It had bright fiery eyes, the mouth and nostrils like an oxe's. It had long hornes and a black fur like a doggs and on its breasts, faces like apes. It was splay-footed, and splay-handed. The feet were like swan's feet and it had a tayle twined upwards, that was crooked backwards about half-an-ell long. It was born and lived four hours and then spoke thus, '*Watch, the Lord our God comes*'."

The ancient Babylonians, Egyptians, and Greeks believed any combination of human and animal parts was possible; indeed, the study of ancient records is a study of human credulity rather than of embryological aberration. We are not surprised, however, that George Buchanan, the Scottish historian, who did so much to strip myth from truth in the records of his own country, should write rationally and with interest of monsters. "About this time (1490)," he says, "a strange kind of monster was born in Scotland. In the lower part of the body it resembled a male child, differing nothing from the ordinary shape of the human body, but the trunk and all other members became double and were distinct both in their use and appearance. The King caused it to be carefully brought up and educated, particularly in music, in which it wonderfully excelled. It learned different languages, and in their various inclinations the two bodies appeared to disagree between themselves, sometimes disputing, each preferring different objects and sometimes consulting for the common pleasure of both."

Mr. Thompson cites examples which taxed the learning of clergymen as well as of surgeons. The clergymen had to determine whether the monster was to be regarded as being made up of two souls or of only one, and whether, in baptising, two names had to be given or if one would suffice. The surgeon's perplexities were of a less metaphysical nature: Was the bond which joined two bodies of a kind which could be severed? If one part of the monster died, could the living part be saved? Modern surgery is now attacking these problems—often successfully.

In the eighteenth century, the study of monsters entered its scientific stage; schemes of classification, based on a knowledge of normal development, were devised; only in the present century did we enter the further stage of learning how monsters could be produced experimentally. Mr. Thompson has brought a wide and accurate knowledge to bear on "The Mystery and Lore of Monsters".

Biochemistry in America.

The Development of Physiological Chemistry in the United States. By Prof. Russell H. Chittenden. (American Chemical Society Monograph Series, No. 54.) Pp. 427. (New York: The Chemical Catalog Co., Inc., 1930.) 6.00 dollars.

THIS is a review of the evolution of physiological chemistry in the United States during the past fifty years. Prof. Chittenden has seen it all happen, from the starting of the first laboratory of physiological chemistry in Yale in 1874 until the present day, when practically every university in the country has a staff of competent investigators and well-equipped laboratories, besides the agricultural experiment stations and laboratories of the Government bureaux at Washington, which are the admiration of the scientific world.

At the beginning, it was necessary for American and British students to go to Germany for training—Chittenden went to Kühne in Heidelberg in 1878. A start had been made in Germany in the study of natural products, although the golden age did not commence for another decade, when Kossel and Emil Fischer in particular introduced more precise chemical accuracy into the field; the reproach that "Thierchemie ist Schmierchemie" had been too true.

The author traces the development of laboratories, equipment, societies, and journals, and then gives a running commentary, arranged mainly under schools, on the workers whose activities have increased knowledge.

The work of W. O. Atwater on nutrition will always remain a classic, and his dietary studies led to the first standard diet. His work with the respiration calorimeter, later followed up with such success by Benedict, has been prolific of results.

The study of vegetable proteins was taken up energetically by Osborne from 1891 onwards; he produced more than one hundred publications, which form the basis of the chemical knowledge of this group.

H. D. Dakin's work on the amino acids and his β-oxidation hypothesis, that of Walter Jones on nucleic acids, of P. A. Levene on nucleic acids and the carbohydrate group, are only a few instances of the long list of positive achievements which are detailed. They suffice to show that the organic chemist has definitely entered the field of natural products. The task of unravelling their constitution and their molecular structure by analysis is near completion, many of them have been synthesised, a hint has been gained of their function, yet how much remains to be done. The best men in the best-equipped laboratories the world over have problems enough for many years to come. How, for example, are meat and milk made from grass? Will it take another half-century to answer this question?

The book is one of the American Chemical Society Monograph Series, and is produced in clear type with the high standard that characterises the series. E. F. A.

Short Reviews.

Die Beschneidung bei Mann und Weib: ihre Geschichte, Psychologie und Ethnologie. Von Felix Bryk. (Monographien zur Ethno-Psychologie, herausgegeben von F. Bryk und C. L. Hansen, Band 1.) Pp. x + 319. (Neubrandenburg: Gustav Feller, 1931.) 15·60 gold marks.

THE need for detailed monographs on genital mutilations has long been felt, and above all a sound and scholarly treatment of circumcision was desirable. This book, however, scarcely fulfils that want. It is a very general account of a number of different operations, but is without orderly plan, and the author has clearly been unable to deal satisfactorily even with the limited number of authorities he quotes, or to appreciate the vast distribution of the practices under discussion. Instead of confining himself to the matter on hand, he wanders off to discuss male infibulation, *ampliatio vaginæ*, perforation of the clitoris, and many other similar practices. The result of this is that the author becomes lost in his own maze: the very multiplicity of the customs bewilders him, and he ends by coming to few new conclusions at all. He quotes largely from Biblical sources, whilst failing to realise that the ideas of earlier civilisations were better worth his ink. Whilst rightly rejecting Reitzenstein's attempts to find evidence for circumcision in palæolithic times, he fails to understand that the ritual significance of the custom is the point on which his attention should have been focused.

According to the author, circumcision of the male arose partly at least from the desire to imitate domestic and other animals which were observed in copulation. To this was added the supposed desire on the part of early man to increase the ease of the process in himself, and the recognition of the hindrance a partial or total phimosis caused to him.

Thus this volume is merely a sketch of genital mutilations, and as such is useful for the purposes of summary. The illustrations are well chosen, the printing good, and the indexes of value. But as a guide towards solving the mystery of circumcision the book is not helpful. It is an epitome of current theories and we cannot pretend that these are convincing. Circumcision still awaits its shrewd interpreter. E. J. DINGWALL.

Femcifrede Logaritmer og Antilogaritmer (Five Figure Tables of Logarithms and Anti-Logarithms). By A. K. Erlang. Udgivet ved (edited by) R. E. H. Rasmussen. Pp. 48. (København: G. E. C. Gads Forlag, 1930.) n.p.

(2) *Addition-Subtraction Logarithms to Five Decimal Places.* By L. M. Berkeley. Pp. xii + 134. (New York: White Book and Supply Co., 1930.) 3.25 dollars.

(1) THIS is a clearly printed table of logarithms and antilogarithms to five places with a four figure argument and mean differences. A seven place table of $\left(1+\frac{r}{100}\right)^n$ for $n=1$ to 9 and $r=0{\cdot}00$ to $7{\cdot}50$ is appended.

(2) If a is greater than b, the addition logarithm of $\log a$ and $\log b$ is $A=\log\frac{a+b}{a}$ and the subtraction logarithm is $S=\log\frac{a}{a-b}$, so that $\log(a+b)=\log a+A$ and $\log(a-b)=\log a-S$. Evidently A and S are functions of a/b only so that $\log a-\log b$ can be used as argument for a table of A and S. The present table is arranged in triple columns corresponding to $\log n$, $\log\frac{n+1}{n}$, $\log(n+1)$ so that the central column is the addition logarithm of two logarithms which differ by $\log n$ and the subtraction logarithm of two logarithms which differ by $\log(n+1)$. This central column proceeds by unity in the last figure so that A and S are found without interpolation. The table is thus in effect a critical table, but is not arranged in the form usual in such tables. The use of addition and subtraction logarithms allows long trains of calculation to be performed without reverting to natural numbers, for

example $\sqrt[5]{(a^5+b^6+c^7)}$, $\cos b \cos c + \sin b \sin c \cos A$. Incidentally from the value of $\log n$ the table gives without interpolation $\log (n+1)$, $\log (n-1)$, $\log \frac{n+1}{n}$, $\log \frac{n-1}{n}$, and the logarithms of the reciprocals. This is a most useful table for five figure calculations with logarithms.

L. M. MILNE-THOMSON.

Advanced Trigonometry. By C. V. Durell and A. Robson. Pp. viii + 335. (London: G. Bell and Sons, Ltd., 1930.) 8*s*. 6*d*.

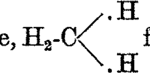
THIS volume, dealing mainly with analytical trigonometry, provides an excellent school course for senior scholars. It embraces the logarithmic, exponential, and hyperbolic functions; expansion in power series; projection and finite series, and complex numbers. No hesitation has been shown in using the methods of the calculus throughout, and a commendable feature is the development and application of the powerful principle of inequalities. The section devoted to complex numbers, occupying considerably more than half the book, is especially noteworthy for its clearness and sound treatment. As the authors point out, the interest and value of higher trigonometry lies in its being an introduction to modern analysis and, for this reason, the methods by which results are obtained are of more importance educationally than the results themselves. This is the basic principle upon which the book has been written.

The extreme rigour which characterises modern analysis is, as every teacher knows, quite out of place in a school course, with the consequence that many of the standard treatises are unsuitable for teaching purposes outside the universities. The present volume therefore, written by experienced teachers who fully appreciate the difficulties in the work of mathematical instruction, can be thoroughly recommended as a fresh and inspiring survey of a difficult section of school mathematics.

Rationalization. By Dr. James A. Bowie. Pp. 36. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 1*s*. net.

ONE of the best signs for the future of British industries is the interest now being taken in problems of industrial reorganisation. In this connexion, 'rationalisation' has frequently been proposed as a remedy for industrial ills, but the meaning of the term is vague and may serve indeed rather to obscure than to clarify discussion of these problems. Dr. Bowie has performed, therefore, a real service in providing a critical examination of its implications and methods in this pamphlet. Defining rationalisation as the *conscious* control and readjustment of industry, he points out that it has two sides: one external, concerned with the grouping of a large number of previously independent, competing enterprises, and the other internal, concerned with the efficient organisation within each unit of the functions of production, finance, personnel, and distribution. In examining the various implications of his subject, Dr. Bowie discusses such questions as vertical versus horizontal combinations, the mechanics of rationalisation, the planning of production, the problem of labour, the problem of control, and labour co-operation.

Constitution et thermochimie des molécules: les constituants moléculaires, les liaisons intramoléculaires, la valeur énergétique des liaisons. Par Albert Gosselin et Marcel Gosselin. Pp. vii + 231. (Paris: Les Presses universitaires de France, 1930.)

THIS volume contains a brief account of the three types of valency which are now generally recognised as definitely distinct in character. The descriptive portion is followed by thermochemical data on the heats of formation of compounds from which the thermal values for the energy required to rupture different bonds in complex molecules are calculated. These in turn are employed to elucidate the structure of numerous compounds. Some of the formulæ proposed, for example,  $H_2\text{-}C\langle{}^{.H}_{.H}$ for methane, $H_2\text{-}N\text{-}.H$ for ammonia, and $NH\text{-}CO\text{-}NH_3$ for urea, are so different from those usually accepted, and the evidence advanced in favour of them is so problematical in character, that the book must be regarded as one which might be somewhat unsafe as a text-book. It does, nevertheless, contain many interesting observations on reactivity of organic compounds.

E. K. R.

Synthetic Inorganic Chemistry: a Course of Laboratory and Classroom Study for First Year College Students. By Prof. Arthur A. Blanchard and Prof. Joseph W. Phelan. Fourth edition. Pp. xii + 352. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 15*s*. net.

THIS book contains a course of experiments and preparations in inorganic chemistry covering all the groups in the periodic system. Full details of the experimental procedure are given. The elementary theory of ionisation and that of mass action are included, and numerous questions and problems are given both in the text and at the ends of the chapters. The book is similar in plan to Biltz' "Laboratory Methods of Inorganic Chemistry", but is more elementary, and it provides a clear and useful course of experimental work in preparative inorganic chemistry, which could supplement the instruction in analysis usually given to degree students. Many of the preparations are suitable for pupils in the higher forms in schools.

Some Modern Mediums. By Theodore Besterman. Pp. xi + 189 + 4 plates. (London: Methuen and Co., Ltd., 1930.) 7*s*. 6*d*. net.

IN this book, the author has made a genuine attempt to present his case in a more or less unbiased manner. He is quite honest in his admission that several well-known mediums have turned out to be frauds. Mrs. Piper he considers perfectly genuine. So much evidence with regard to mediumistic performances consists of a 'has not been found out' attitude, that it is interesting to read evidence of a positive nature.

Deep Oil-Well Drilling.

IT is perhaps not generally known that the long-projected depth of a 10,000 ft. oil-well was reached recently by the drilling of a hole to 10,030 feet in Ventura County, California, by one of the leading petroleum corporations in that State. The well was actually a 'wild-cat' put down to prove a possible extension of the Rincon field, though undoubtedly there was behind the venture a determination to create a depth record. Drilling was started in 1929, delay in completion occurring as a result of fire and technical difficulty last year.

This is the deepest oil-well, if not boring, in the world as yet on record. Apart from a matter of doubtful economics, especially in view of the present situation in the oil industry, the result undoubtedly is a great achievement in the history of petroleum engineering, and bears eloquent testimony to the high state of efficiency of both technical skill and plant existent in the industry to-day.

Deeper drilling for oil and deeper workings for other natural resources are contemplated and planned to-day with much vigour. Such propositions would have been condemned a few years ago. In the case of petroleum, while area may be limited for structural or other reasons, the possibility of productive oil-measures lying beneath the known pay-horizons is often considerable, particularly where a thick series of sediments comprising multiple reservoirs is involved. The limit to their exploitation is either that dependent on commercial policy or current economic conditions, or is one of plant design and performance. If cost is not a first consideration, it is clear from this new record that drilling equipment can be built and operated to carry a boring successfully to even greater depths; in fact, it is unlikely that American oil engineers will rest until the two-mile hole has been drilled and until commercial production from such a distance has been realised.

It is this last factor which constitutes the steadying influence on any wild projects, since it pays no one to put down deep wells simply to finish up in an unproductive stratum, as was the case with this Californian well. Even supposing such a well is successfully drilled—that is, without unusual hazard in the shape of fire, abnormal water conditions, mechanical faults, bad deviation from the vertical, and so on—unless there is sufficient gas to cause the oil to flow easily to the surface, compressors and pumps have to be installed, and production costs mount up to a prohibitive level at the outset.

In other mining spheres, deep borings are usually of an exploratory character, with the view of subsequent underground developments calling for human activity at or near to the depths attained. Unlike oil, controlled mechanically from above, the winning of ore, for example, demands actual contact with the reserves, so that in the long run the depth limit in this case is that determined by physiological factors. Despite the great depths at which it is possible for man to work underground, it would seem inevitable that human endurance will place a limit on depth working sooner or later (it is clear from South African mining tendencies that that limit has not yet been defined), and that projects and accomplishments in the realms of oilfield drilling will far outstrip those in other fields of subsurface exploitation.

The influence which this deep oil-well drilling campaign has had throughout America, and incidentally in other countries as well, has been enormous. It is one of the primary causes of the existing glut of petroleum and market stagnation. Where formerly extension of productive area was sought superficially, geological field survey has given much of its place to subsurface calculations and extensions in the third dimension. Geophysical methods have played an important part in this reversal of technique. Other things being equal, the risks are probably far less in deepening a field where the log is known for some thousands of feet, than in opening up new territory; probably the latter proposition is far more costly in any event. Where geological knowledge presupposes that older formations or horizons are potentially more productive than those long exploited, then, given the plant to penetrate successfully those lower levels, it is obviously rational to test the theory as thoroughly as possible. The fact that many of the wells already down can be deepened, thus saving the cost of complete new rigs, has also influenced this policy, and for some time to come it is evident that all over the world, where increased production of oil is sought, the American example will be zealously followed.

There is another and equally important aspect of the matter. The achievement of holes in the earth's crust to such depths as this Californian well should direct attention to the possibilities of making accurate physical measurements to confirm or modify data which have previously been based on calculation. It may be presumed that some scientific advantage was taken of the progress of this particular well, though we have not heard as yet that this was so. The measurements of thermal and pressure gradients, to cite only two lines of investigation, would be most valuable in such a case as this; had the well been productive, comparisons between the oil and water from such depth and similar fluids from shallower horizons would furnish data, both chemical and physical, still much needed to square our ideas of petroleum genesis.

If deep oil-well drilling, as a technique, is to advance further (and there is little doubt but that in time it will do so), then, given the opportunity, science is likely to gain in yet another direction from industrial operation. Failure to bring in a two or three mile oil-well successfully may find its mitigation in the advancement of knowledge which carefully controlled operations should bring about. The 10,000 ft. oil-well establishes a record, but it also has been the cause of a great human effort to produce something better. This is perhaps its vindication, if such need be.

The German Bunsen Society in Vienna.

By Prof. Fritz Paneth (Königsberg i. Pr.).*

THE German Bunsen Society for Applied Physical Chemistry and Electrochemistry holds a general meeting annually, and this year the meeting took place in Vienna on May 25–28. Some 350 physicists and chemists from Germany and Austria attended the meeting and, as is usually the case, there were present a number of representatives from several other countries, including Switzerland, Czecho-Slovakia, Hungary, Poland, Holland, Sweden, Spain, the United States of America, and Great Britain. From the last-named country no less than eight well-known chemists were present.

In the Bunsen Society it is customary to fix upon a main topic for the lectures, and this principle was again adopted. Last year the main topic was of an essentially theoretical nature, so that this year, in view of the fact that the Bunsen Society is intended to serve the interests also of applied physical chemistry, a topic of importance in technical work was chosen as the subject for discussion. The title was "Advances in the Science of Metals, and their Applications to Light Metals". The president of the Bunsen Society had invited five members to give lectures in the nature of a comprehensive survey on the selected theme, and these included Prof. G. Tammann, who celebrated his seventieth birthday during the meeting on May 28, and was the object of numerous expressions of esteem. Amongst others, there was an address written by Prof. Nernst, which was presented to him during the first session by the president of the Society, and in which his great services to the most divers branches of physical chemistry were emphasised.

The first comprehensive survey was given by Prof. R. Becker (Berlin) on "Electrical and Magnetic Properties of Metals". He commenced by pointing out that the old classical theory, which treated as a gas the whole of the free electrons present in a metal, is entirely inadequate in the face of two facts of experience; it is unable to explain either why the electrical resistance vanishes with diminishing temperature, or why the free electrons make no contribution to the specific heat. Both points are cleared up by two profound alterations which have to be made to the classical picture, according to quantum mechanics. The individual electron is not to be described as a point charge, but as a wave function, and the interference of the electron thus rendered possible brings about the disappearance of the resistance in a lattice which is not disturbed by thermal movement. On the other hand, Pauli's principle (Fermi statistics) becomes effective in the sense that the free electrons are unable to supply any appreciable contribution to the specific heat. The practical application of the quantum mechanical picture of the metallic state envisaged by modern theoretical physics is, for the time being, however, held up by mathematical difficulties.

The next lecture, by Dr. G. Masing (Berlin), was entitled "Age-Hardening, especially on the Basis of Experience with Light Metals and with Alloys of Beryllium". Masing started off from the effect discovered by Wilm in 1909 with duralumin, in which a marked hardening (*Vergütung*) of alloys can be attained by quenching the material from a high temperature, and afterwards storing it at ordinary temperatures. This phenomenon, which has been observed not only with alloys of aluminium, but also with alloys of copper and other heavy metals with beryllium or silicon, as well as with several varieties of steel, etc., has not hitherto found a wholly satisfactory explanation. It is certain that a necessary condition for the hardening is that supersaturated mixed crystals are produced by the quenching; hence we must assume that the hardening is somehow associated with an alteration of these supersaturated mixed crystals. On the basis of all the available evidence, especially the results of X-ray investigations, Dr. Masing was of the opinion that the hardening can be regarded generally as an accompaniment of the separating out of a second type of crystal from a mixed crystal. The details of this segregative process, and accordingly also of age-hardening, are probably different, however, for different alloys.

The third speaker was Prof. Tammann (Göttingen), on the subject of "Recrystallisation". It is well known that the structure of a specimen of metal can be fundamentally altered by rolling or forging. This is due to the fact that the crystallites become drawn out into plates or fibres by slipping on defined crystallographic planes. In this way the originally random orientation of the crystallites passes over into a more or less completely ordered form. The physical and chemical properties of the metal, as well as its elastic properties, change in this process, and we may thus assume that, as a result of the displacement along the slip-planes, an alteration takes place also in the atoms themselves. If we increase the temperature of the specimen, the original properties tend to return, and in every metal this recovery of the crystallites takes place within a different range of temperature. With further increase of temperature, fresh boundaries and individual small grains, which can be detected by etching, make their appearance in the plates or fibres. The orientation of the bodies with respect to each other is different, and for temperatures in the neighbourhood of the melting-point a random orientation of the grains is produced; at the same time the grains increase in size, and the last traces of the cold-working vanish.

In continuation of the subject, Dr. Sachs (Frankfurt a. M.) discussed "Problems of the Science of Metals in the case of Aluminium and

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* Translated by Dr. R. W. Lawson.

Aluminium Alloys", whereby in particular he dealt with the technically important cohesional properties of individual crystals, of rolled alloys, and of cast alloys. Attention was directed to the relations between the plastic properties of metallic crystals and their lattice structure, and emphasis was laid on the differences which exist in the formation of alloys of aluminium as compared with those of copper, silver, and gold. Another aspect of aluminium alloys was discussed, namely, the complicated hardening effects, which may lead to increases by two orders of magnitude in the cohesive properties, as compared with the original modulus of shear of the crystal. Dr. Sachs is inclined to attribute this to changes in the homogeneous phase. Later, the harmful influence of a gas content on cast alloys was discussed theoretically, and finally he considered the process whereby aluminium is protected against corrosion by means of a compact oxide film produced electrolytically.

The last of the general surveys on the subject was presented by Dr. E. Schmid (Berlin-Dahlem). He discussed the "Physics and Metallography of Magnesium", in which connexion he dealt particularly with those differences which are based on the hexagonal crystal structure of magnesium and its alloys, in contrast to the large group of cubic technical metals.

The president of the Society had not only drawn up the programme of the session at which the five general surveys just mentioned were delivered, but he had also recommended that in the choice of the individual lectures preference should, so far as possible, be given to topics which are related in some way with the main topic of the meeting. Accordingly, in the other sessions at which freely selected individual lectures were delivered, topics taken from the science of metals were in many cases discussed. In view of the large number of these shorter papers—in all about sixty single papers were read—it is only possible here to direct attention briefly to a few of them.

Dr. W. Schmidt (Bitterfeld) dealt with the "Technology and Application of Electron-Metal", and made detailed statements on the components of this alloy, which is so valuable owing to its lightness, and also on the process of refining and the method of working it. Dr. W. Kaufmann (Frankfurt a. M.) reported on the "Vaporisation of Magnesium in a Vacuum", and illustrated his remarks by the demonstration of interesting preparations. Dr. Seith (Freiburg) communicated the results of experiments that he had performed in collaboration with Prof. Hevesy on "Diffusion in Metals". The diffusion of a metal in itself (self-diffusion) was treated as a limiting case of the diffusion of one metal in another (foreign-diffusion), and it was shown that in metals self-diffusion is always very slow, large velocities of diffusion only being able to manifest themselves in certain cases of foreign-diffusion. For example, the diffusion of gold in lead at 150° C. amounts to 4×10^{-3} cm.^{2} day^{-1}, whereas lead in lead at the same temperature has a diffusion coefficient of only 8×10^{-10} cm.^{2} day^{-1}. Papers by Dr. Pietsch (Berlin) and Dr. Schwab (Munich) dealt with the "Activity of Complex (*Mehrstoff*) Catalysts" and the question of the active centres in hydration catalysis.

More detailed reference may be made to the lecture by Prof. K. Przibram (Vienna), who presented a very illuminating contribution to the topic of the main lectures, more especially to the lecture of Prof. Tammann; Przibram has succeeded, in a special case, in permanently recording cinematographically the process of recrystallisation.

It is well known that rocksalt assumes a yellow colour under the influence of the rays from radium. The coloration takes place more rapidly and penetrates more deeply when the mineral has been subjected to a uni-directional pressure of more than 100 kgm./cm.^{2} before treatment with the rays; rocksalt which has been compressed by a force equal to the weight of a few thousand kilograms becomes almost black in a short time when rayed by means of radium. About two years ago Przibram observed that such specimens, after some time, again show clearer regions, which slowly grow. Since the deeper coloration of the compressed salt was attributable to disturbances of the crystal lattice, it was necessary to conclude that the reoccurrence of clearer patches was due to a progressive healing up of the disturbed lattice, that is, to recrystallisation, a conclusion which could be verified simply by cleaving the specimens, when large reflecting crystal surfaces were revealed as the cleavage planes of the clear patches, whereas the black part showed no cleavage. It could also be proved by means of X-rays that the clear regions again possessed an orderly crystal lattice.

A method thus presented itself of conveniently following up the recrystallisation of the compressed rocksalt, and even of recording it cinematographically by 'stealing a march on time'. The process in the production of the film was the following. A small slab of rocksalt was chosen, which, a few weeks after the above described treatment, revealed a beautifully regular and almost square grain of recrystallisation. Forty exposures of this slab were taken daily—twenty in the morning, one directly after the other, and likewise twenty in the afternoon—and this process was continued for a period of two months. The exhibited film showed first the compressed specimen of rocksalt traversed by cracks, with the above-mentioned clear recrystallised grain in the left upper quadrant. The gradual growth of this grain was clearly to be seen, and it was also evident that the marked horizontal crack separating the two left quadrants provided an insurmountable obstacle to the further growth; the corner of the grain approaching it became blunted. Apart from the first-mentioned grain, a number of other grains formed in the course of time, and these likewise grew, until finally a large part of the specimen appeared in the recrystallised state.

This first film illustrating recrystallisation is naturally still somewhat defective. There is, however, no doubt that when it has been arranged to take the photographs at regular intervals of, say, an hour, day and night, by means of an automatic device, it will be possible to undertake accurate measurements of the velocity of recrystallisation, with the aid of the film. The method is already very useful for the demonstration of the process of recrystallisation.

Mention should be made of a few papers which had no direct connexion with the main theme. Dr. Werner Kuhn (Karlsruhe) presented a communication on "Single and Superposed Absorption Bands and their Behaviour with respect to Optical Activity". With *d*-camphor Dr. Kuhn has found that an absorption band which has usually been considered single is in reality a superposition of a weaker and a stronger band. He was led to this view by the observation of certain deviations in the behaviour of camphor as compared with that of other optically active compounds. Dr. Fromherz (Munich) spoke on "A Spectroscopic Investigation of the Conditions of Dissociation of the Halides of Metals in Solution". Whereas the absorption curves of light in aqueous solutions of the halides of the alkali and alkaline earth metals are essentially independent of the concentration as regards their shape and position, up to the highest concentrations, new absorption bands of association products make their appearance alongside the absorption bands of the hydrated ions in aqueous solutions of lead, thallous, cadmium, and mercury halides, and they arise to an increasing degree as the concentration of the solutions is increased. From the spectral position of the bands and the dependence of their height on the concentration of the contributing ions, it has been possible to determine the nature of the association products, the dependence of the degree of association on the concentration, and hence the equilibrium of association in the solutions. Dr. Beutler (Berlin) gave an account of a piece of work which was concerned with dissociation as a result of collisions of the second kind, and in which, in particular, the splitting up of the hydrogen molecule into a normal and an excited hydrogen atom by means of excited neon atoms was followed up spectroscopically. Prof. W. A. Noyes (Urbana) pointed out that the formula proposed by Mecke on the basis of spectroscopic data for nitrogen dioxide $O=N-O-$ is in good agreement with the views on 'shared' and 'unshared' electrons which have been derived from the chemical behaviour of nitrogen dioxide.

Dr. Frankenburger (Ludwigshafen a. Rh.) has continued with his collaborators the attempts to combine hydrogen or nitrogen with highly disperse metals. Their method is to separate iron or nickel from the vapour phase; the resulting metals, which are always at first in an extremely finely divided form, join up to form larger particles if this process of collective crystallisation is not suitably prevented. Frankenburger realises this by arranging that sodium chloride is deposited from the vapour phase simultaneously with the metal. When the molecular ratio $NaCl : Fe$ was increased to 2000 or 3000, it was found possible to combine up to six molecules of hydrogen with each atom of the separated iron. We are here obviously dealing with weak affinities between metal atoms and gas molecules, forces akin to those of van der Waals in the gas theory. In the discussion, Prof. Biltz (Hannover) suggested that the phenomenon is perhaps in its nature related to the attachment of five or six molecules of water of hydration to the chemically non-reactive atoms of argon, krypton, and xenon.

Prof. Paneth (Königsberg) reported on the continuation of the investigations on free methyl and ethyl, which were intended to bring clarity with regard to the mechanism of the disappearance of the free radicals. If helium instead of hydrogen is used for the transport of the radicals, their activity falls off with the same velocity as in hydrogen; from this and from related observations it is concluded that a reaction takes place with the vessel walls. Whereas in a glass tube the radicals can be transported more than half a metre by a rapid gas flow, a metal mirror 1 cm. in length introduced into the tube suffices to bind the radicals quantitatively. On the basis of formulæ derived from the kinetic theory of gases by Prof. K. F. Herzfeld (Baltimore), we can calculate from these results that every free radical is bound by a single impact on a metal capable of reaction, whereas from amongst one thousand radicals incident on a glass wall only about one is not reflected. From the discussion on this paper we may direct attention especially to the remarks of Prof. Bodenstein (Berlin), who mentioned similar observations in the combination at glass walls of 2 Cl to form Cl_2.

It was decided to hold the next meeting of the German Bunsen Society at Münster, in the year 1932.

Obituary.

SIR HUGH BELL, BART., C.B.

THE north-east coast of England will have bitter reason to remember for long the first half of the current year, because this highly industrial corner of England has lost by death a greater number of its leading industrialists than can be remembered in any similar period. The names of such men as Sir Arthur Dorman, Sir Charles Parsons, Andrew Laing, Sir Archibald Ross, and now Sir Hugh Bell, all dead since the beginning of the year, show how severely it has suffered; such losses would be serious enough at any time, but at a time of crisis like the present, when men of experience, judgment, and knowledge are so badly needed, the loss is even exceptionally deplorable: for, as the above names show well enough, these were men who were known and honoured not only in their own district but also in all industrial circles throughout the world, and no one was better known or more highly honoured than the man whose loss we mourn to-day.

Sir Hugh Bell was born at Walker-on-Tyne on Feb. 10, 1844, and was thus more than eighty-seven years of age when he died, but fortunately he retained his keen intellect and active interest in affairs down to the end. He was the eldest son of a famous father, Sir Lowthian Bell, well known for his classical researches into the chemistry of the blast-furnace, and an ironmaster of high repute. The son received his first education at Merchiston Castle School, Edinburgh, but at fifteen years of age, in 1859, he went to Paris and studied chemistry at the Sorbonne under Ste. Claire Deville, continuing his studies afterwards at the University of Göttingen. His stay abroad was not, however, a very lengthy one, for in 1862, at eighteen years of age, he had returned to England and commenced to take part in the family business of ironmaking.

Sir Lowthian Bell was one of the first to appreciate the importance of the Cleveland ironstone, and thus played an important part in the development of modern industrial Middlesbrough, the centenary of the foundation of which was celebrated last week. Sir Lowthian Bell with his brothers erected blast-furnaces at Port Clarence, and Hugh Bell was made manager of these works. The father formed his business into a public company under the title of Bell Brothers, Ltd., in 1899, and Hugh Bell was the managing director; meanwhile, steel works had been added to the blast-furnace plant at Port Clarence. Sir Lowthian Bell died in 1904, and Sir Hugh Bell succeeded to the baronetcy in that year, and was made chairman of the company in succession to his father. Sir Hugh Bell continued to direct the fortunes of Bell Brothers, Ltd., until this became one of the important iron and steel making firms of the country. It was taken over in 1923 by Dorman, Long and Co., Ltd., Sir Hugh Bell becoming a director of that company, with his lifelong friend, Sir Arthur Dorman, as chairman. After Sir Arthur Dorman's death on Feb. 12 of this year, Sir Hugh was made chairman of Dorman, Long and Co., Ltd., so that this great firm has had the sad experience of losing two chairmen by death within a few months of each other. Sir Hugh Bell was also chairman of the firm of Pearson and Dorman, Long, Ltd., the interests of which lay more particularly in the development of collieries in Kent, whilst he was also chairman of the Horden Collieries, Ltd., an important colliery in East Durham. It may be added as a matter of historical interest, which will, however, be fresh in the minds of most people, that Messrs. Dorman, Long and Co., Ltd., took over the famous firm of Bolckow, Vaughan and Co., Ltd., so recently as 1929, and Sir Hugh Bell necessarily took his share in this increased responsibility. He was also a director of the London and North-Eastern Railway Company and of numerous other technical and industrial concerns.

In 1869, Sir Lowthian Bell took a prominent part in the foundation of the Iron and Steel Institute, the object being to afford a free means of communication between all interested in iron and steel manufacture, especially in its technical and scientific aspects, deliberately excluding all questions connected with wages. The first meeting of the Institute was, appropriately, held at Middlesbrough, the late Duke of Devonshire having been the first president. Sir Hugh Bell, naturally enough, became an original member of the Institute, being at the time of his death one of the last living representatives of that class; he became president of the Institute in the year 1907, and occupied the chair for three years. The Bessemer gold medal, the highest distinction that the Iron and Steel Institute can award, was founded in 1873 by Sir Henry Bessemer, and it was awarded to Sir Hugh Bell in 1926 in recognition of his eminent services in the cause of iron and steel manufacture. He was also an original member of the Institute of Metals, founded in 1906.

Merely to recount the work of Sir Hugh Bell as a successful ironmaster would, however, be to give a very limited and one-sided view of his activities. He was, above all, a great public servant, and rendered services to the community of which it is difficult to speak too highly. He was Mayor of Middlesbrough on three occasions, in 1874, 1883, and 1910, and he played a prominent part in the conversion of the river Tees from a shallow, dangerous, and almost useless stream into a wide and navigable river, capable of accommodating some of the largest cargo carriers now afloat. This particular work was done by the Tees Conservancy Commission, which was founded in 1852, and of which Sir Hugh Bell was chairman for the last thirty years, during which his shrewd foresight and bold enterprise were instrumental in guiding the work of the Commission to its present successful issue. It is perhaps fortunate for the nation that Sir Hugh Bell's attempts at entering Parliament were unsuccessful; he contested Parliamentary elections on two occasions, first as a Unionist at Middlesbrough in 1892, and afterwards, when he had severed his connexion with the Unionist party because he disagreed with their fiscal policy, as a Liberal in the City of London in 1910. It is perhaps unnecessary to add that Sir Hugh Bell never missed an opportunity of showing his ardent adhesion to the principles of free trade.

As might well be expected from such a man, he took the keenest possible interest in everything pertaining to technical education, and received honorary degrees by several universities, including the degree of D.C.L from the University of Durham and that of LL.D. from the Universities of Oxford, Leeds, and Sheffield. He was a member of the Board of Governors of the Imperial College of Science and Technology, but his closest connexion with technical education was through Armstrong College in the University of Durham. Sir Lowthian Bell had been a member of the council of this College, first known as the Durham College of Physical Science, up to his death, and soon thereafter Sir Hugh Bell was elected to a seat on the council. The constitution of the College was reconstructed in 1909 under the University of Durham Act, and Sir Hugh Bell became the first chairman of the College council in 1910. He held this important post for many years, during which again his shrewd judgment and keen intellect were of the greatest value to the College. Pressure of work caused him, however, to relinquish the chair in 1923, and it is significant of the aims of Armstrong College that he was succeeded by Dr. Cecil Cochrane, whose connexion with iron manufacture is too well known to need emphasising here.

Sir Hugh Bell was a notable exception to the widely held view that an able father does not produce an able son. Although in this case both father and son were distinguished ironmasters, it must, however, be admitted that their mentalities were of an entirely different order. Sir Lowthian Bell will be remembered best for his scientific acquirements and their application to technology, whilst Sir Hugh Bell's fame is not that of a man of science, but of a man who devoted his brilliant abilities and keen insight to the service of the community. It is not too much to say that he would have been eminent in any profession or career that he had cared to take up. It is a curious comment on the lives of these two great men that Sir Lowthian Bell, eminent as his scientific acquirements were, is now seen to have thrown back the industries of coke-making and of pig-iron production, to which he devoted his life, many years by his obstinate preference for the old-fashioned beehive to the more modern retort-oven coke. The future may possibly show that his brilliant son may have retarded the progress of the nation to a similar extent by his obstinate adherence to old-fashioned free-trade principles. He appeared to disregard entirely the wise saying, *Temporibus mores sapiens sine crimine mutal*, and did not seem to realise that a policy which might have been entirely right and sound at one period of the world's history, might be disastrous under different conditions.

As is perhaps only natural in the case of a man who has succeeded in living to an age beyond that of most others, the closing years of Sir Hugh's life were saddened by the loss of many dear to him; here it is only necessary to mention the death of his gifted daughter, Gertrude Bell, who died in July 1926, and that of Lady Bell, who died a little more than a year ago.

The whole record of the life and activities of the man whose loss we mourn is that of a man of keen and penetrating intellect, a brilliant speaker, an advanced thinker, and a shrewd observer, whose keenness was, however, tempered by the geniality of his character, a man who devoted his great gifts unselfishly and unsparingly to the service of his fellow-men. HENRY LOUIS.

THOUGH the Science Museum at South Kensington was established in 1857, the development of its collections had lagged far behind those representing art; but in 1909 a number of people distinguished in science and representing technical institutions sought an interview with the President of the Board of Education in order to represent the urgent importance of developing its collections and of providing more suitable buildings for their accommodation. The result of the representation thus made was that a Departmental Committee was appointed in the following year, of which Sir Hugh Bell was the chairman, its terms of reference being to consider and report upon the condition and the future development of the Science Museum and the Geological Museum.

Sir Hugh Bell took the keenest interest in this task, and under his guidance the Committee prepared a detailed report, which was adopted by the Board, laying down the lines which the development of the Museum has since followed. The report proposed the replacement of the old buildings by others of modern type, of which the eastern and centre blocks were to be completed as soon as practicable, but the outbreak of war delayed the execution of this plan and only the former of these has as yet been constructed.

In 1913 Sir Hugh Bell was appointed chairman of the Advisory Council of the Science Museum, and in this capacity for eighteen years he watched over the development of the collections and their exhibition in the galleries of the new building in accordance with the plan devised by his Committee. Difficulties and delays occurred from time to time, and on all such occasions his tact, influence, and ready help were of the greatest value in overcoming them. He took a wide view of the influence which the museums at South Kensington might, he thought, exert, and he strongly advocated a general policy of co-operation in which each museum would not only work out its own line of policy but should also look out for and develop contact with the others in order that the various aspects of human endeavour might be more fully represented.

The Science Museum owes more to Sir Hugh Bell than to anyone, and by his death it has lost a wise counsellor, a ready helper, and a valued friend.

PROF. H. WILDON CARR.

BY the death of Prof. Herbert Wildon Carr, which took place on July 8 at Los Angeles, at the age of seventy-four years, philosophy has lost an enthusiastic student and exponent, and philosophers in many countries a friend greatly respected for his single-minded devotion to learning and beloved for his generosity and kindness of heart.

Wildon Carr's life had some of the features of a romance, including (one may be permitted to say) a singularly fortunate and happy marriage. Born in circumstances which precluded a prolonged education, he had to go out into the world at the age of fourteen. But even at that tender age he had already marked out for himself what was to be the real business of his life, and addressed himself deliberately to the task of winning as soon as possible a financial competence in order that he might thereafter devote himself to philosophy. Not often have the dreams of boyhood worked out more completely 'according to plan'. For in due course Wildon Carr enjoyed in succession the status of a member of committee of the London Stock Exchange and of a president of the Aristotelian

Society and honorary professor of philosophy in the University of London.

Nevertheless, all did not go smoothly; for the youth who set out on the philosophical quest in high hopes found himself as a man brought up against the blank wall of Humean scepticism. At a memorable dinner which Carr gave in 1911 in honour of Henri Bergson, he pictured in moving terms the sadness of his intellectual plight and hailed the French philosopher with gratitude as his rescuer. Students who have followed Wildon Carr's work during the last twenty years will, indeed, recognise how powerful an impulse he received from Bergson—an impulse which, reinforced by the later influences of Croce and Gentile, carried him forward to his own monadistic idealism.

Wildon Carr's development as a philosopher is dealt with below by another hand. It is, however, fitting to emphasise here what he did for philosophy and philosophers, apart from his output as a writer. For many years he was the honorary secretary of the Aristotelian Society, and from the death of Shadworth Hodgson onwards to the time when the state of his own health compelled him to seek sunnier skies, he might almost be said to have been himself the Society. This does not mean that he ruled it as an autocrat, seeking to make its voice his own. On the contrary, there was never a more generous appraiser of an opponent's merits, nor a scholar who sought more earnestly to let all sides of a question have the best exposition and the fairest hearing. Nor did an older philosopher ever keep a more watchful eye upon promising beginners or give them more encouragement.

Under Carr's kindly and inspiring rule the Aristotelian Society was for many years a forum where most of the notable thinkers of the day debated most of the living philosophical issues. His associates during those fruitful years knew how dear the welfare of the Society was to him, and how generously he spent upon it both his time and his material means. The solid work done by it under his guidance will be an enduring part of the monument he has left behind him; while so long as those who knew him and worked with him still live, the memory of his singularly gracious and generous personality must continue to " smell sweet and blossom ". T. PERCY NUNN.

IN speaking of Carr's philosophy, it is particularly difficult to separate the philosopher from the man. Like his first teacher, Shadworth Hodgson, he, if any man of my time did, lived the philosophic life, and, after his success in business enabled him to retire, he devoted himself entirely to cultivating philosophy in himself and others. Yet he remained rather a centre of philosophers than of philosophy, and his work was an influence rather than an achievement. He taught us, through his own devotion and through the affection he inspired, to feel that we were fellow-workers in one subject, however different in our methods of approach; and I scarcely like to think what we shall do without him. Nor was it only philosophers he brought together; he also brought science and philosophy into their wholesome and natural contact. He believed that philosophy and science belonged together, and that philosophy could not be indifferent to changes in scientific ideas such as his time had witnessed. In this he was surely right. The work of the Aristotelian Society in the last twenty years is a standing witness to his success in this effort and to its fruitfulness.

Carr owed both his strength and his weakness to his open-mindedness; and the personal hold he had over philosophers of such differing views was only the other side of his candour and his intense effort to understand and assimilate. His own originality and independence showed itself in the tenacity with which he worked out a doctrine for himself, while making use of what he was continually learning from them. You would call him markedly suggestible, and impulsive as well, so that, as each successive thinker like Bergson or Croce or Einstein or Gentile fascinated him, he devoted himself to expounding them with enthusiasm. When I knew him first, he was still a disciple of Hodgson. Afterwards he leaned towards a Humean idealism, and the idealism which began thus early he never ceased to entertain under some form or other. In the end he worked his way to a kind of Leibnizianism which was very much his own. But, as anyone may see from his latest constructive pronouncement, " Cogitans Cogitata ", it retained plain traces of the doctrines that had influenced his mind, and it would be an interesting and profitable task to follow him from his phase of discipleship up to that of mastery.

Carr's readiness to accept from others may have disturbed some persons; for my part, I admired rather the independence with which he converted them to his own uses, and always, even without assenting to him, I found him one of the most interesting and stimulating minds among my contemporaries. I still have the feeling that in dealing with relativity he was over-hasty in his deliverances. I subscribe to Bertrand Russell's statement that relativity is of immense importance to philosophy but that we do not yet quite know in what way. Carr had no doubt. He thought it had dethroned Newtonianism to make way for Leibnizianism; and I expect he was, in general, right. There was, however, a want of special authority about what he said when he was expounding the new science as science, and I understand his exciting some impatience among those who knew. But he showed philosophers the way, and that it was our duty to find material for our philosophy in a thorough understanding of this new mode of scientific thought. It would be an evil day for metaphysics if a great change should occur in men's minds about the science of things and we philosophers should go our way as if nothing particular had occurred.

In philosophy there has been a marked tendency in recent years to revert to Leibniz and monadism, but to treat the monads not as windowless, like Leibniz's, but as communicating. Carr would have nothing of it, and insisted that the monads were completely independent of each other, each "expressing" itself (the word is his own) through its own activity in its own world of what is commonly called reality or external reality. The true reals are thus the monads, the so-called world of knowledge is ideal. The crux of any such theory is its solipsism, but he avowed and defended that attitude. He evaded the objection to solipsism by making community with other individuals part of the essential nature of each individual. I do not myself see how if the universe is each man's expression, it can still contain individuals who, like himself, are independent centres of activity. Often, however, as I pressed this point upon him, he did not seem to feel that it presented a real difficulty, and he seemed to think he had met it by reference to speech and mutual intercourse. In the same way he seemed to me to make the special interpretations by individuals of the physical world too exclusive of each other, and to forget that the very pith of the doctrine of relativity is that physical laws are the same in form for every observer. Leibniz himself had God and the pre-established harmony to save his monadism: but for Carr, God was but a part of the world of each monad; and this, to my mind at least, presents difficulties.

Carr's explicit philosophy is chiefly contained in the work I have mentioned and the earlier "A Theory of Monads". But besides these and his expository books, there were others, which show what a wealth of knowledge he had, outside strict philosophy or only partially related to it; in particular, two books which he published during his Californian period, "Changing Backgrounds in Religion and Ethics" and "The Unique Status of Man". When I happened once to speak to him enthusiastically of Pascal's "Pensées", with which I had made acquaintance quite late in my life, I found that the book had been his constant companion for many years.

His assiduity and industry were immense, and if his friends knew well the sweetness of his character, the amount of work he accomplished is a witness to the strength and persistence of it. To my mind, Carr's work has been for the philosophy of our time a refreshment, and even, with all allowance for its shortcomings, a fecundation; and I must not forget the singular beauty and simplicity of his style of writing, which reflected his own directness and candour of mind.

S. Alexander.

Mr. Ernest Noel.

Mr. Ernest Noel, who died at his home, Dulaney House, Patching, Sussex, on May 20 at the age of ninety-nine years, was the doyen of the Geological Society of London. Elected into the Geological Society in 1849—P. Martin Duncan, who afterwards became a fellow of the Royal Society, was also among the chosen in that year—he had been eighty-two years on its roll, a span probably without parallel in the annals of English scientific bodies. At the date of Noel's election (he was then living at Hornsey), Sir Charles Lyell occupied the presidential chair, and Charles Darwin was a member of council. Such circumstances had provided many interesting reminiscences of contemporaries and original workers in geological and general science. Born on Aug. 18, 1831, Mr. Noel was the second son of the Rev. the Hon. Baptist Noel, who himself was the tenth son of Sir Gerard Noel, and brother of the first Earl of Gainsborough (second creation). Mr. Noel was educated at Edinburgh and Trinity College, Cambridge.

T. E. J.

News and Views.

The summary by Sir James Jeans of a series of lectures on the annihilation of matter, delivered by him during his recent visit to the United States, which we publish as our supplement this week, is a characteristically skilful presentation of the case for the reality of this process, of which he has for some time been convinced. Although, as he indicates, the doctrine of the permanence of matter has been a leading feature of the greater part of the history of science—it dates at the latest from the time of Aristotle—supporters of the opposite idea have never been wanting. It appears to be peculiar to our own time, however, that they are to be found among followers of the 'experimental philosophy'. Yet, fantastic as the idea would have seemed to the physicists of a few generations ago, it is impossible, after considering the evidence which Sir James Jeans so ably summarises, to dismiss it as unworthy of scientific attention. The process is mathematically possible; it is certainly not fundamentally inconsistent with modern atomic theory; it provides a plausible explanation of a physical observation—the highly penetrating radiation; and it appears to be the only means of bringing order into the perplexing mass of data concerning the constitution and history of the stars. The cumulative effect of these facts, even if they are not strictly additive, is considerable, and it is not surprising that the hypothesis of annihilation is being treated with marked respect.

General acceptance of the idea, however, is out of the question until more facts of observation are available. Sir James remarks that "the majority of astronomers think it probable . . . while many, and perhaps most, physicists look on the possibility with caution and even distrust". It is perhaps for that reason that he has devoted the greater part of his discussion to the physical evidence. While his diagnosis of the situation is, perhaps, not very inaccurate, it is scarcely a fundamental one. The reaction of the man of science—whether he be physicist or astronomer—to the idea will depend on his mental constitution. The passage from mathematical possibility to physical actuality is traversed much more easily in some minds than in others. Physicists have been known whose enthusiasm has sometimes triumphed over their scientific scepticism, and, on the other hand, even an astronomer may demand more than an æsthetic satisfaction in co-ordinating his observations. It would be a mistake to suppose either that the astronomer has a more elastic scientific conscience than the physicist or that the physical evidence for the annihilation of matter is less than the astronomical. The simple fact is that the hypothesis of the annihilation of matter is a legitimate, useful, and stimulating one, with at least as great a probability as any alternative that has been suggested, but that it awaits further observational and experimental data for its final assessment. In the meantime, we may be thankful that in these matters we have both pioneers and critics of the highest quality.

AT a meeting of the Council of the Royal College of Surgeons of England, held on July 9, Lord Moynihan was elected president, for the sixth year in succession. This constitutes a record in the annals of the College. Although an election to the presidential chair is made annually, it has become the custom to extend the office to three years. Only once before has this term been exceeded, when the late Sir William MacCormac was elected president five years in succession—1896–1901. During Lord Moynihan's presidency, research laboratories have been opened in connexion with the museum of the College, and research scholarships have been endowed to permit young men who intend to become surgeons to devote one year or more to experimental research. Research scholars are encouraged to maintain their connexion with their hospitals and to continue their participation in clinical work.

ON the eve of his re-election to the presidency of the College, Lord Moynihan laid the foundation-stone of an institute for surgical research—to be known as the Buckston Browne Farm for Surgical Research. The object of this farm is to permit the research students of the Royal College of Surgeons to carry out experiments on animals kept under the most favourable conditions. The erection and endowment of this invaluable addition to the equipment of the Royal College of Surgeons has been made possible by the munificence of one of its fellows, Mr. George Buckston Browne, who is giving £100,000 to the College in order that it may complete its scheme of research. Mr. Buckston Browne, as readers of NATURE will remember, purchased Down House, Charles Darwin's home for forty years, endowed it, and handed it over, with its grounds, 23 acres in extent, to the custody of the British Association. More recently, he bought 13 acres of land adjoining the western side of the Down House property and beautifully situated. This land he has conveyed to the Royal College of Surgeons, and it was a site on these new fields which was the scene of the ceremony in which Lord Moynihan played the leading part on July 8. In laying the foundation-stone, he said that owing to the great beneficence of a fellow of the College, they were laying the foundation-stone of an institute for experimental research which would add the one remaining link required for the proper development of surgery in Great Britain. The donor of the institute, in reply to Lord Moynihan, said that they had been able "to bring the great genius of John Hunter, who did so much to throw light on the living processes of the human body, alongside of the home of that other great genius, Charles Darwin, who did so much to emancipate the human mind from superstition. Both men are now brought together on a sacred spot in Kent." Mr. Buckston Browne's gift has been rightly described as the most beneficent ever made by a surgeon for the advancement of his profession.

To mark the occasion of its jubilee, the Society of Chemical Industry has issued a special number of *Chemistry and Industry* which will undoubtedly appeal to all who are interested in the historical aspect of applied chemistry. The earlier part of the issue is devoted to an account, not hitherto available in compact form, of the formation and development of the Society, which has been very closely identified with the growth of the chemical industry in Great Britain, and to an illustrated series of biographies of past presidents and medallists, amongst whom are numbered such distinguished men of science as Sir William Ramsay, Sir William Crookes, and Sir James Dewar. The second half of the volume, consisting of reprints of twenty-one of the more important papers which have been read before the Society during the past fifty years, indicates the wide range of topics which fall within the scope of the Society's activities. The reprints include the paper read by Sir Oliver Lodge before the Liverpool Section in 1886 on "The Electrical Deposition of Dust and Smoke, with Special Reference to the Collection of Dust and Fume, and to a Possible Purification of the Atmosphere"; Weldon's account of "Some Recent Improvements in Industrial Chemical Processes", read in 1882; Mr. William Macnab's fascinating story of "Some Achievements of Chemical Industry during the War in this Country and in France" (1922); and Sir William Pope's Royal Institution discourse on "Faraday as a Chemist" (1925). Apart from the event which its appearance commemorates, the issue is of importance on account of the great historical value of its contents.

THE Safety in Mines Research Board has issued its paper No. 66, being a report upon haulage accidents in collieries, and, as usual, the report is issued at the nominal price of 6*d.* so as to be available to all interested in colliery work. The subject is one of very great importance, first, because next to falls of ground, haulage accidents claim the largest number of victims in collieries, and in some districts are even the most prolific cause. Whereas it is quite true that the proportion of fatal to non-fatal accidents due to haulage is much less than that due to certain other causes, such as explosions of firedamp or coal dust, nevertheless, the very large number of non-fatal accidents show that the subject is one worthy of investigation. An interesting table in the report shows that whilst the number of fatal accidents per thousand persons employed has, roughly speaking, been halved since 1873, that due to haulage accidents is practically unchanged in that period, and this fact alone shows that the subject is worthy of serious investigation.

THE problem is a difficult one on account of the great variations, not only between different districts but also between different collieries in the same district. Thus, it is pointed out that there is a high rate of haulage accidents in Northumberland and Durham, and it is suggested that this may be due to the prevalence of bord-and-pillar working in this coalfield, involving a large use of pony haulage and of young lads in charge of the ponies. Again, it is pointed out that in one of the Scottish collieries the highest accident rate is nearly thirty times the lowest accident rate. The report naturally makes no definite recommendations as to what steps should be taken to decrease the number of accidents, that not being the object of the Committee; its work was simply to prepare a scheme for investigating possible methods of reducing the number of haulage accidents, and accordingly the Committee makes a number of recommendations for research, which appear to be thoroughly sound and well warranted by the conditions, although the Committee itself points out that many of these accidents "are due to causes which could only be overcome by a change in human nature".

THE small tortoise-house behind the old reptile-house—now converted into a bird-house—at the London Zoological Gardens has just been refitted as a tropical house; the atmosphere is most convincingly tropical, and one side is fitted up as a greenhouse-aviary, with stone-plants, rockwork, and a little streamlet and pool. Here are located a pair of African jacanas (*Actophilornis africanus*) and some interesting passerine birds, pittas, sunbirds, sugar-birds (Cœrebidæ), and small tanagers. On the other side there are three compartments, two tenanted by platyrhine monkeys, including a howler, and the third by the first hoatzin ever exhibited here. It is interesting to note that, just as the anatomy of this peculiar bird points to several different groups, so do some of its actions recall groups different again—it has the crouching walk and squatting pose on a perch of the cotton-teal or goslets (*Nettopus*) and the upthrow of the wings on alighting of the sandpipers. With the exhibition of this type the number of scientifically important bird-families yet to be exhibited is reduced to five—the todies, jacamars, puff-birds, finfoots, and the Mesitidæ of Madagascar. In the present reptile-house, an important acquisition is that of specimens of the Australian frilled lizard *Chlamydosaurus*, an agamid species so rare in captivity that it has only once been exhibited before. It has to rely for notoriety on its frill, its power of rearing and running on its hind-legs being now known to be shared by several other lizards, notably by the iguanid *Basiliscus*.

THE practice of shooting all abnormal varieties of birds is so prevalent that it is worth while to direct attention to a case recorded by Mr. M. Mason in the *Field* of June 20, in which a white hen grouse was protected instead. The result was that she lived to rear four broods, being at last found dead and torn in her fifth year. Of her offspring, many were pied and one cream-coloured, but no white was found in the second generation. Although it was suspected that her death was due to an eagle, her survival for so long may perhaps be attributed to the reduction in the number of predatory birds by modern game-preserving, but the fact that her offspring so soon lost any trace of her abnormal colouring indicates that other causes besides natural selection by enemies contribute to limit white colouring; it must also be remembered that though a brown protective plumage is so very common among game birds, and generally characterises the females even where the males are conspicuous, yet hens may be green, in *Rollulus*, and black in *Acomus*, while *Crossoptilum tibetanum*, a large, conspicuous bird, is nearly all white in both sexes and at all seasons.

CAPT. C. W. HUME has written protesting against our suggestion that truth had been sacrificed to propaganda in certain statements in "The Animal Year Book". Clearly he has not read our comments carefully, for although we gave page references to two particular statements, his reply omits to mention one and deals with another of which we made no mention and which is on neither of the pages quoted. But the kernel of the whole matter seems to us to be this. If cruelty is to be measured by the amount of suffering borne by the victim, the same punishment may have different cruelty values even in different men, for it will depend upon their sensitivity. Therefore the statement that the degree of pain suffered by a lower animal trapped by the leg is "roughly comparable to crucifixion" suffered by the much more highly organised and, moreover, self-conscious human being, is, to put it bluntly, rubbish. If, on the other hand, cruelty is to be measured by the intention of the torturer as well as by the suffering of the victim, the other statement we referred to is even less accurate, namely, that the torture inflicted by the steel-toothed trap and the common snare is on a par with the medieval torture of human beings. For, apart from the facts of comparative sensibility we have stated above, the deliberately designed tortures of human beings devised for the sole purpose of causing pain stand in a category by themselves. We do not wish to minimise the sufferings caused by steel traps; surely there is no need to exaggerate them.

MESSRS. Cooke, Troughton, and Simms have produced a simple instrument known as "The Orientator", for enabling architects, builders, house-agents, and others to determine visually from plans the direction in which the sun's rays will fall on any window, building, or wall during winter or summer. It consists of a flat metal ring, to the central end of a radius of which is attached a thread terminating in a small ball representing the sun. A portion of a second ring (which, if complete, would form a short

(*Continued on p.* 111.)

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The Annihilation of Matter.*

By Sir JAMES JEANS, F.R.S.

THROUGHOUT the greater part of the history of science, matter was believed to be permanent, incapable either of annihilation or of creation. Yet a large amount of astronomical evidence now seems to point to the annihilation of matter as the only possible source of the energy radiated by the stars. A position has thus been reached in which the majority of astronomers think it probable that annihilation of matter constitutes one of the fundamental processes of the universe, while many, and perhaps most, physicists look on the possibility with caution and even distrust. I have thought it might be of interest to attempt a survey of the present situation in respect to this question.

THE ASTRONOMICAL EVIDENCE.

The astronomical argument for the annihilation of matter is based, not on the intensity of stellar radiation, but on its duration. No transformation of a less drastic nature than complete annihilation is found capable of providing continuous radiation for the immense periods of time throughout which the stars have, to all appearances, lived. For, with one conspicuous exception, to be discussed later, all available methods of estimating stellar ages are found to indicate that the stars, as a whole, have already lived through periods of millions of millions of years.

Some of these methods depend on the rate of gravitational interaction between adjacent stars, for example, the velocities with which the stars move through space show an approximation to equipartition of energy, such as must have required millions of millions of years for its establishment. The individual members of the groups of stars known as moving star clusters appear to have had their courses changed by the gravitational pull of passing stars to an extent which again indicates action extending over millions of millions of years. The same is true of the orbits of visual binary stars. In each of these three cases, the clock we use has for its unit a time analogous to what is called the 'time of relaxation' in the theory of gases; in this comparison the single stars correspond to monatomic molecules, and binary stars to diatomic molecules, while the disintegration of a moving star cluster provides the counterpart of the process of gaseous diffusion.

These estimates of stellar ages are, of course, valid only if we assume that the changes in stellar motions and arrangements are produced solely by the gravitational pulls of other stars. Other causes are conceivable, and must indeed contribute something—pressure of radiation, bombardment by stray matter in space, or by the atoms of cosmic clouds diffused through space. But calculation shows that the contributions from these sources are quite negligible. Indeed when we take them into account, the discussion of stellar movements is no longer a problem of astronomy, but of physics; we have to treat the stars as Brownian 'particles' in a physical medium. When they are so treated, we find that the starry medium has a temperature—in the sense in which we speak of the temperature of moving Brownian particles—of the order of 10^{62} degrees. Both individual and binary stars exhibit the equipartition of energy which corresponds to a temperature of this order, whence it is obvious that physical agencies such as pressure of radiation and atomic pressures, which are in equilibrium with far lower temperatures of the order only of 10^4 degrees, cannot have made any appreciable contributions to the establishment of this equipartition; they act as mere drags on the stellar motions, tending on the average to check their speed.

In a second class of binary stars, the spectroscopic binaries, the two components are so close together that the gravitational pull from passing stars is approximately the same on each, and so cannot exert the differential action which would change the relative orbits of the constituent masses. Clearly there can be no question of any approximation to equipartition of energy in the internal motions of these systems. Nevertheless, it is possible to trace a steady sequence of configurations, beginning with almost circular orbits in which the two constituents are practically in contact—this being probably the condition of a system which has just formed by fission—and proceeding to orbits which are far from circular in shape, in which the components are at a substantial distance apart. It seems likely, although not certain, that this sequence is one of advancing age; when the parent star first breaks up to form a binary, the newly formed system starts at the first-mentioned end and moves gradually along the sequence. Now observation shows, beyond all doubt, that the stars at the far end of this sequence are substantially less massive than those at the beginning. We know the rate at which the various types of stars are radiating their mass away in the form of radiation, and from this we can calculate the time needed to produce the difference of mass which is observed to exist between the two ends of the sequence; again it proves to be a matter of millions of millions of years. Here the clock we use is the rate of outflow of radiation from a star, or its equivalent, the rate of loss of mass.

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* The substance of lectures delivered before the Universities of Princeton, Yale, and Harvard on May 23, 26, and 27 respectively, under the auspices of the Franklin Institute of Pennsylvania.

Against these various estimates must be set one piece of evidence which, if interpreted in the most obvious way, seems to point in exactly the opposite direction. This is, that the remote extra-galactic nebulæ all show a shift of their spectral lines to the red, the amount of shift being approximately, although not exactly, proportional to the distance of the nebula. If this is interpreted in the most direct way, as a Doppler effect, the nebulæ must all be scattering away from us and from one another in space, at so great a speed that the whole universe doubles its size about once in every 1400 million years. Such a rate of increase seems quite inconsistent with the estimate which assigns ages of millions of millions of years to the stars. Calculation suggests that the original radius of the universe must have been of the order of 1200 million light-years (Eddington), while the present radius of the universe appears to be only of the order of 2000 million light-years (de Sitter). If these estimates could be treated as exact, we could fix the age of the universe definitely at just more than 1000 million years, which is substantially less even than the age of the earth as indicated by its radioactive rocks. No one would claim any great degree of exactness for either of these estimates, especially the second, yet the general situation seems to forbid that the universe can have been doubling in size every 1400 million years throughout a period of millions of millions of years.

Although alternative interpretations are tenable, none of them seems entirely convincing, and the present situation is extremely puzzling. While there is obviously room for much difference of opinion, many astronomers consider it likely that some other explanation of the apparent recessions of the nebulæ will be found in time, in which event the road will be clear for the acceptance of ages of millions of millions of years for the stars, as suggested by the main bulk of astronomical evidence.

If such ages are provisionally accepted, calculation shows that the average star has already emitted many times its total mass in radiation; in other words, the average star must have started life with many times its present mass. Indeed, the sequence of spectroscopic binaries gives us a sort of picture of the life-history of a typical star. It starts with anything from ten to a hundred times the mass of the sun, and ends with a mass comparable to, or even less than, that of the sun. It is difficult to see where the enormous weight of the newly-born star can have been stored if not in the form of material atoms, or at any rate of material electrons and protons. Thus we are led to suppose that the life-history of the star is one of continual annihilation of its substance, the electrons and protons annihilating one another, and providing the energy for the star's radiation in so doing. Such, at least, is the conjecture suggested to us by astronomy; the testing of the conjecture rests with physics.

HIGHLY PENETRATING RADIATION.

If any direct evidence of this process of annihilation is to be obtained, it seems most likely that it will be found in the highly penetrating radiation which McLennan, Rutherford, and others discovered in the earth's atmosphere at the beginning of the present century. The reason, as we shall see later, is that here, and here alone in the whole of physics, we are dealing with photons of radiation whose mass is comparable with that to be expected in photons resulting from the annihilation of electrons and protons. In the last few years, this radiation has been studied in great detail by Hess, Millikan, Regener, and many others. Their investigations scarcely leave room for doubt that the radiation enters the earth's atmosphere from outer space: for which reason it is often described as 'cosmic radiation'.

It was at first taken for granted that this radiation must be of the nature of γ-radiation, since its penetrating power was greater than seemed possible for any kind of corpuscular radiation. This reason is now known to be inadequate, theoretical investigations having shown that corpuscular radiation, consisting of either α- or β-particles, might conceivably possess as high a penetrating power as the observed radiation.

Other arguments have, however, stepped into the breach, and show very convincingly that the radiation cannot be of the nature of either α or β radiation. The central fact is, in brief, that radiation which consisted of charged particles would be influenced by a magnetic field, whereas cosmic radiation is not. An electron or other charged particle in motion acquires magnetic properties in virtue of its motion; the faster it moves, the greater the force which a magnetic field exerts upon it. Now the penetrating power of the radiation under consideration is so great that it could only be attained by charged particles, if these were moving with very high speeds indeed. If a swarm of such particles became entangled in the earth's magnetic field, their high speed of motion would cause them to describe spiral paths coiled quite closely around the earth's lines of magnetic force, with the result that they would fall far more abundantly near the earth's magnetic poles than elsewhere. Epstein[1] estimates that for a shower of electrons to have the penetrating power of cosmic radiation, they would have to move with the energy produced by a fall through about 1000 million volts, and has calculated that the incidence of electrons moving with this energy would be limited entirely to comparatively small circles surrounding the two magnetic poles. Actually the observed radiation falls so evenly on the different parts of the earth's surface that no variations have ever been detected. Members of the B.A.N.Z. Antarctic Expedition[2] found the same intensity of radiation within 250 miles of the south magnetic pole as they had previously measured in South Australia, and as others had found in the United States, Canada, and the North Atlantic. This seems to leave little room for doubt that the radiation is of the nature of very hard γ radiation.[3]

At first, some experiments by Bothe and Kohlhörster seemed to throw doubt on this conclusion. They had placed two Geiger counters, one vertically above the other, and found that the number of coincident discharges in the two counters was just about that which would be expected from purely geometrical considerations, if the radiation was corpuscular. Of course, the radiation which produced these ionisations was not necessarily the primary radiation which fell on the earth from outer space. Any primary radiation, as it traverses the atmosphere, is bound to produce secondary radiation of a variety of kinds, and any one of these might have been the immediate cause of the ionisation observed by Bothe and Kohlhörster. The primary radiation which first enters the earth's atmosphere might quite conceivably be electromagnetic, while the ionisation might be produced by a secondary corpuscular radiation.

To examine this possibility, Bothe and Kohlhörster placed a block of gold between their two counters. This naturally caused a reduction in the number of coincidences, and from the amount of the reduction it was possible to calculate the penetrating power of the radiation which actually effected the ionisations. It was found to be approximately the same as that of the primary radiation. So far, then, everything could be explained by supposing that it was the primary radiation itself which produced the ionisations in the counters, and that this was corpuscular in its nature.

Recently this explanation has been tested by Moss-Smith[4] and found wanting. He extended the apparatus used by Bothe and Kohlhörster, by mounting yet a third counter vertically below the original two, and first verified that the number of coincident ionisations in all three counters was that which their geometrical arrangement would lead us to expect. Now if the radiation which produced these ionisations were corpuscular, it ought to be deflected by a magnetic field. For example, if a sufficiently strong magnetic field were inserted between the second and third counters, the third counter ought to be entirely shielded from the radiation which had passed through the first two counters, so that the number of coincident ionisations in the first two counters would remain as before, while the number in the third counter would fall to zero. Moss-Smith found that this did not happen. Although his magnetic field had many times the strength needed to shield the third counter completely, its insertion had no effect on the number of coincident ionisations. This showed that the ionising radiation was not corpuscular, and as Bothe and Kohlhörster had already shown that the ionising radiation was probably identical with the primary radiation, it confirmed the theoretical arguments of Millikan and Epstein, which proved the primary radiation to be of the nature of γ radiation.

THE MODE OF PRODUCTION OF THE RADIATION.

If the primary radiation is of the nature of γ radiation, as these arguments and experiments seem to show, its origin ought to be disclosed by its penetrating power. Such radiation consists of photons, which may be compared to bullets, all moving with the same speed—the velocity of light. Their penetrating power accordingly depends solely on their mass, and a theoretical investigation enables us to deduce the one from the other. Every photon is, however, produced originally by an atomic upheaval, and its mass is exactly equal to the decrease of mass which the parent atom experienced as the result of this upheaval. For example, if the atom was one of hydrogen and the upheaval consisted of annihilation, the photon resulting from this annihilation must have a mass exactly equal to the original mass of the hydrogen atom, namely, $1{\cdot}66 \times 10^{-24}$ gm. Or again, if a proton and an electron mutually annihilate one another in any atom whatever, thus reducing its atomic weight by unity, the mass of the resulting photon must be equal to the combined masses of the proton and electron in situ in the atom, which again, except for a small 'packing-fraction' mass, is equal to the mass of a hydrogen atom.

The most effective means of investigating the penetrating power of cosmic radiation is to sink suitable apparatus to varying depths below the surface of a lake, and observe the ionisation produced by the incidence of the cosmic rays after absorption by varying depths of water. Observations of this type have been performed with great care and skill by Millikan, Regener, and others.

Their results are none too easy of interpretation. L. H. Gray has shown [5] that there is a sort of softening effect continually in progress by which the absorption of a quantum of energy produces a recoil electron, which in turn produces radiation of energy comparable to, although somewhat lower than, the energy of the original quantum. After the radiation has travelled through a certain thickness of absorbing material, the observed ionisation no longer gives a true measure of the intensity of the primary radiation which has escaped absorption, but of this primary radiation in equilibrium with all its softer secondary components.

When this complication has been allowed for, the ionisation curve gives the intensity of the true primary radiation which remains after passing through varying thicknesses of absorbing matter. If this primary radiation consists of a mixture of constituents of different and clearly defined wavelengths, so that it has a line spectrum in the language of ordinary optics, these different constituents will have different coefficients of absorption. In such a case, it ought to be possible to analyse the observed curve into the superposition of a number of simple exponential curves, one for each constituent of the radiation.

Actually, it is found that this can be done. Different experimenters do not obtain results which are altogether accordant, but all agree in finding that there is a long stretch, near the end of the range of the radiation, over which its intensity decreases according to a simple exponential law. This can only mean that one particular constituent of the radiation is so much harder than the others that it persists in appreciable amount after traversing a thickness of matter which has completely absorbed all the softer constituents. Regener, who has studied the problem in great detail, finds that the hardest radiation of all has an absorption coefficient of 0·020 per metre of water. Other experimenters have found values which agree with this to within about 10 per cent.

The mass of the photon can be deduced from the observed absorption coefficient μ of the radiation, by the use of a theoretical formula given by Klein and Nishina.[6] This can be written in the form

$$\mu = \frac{2\pi N e^4}{m^2 c^4} f\left(\frac{M}{m}\right),$$

where M is the mass of the photon, m of an electron, e, c have their usual meanings, and f represents a fairly complicated function of M/m. In all the applications of the formula to cosmic radiation, M/m is quite large, and for such values of M/m, f assumes the form

$$f\left(\frac{M}{m}\right) = \tfrac{1}{4}\left(\frac{M}{m} + 2 \log \frac{2M}{m}\right).$$

These formulæ are calculated on the supposition that the absorption is caused by N electrons per unit volume, and that these are entirely free. This last condition can never be fully realised in Nature, since every electron is bound, more or less closely, to other electric charges. If an electron is bound to a system of mass m', we can allow for this binding by increasing m in the formula by a fraction of m', the fraction being large or small according as the coupling is tight or loose. Thus a loosely coupled electron behaves almost like a free electron, but an electron coupled tightly to a massive system, such, for example, as a proton or an atomic nucleus, behaves like an electron of very great mass, and the formula shows that this has no appreciable absorbing power.

The Klein-Nishina formula has been tested by comparing it with observation for γ-rays. In the case of the lighter elements, it gives values whch agree well with the observed absorption, provided all the extra-nuclear electrons are treated as free, while the nuclear electrons are disregarded entirely. It is natural to disregard these, because the coupling of nuclear electrons in the lighter elements is known to be so close that even the hardest γ-rays make but little impression on them. This is true for the lighter elements only; in the case of lead, Chao[7] has found an additional scattering of the hardest γ-rays, which he believes to be of nuclear origin. In other words, he finds that some at least of the nuclear electrons in lead are not so closely coupled as to resist the onslaught of the hardest γ-radiation. Still less, then, can they be so closely coupled as to resist the incidence of the far more massive photons of cosmic radiation. From theoretical considerations of a very general nature[8] it appears probable that in dealing with cosmic radiation, the *N* in the Klein-Nishina formula should refer to all electrons, nuclear as well as extra-nuclear, and not merely to the latter. A further term ought also to be added to represent scattering by nuclear protons, but calculation shows that this is entirely insignificant in amount. The result of taking the nuclear electrons into account is to replace atomic number by atomic weight, so that the absorption by a given thickness of matter becomes strictly proportional to the mass of the matter, and absolutely independent of its nature, except possibly in so far as a further small absorption, caused by photoelectric action, may depend on the latter. The effect of this is to double, or more than double, the capacity of all atoms except hydrogen for absorbing cosmic radiation; it increases the absorbing power of water to 80 per cent above the value usually calculated.

The following table shows the absorption coefficients (per metre of water) which I have calculated for the radiation produced by the synthesis of iron and by the annihilation of 1 and 4 protons respectively, with their accompanying electrons. The calculation is based on the Klein-Nishina formula, all electrons, including the nuclear electrons, being treated as absolutely free:

Process	$\frac{M}{m}$.	Calculated μ (per metre, water).	Observed μ (Regener).
$56H \longrightarrow Fe$	876	0·136	..
$+, - \longrightarrow 0$	1845	0·071	0 073
$4+, 4- \longrightarrow 0$	7380	0·020	0·020

The last column gives the absorption coefficients of the two most penetrating constituents of cosmic radiation, as analysed by Regener. Their agreement with the figures in the preceding column is probably well within errors of observation and analysis, and is rather too good to be attributed with much plausibility to mere accident; the odds against a double agreement, within 5 per cent in one case and 2·7 per cent in another, being about 3000 to 1. This seems to me to suggest quite strongly that the most penetrating constituent so far observed in cosmic radiation may originate in the annihilation of an α-particle and its two neutralising electrons (the components of a helium atom), while the next softer constituent may originate in the annihilation of a proton and its one neutralising electron (the components of a hydrogen atom).

An alternative possibility, which was first suggested by Millikan and has been championed mainly by him, is that the cosmic radiation may result from the building of electrons and protons into atoms. Yet the hardest constituents of the cosmic radiation appear to be far too hard to be produced by the synthesis of iron, while Millikan himself considers that the synthesis of heavier elements is probably ruled out by their rarity in the universe. If, as I have suggested, the annihilation of matter is the true origin of the two hardest constituents of the cosmic radiation, then it becomes possible to suppose, with Millikan, that the softer constituents are produced by the synthesis of simple atoms into complex. Many will, however, hesitate to accept such a mixed origin for the radiation. It certainly seems simpler to suppose that the two hardest constituents, and these alone, form the fundamental radiation, while all other constituents represent mere softened or degraded forms of these. Yet this supposition brings its own difficulties, since if we measure the intensity of the radiation by its ionising power, the supposed secondary radiation is found to have many times the ionising intensity of the primary. But whatever the origin of the softer constituents may be, the two hardest constituents, with their photons equal in mass to the atoms of hydrogen and helium respectively, appear to provide weighty evidence that matter can be, and is, annihilated somewhere out in the depths of space. If we can assume that this process occurs on a sufficiently large scale, this supposition brings order and intelligibility into a vast series of problems of astronomy and cosmogony in a way in which no other suppositions can.

THE PLACE OF PRODUCTION OF THE COSMIC RADIATION.

Various suggestions have been made as to the place of origin of this highly penetrating radiation. Many of them are put out of court by the fact, which must now, I think, be regarded as well established, that the radiation is nearly constant in intensity at all times of day and night,[9] any variation being, at most, of the order of one part in 200. There seems to be a real variation of this amount, but in the main it appears to follow the variation of the barometer: Millikan considers that it is adequately explained by fluctuations in the absorbing power of the air blanket formed by the earth's atmosphere. It was at one time suggested that the radiation might consist of electrons ejected from thunder-clouds high up in the earth's atmosphere, or of electrons moving with enormous speeds acquired by drifting through electrostatic fields in space, the potential gradients in these fields being slight, but the potential differences immense simply on account of the vast extent of the fields. Even if the radiation could still be treated as corpuscular, it would be very difficult to reconcile either of these suggested origins with the steadiness and uniformity with which the radiation falls on the earth's surface.

The fact that the intensity of the radiation is very approximately independent of both solar and sidereal time seems to show that no appreciable part of the radiation comes from the sun or stars. Counting the sun as a star, we receive more than 100,000,000 times as much starlight at midday as at midnight, yet apart from the purely local 'barometer' effect just mentioned, we receive the same intensity of the radiation at both times. The fact that the intensity is approximately independent of the position of the Milky Way seems to show that the bulk at least of the radiation must come even from beyond the confines of the galactic system, thus justifying the name 'cosmic radiation'.

Where, then, does the radiation originate? For reasons which will be clear at the end of our quest, it is simpler to conduct our search in time rather than in space. The average density of matter in space is probably of the order of 10^{-30} gm. per c.c., and in each second of its existence, a beam of cosmic radiation passes through a layer of space 3×10^{10} cm. thick. Thus every second it passes on the average through 3×10^{-20} gm. per sq. cm. of its cross-section. We have, however, seen that the hardest constituent must pass through 50 gm. per sq. cm. before it is reduced in intensity by one per cent, and this requires an average time of 16×10^{20} seconds, or about 5×10^{13} years—a period which, on any reckoning, is greater than the age of the stars; its intensity is reduced to $1/e$ times its original value after 5×10^{15} years, which is greater, so far as we know, than the age of the universe.

Thus, to an approximation, we may think of the hardest constituent of the cosmic radiation as indestructible, since the universe has not yet existed long enough for any appreciable amount of it to be absorbed. To a slightly less good approximation, the same is true of the softer constituents. This leads us to regard space as being permeated with all, or nearly all, of the cosmic radiation which has ever been generated since the world began. The rays come to us as messengers, not only from the farthest depths of space, but also from the remotest eras of time. And, since we cannot produce cosmic rays on earth, their message appears to be that the physics which prevails out in these far depths of space and time is something different from our terrestrial physics: different processes result in different products. So far as we can read the riddle of the rays, one at least of these processes appears to be the annihilation of matter, although whether this annihilation is taking place now, or occurred only in the remote past, or even only at the beginning of the world's history, we have no means of knowing; all that the rays show is that somewhere and sometime in the history of the universe, matter has been annihilated.

Similar remarks may be made with respect to the softer constituents. Millikan believes that these originate in the synthesis of complex atoms out of lighter ones, and so argues that the act of creation is still in progress. But these softer constituents also have such high penetrating powers as to be virtually indestructible. Even if Millikan's interpretation of the origin of these rays were established, it would only prove that synthesis of matter had occurred somewhere and sometime during the long past history of the universe; it would not prove that any such synthesis was still in progress.

Indeed, the fact that the radiation does not vary in intensity with the position of the Milky Way may be thought to suggest that it is merely a relic of past eras in the history of the universe. It may be argued that if the radiation were still being generated, the huge mass of the Milky Way, comparatively close to our doors, would surely make its influence felt. It is, however, possible (and, I think, likely) that the radiation is still being generated in extra-galactic nebulæ of earlier type than the galactic system; it may be that they only emit this radiation before they condense into stars; and that the atoms which can produce such radiation in the galactic system are all shut up inside the stars, so that the radiation is transformed into starlight before it reaches us.

Millikan has estimated that the total amount of cosmic radiation received on earth has about a tenth of the energy of starlight, sunlight not being counted in. Near the earth, the energy of radiation from the stars is intense enough to raise space to a temperature of about 3·5 degrees absolute, whereas the energy of cosmic radiation will raise this space only to about 2 degrees absolute. Out in the inter-galactic darkness the position is reversed. Here the feeble starlight and star-heat from distant galaxies can at most raise space to a fraction of a degree above absolute zero, but the intensity of cosmic radiation is probably the same as nearer home, corresponding to about 2 degrees absolute. Space as a whole appears likely to contain far more of cosmic radiation than of light and heat, although in assessing this fact, we must remember that cosmic radiation is virtually endowed with immortality, whereas ordinary radiation, in the form of light and heat, is not. The total annihilation of all the matter in the universe would raise space to about 10 degrees absolute, so that the cosmic radiation we observe could be produced by the annihilation of quite a small fraction of the universe.

This is not surprising, since the cosmic radiation which pervades space is necessarily quite distinct from the similar radiation which astronomers regard as the source of stellar light and heat. The annihilation of matter in stellar interiors would produce radiation of exactly the same high frequency as the observed cosmic radiation, but as this radiation fought its way outwards to lower temperatures, and finally to outer space, it would be continually softened, by a long succession of Compton encounters, until it finally emerged in the familiar form of starlight—ordinary temperature radiation at anything from 1650° abs. to about 60,000° abs.; none of it could reach the earth in its original form.

The mere fact of its not having been completely absorbed shows that the cosmic radiation we receive on earth cannot have passed through more than a few kilometres of stellar matter at most; its penetrating power, high though it is, will not carry it through a greater thickness of matter than this. Consequently, it can scarcely have been generated at a place where the temperature was more than about 100,000 degrees. We must suppose that it originated fairly near to the surfaces of astronomical bodies, or, more probably still, in unattached atoms or molecules in free space. In contrast to this, the radiation which provides the energy poured out by the stars was probably generated in their central regions. Thus it must have been generated in matter at very high temperatures, while the similar radiation we receive on earth must have been generated at comparatively low temperatures.

PHYSICAL PRINCIPLES.

According to classical theories of electro-magnetism, any acceleration of a moving electron is accompanied by an emission of radiation, of amount given by the well-known formula of Larmor. Thus an electron, describing an orbit in an atom of, say, hydrogen, must continually radiate energy away, so that the orbit will continually shrink.

The quantum theory replaces this continuous emission of energy by a succession of discontinuous emissions; at each moment there is a definite calculable chance that the orbit will shrink in size by a finite amount, and emit a photon in the process. The orbit of lowest energy is anomalous; when an electron is describing this orbit, no further shrinkage in orbit or emission of radiation is possible.

The concept of annihilation of matter removes this anomaly by providing a state of still lower energy, in which proton and electron have both disappeared in radiation. The energy emitted in the process of annihilation corresponds, of course, to that which would be emitted continuously on the classical electro-dynamics while the orbit was shrinking to zero radius.

Although neither the new quantum theory nor the theory of wave mechanics in any way predicts that this process must actually happen, they are in no way definitely antagonistic to its occurrence. Certain forms of both, on the whole, seem rather to favour the possibility, but theoretical calculation based on these does not at present agree with numerical estimates derived from astronomical evidence. Dirac[10] has recently calculated the probability of annihilation given by the new quantum theory, and obtained a value which is substantially too large; according to his calculations, the universe ought to have dissolved into radiation long ago. Or, to put the same thing in another way, the stars ought to radiate energy far more furiously than they do.

The general principles of the quantum theory show that annihilation of matter might either occur spontaneously, after the manner of radioactive disintegration, or might be incited by a sufficiently high temperature, like the atomic changes which produce ordinary temperature radiation. The second process will only occur when the matter is traversed by photons with energy equal to that set free by annihilation of matter; the requisite temperature is found to be of the order of a million million degrees. Now it is quite impossible that the cosmic radiation we receive on earth can have originated in regions where the temperature approaches this; indeed, we have seen that it can scarcely have been more than 100,000° or so. Thus this radiation can only have originated from spontaneous annihilation. Cosmic radiation can, and very possibly does, provide evidence of the spontaneous annihilation of matter at low temperatures, but it cannot, from the nature of the case, give any evidence of annihilation being produced by high temperatures, since any radiation so produced could never get out to empty space.

There seem to me to be two strong reasons for supposing that this latter process is not operative in the stars, and that any radiation which is produced by annihilation inside the stars must be produced spontaneously, like the cosmic radiation which is produced outside.

In the first place, if the generation is not spontaneous, the temperature at the star's centre must be of the order of a million million degrees. An immensely steep temperature gradient would be needed to connect this temperature with that of a few thousand degrees at the surface of the star, and so steep a gradient can only be reconciled with the observed flow of heat out of the star by postulating a very high opacity for the stellar material. It has so far proved impossible to reconcile such a high value for the opacity with the theoretical value given by Kramers.

The second reason is as follows. If the generation of energy results from high temperature, the rate of generation will involve a factor of the usual type $e^{-Mc^2/RT}$, where M is the mass annihilated. As the temperature increases from zero up, this factor first becomes appreciable when RT begins to be appreciable in comparison with Mc^2. This happens at the temperature of about a million million degrees already mentioned. When this temperature is first approached, the exponential term is increasing very rapidly in comparison with the temperature T. But a dynamical investigation shows that when this happens, the star must be very unstable. In brief, the emission of appreciable radiation would be accompanied by instability in the star, so that the very stable structures we describe as stars cannot radiate by means of this mechanism. The dynamical result has, it is true, been rigorously proved only for a simple, and very idealised, model of stellar structure; but general thermodynamical principles show that any structure in which a small change of physical conditions results in a very great liberation of heat, is likely to be unstable—in brief, it is in an explosive state.

On the other side, there is one strong argument against supposing that stellar radiation is produced by spontaneous annihilation of matter; it is that if the sun's heat were produced by the spontaneous annihilation of its atoms, we might expect that the earth's atoms would be subject to spontaneous annihilation at an equal or similar rate. Yet calculation shows that annihilation at even a ten-thousandth part of this rate would make the earth too hot for human habitation. Clearly, then, no appreciable annihilation of matter can occur inside the earth. This must be formed of atoms of a kind which do not undergo spontaneous annihilation, and if the sun derives its heat from the spontaneous annihilation of atoms, these must be of a different kind from the atoms of which our earth is formed. This is not in itself unreasonable; from the mode of the earth's formation, its atoms can be a sample only of those in the sun's outer layers. If we conjecture that those kinds of atoms which undergo spontaneous annihilation are of very great atomic weight, and so sink to the interiors of the stars, this difficulty disappears, and with it the problem of why no cosmic radiation is received directly from the Milky Way.

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[1] *Proceedings National Academy of Sciences*, Oct. 1930.

[2] NATURE, **127**, 924, June 20, 1931

[3] Millikan, Dec. 29, 1930, Lecture at Pasadena, reprinted in NATURE, **127**, 167, Jan. 31, 1931.

[4] *Physical Review*, April 15, 1931.

[5] *Proc. Roy. Soc.*, **122**, p. 647.

[6] NATURE, **122**, p. 398, Sept. 15, 1928.

[7] *Physical Review*, Nov. 15, 1930.

[8] NATURE, **127**, 594, April 18, 1931.

[9] V. F. Hess, NATURE, **127**, 10, Jan. 3, 1931.

[10] *Proceedings of Cambridge Philosophical Society*, July 1930.

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cylinder) is fixed to it at such an inclination that if the first ring is horizontal the edges of the second follow respectively the paths of the sun in the sky at the summer and winter solstices. Any one instrument is, of course, suitable only for a single latitude. The instrument is placed on the plan with the centre of the horizontal ring over the window or wall in question and with an appropriately marked point in the north direction, and the thread is stretched by holding the ball between the fingers. When the thread rests against an edge of the inclined ring (on which a scale is engraved giving the hours of the day) its direction is therefore that of the sun's rays at the corresponding solstice. Observation of the plan from above then shows immediately what obstacles to sunlight, if any, are encountered. The makers point out that since the declination of the sun changes only slowly near the solstices, the instrument is trustworthy for a considerable portion of the year; but an obvious improvement would seem to be the provision of slits in the inclined ring, through which the thread could pass to represent the sun's rays at intermediate times. The instrument can be supplied for any latitude, north or south. It weighs 1 lb. and is 6 in. in diameter at the base. It is constructed of stout brass, which is chromium-plated to resist corrosion and to prevent soiling of the plans. The cost is £2 2*s*.

An international festival of folk-dancing is to be held in Copenhagen on July 25, when representative teams from all Scandinavian countries, including Finland, Greenland, and the Faroe Islands, will attend. An English team of members of the English Folk-Dance Society will also take part. The festival should be of the greatest æsthetic and scientific interest, especially as some of the dances—those from the Faroes, for example—must be of considerable antiquity, and in certain cases suggest, almost unquestionably, an ancestry to be traced ultimately to a form of sun worship. Folk-dancing is becoming increasingly international, and thus, when the dances of different countries are seen side by side, affords exceptional opportunities for the comparative study of survivals of primitive custom and belief. For example, in the year-book entitled "In Northern Europe 1930", edited by Mr. Rolf Gardiner, there are accounts of expeditions to East Prussia, Silesia, and the Baltic towns, as well as a description of the English tour of the German singers, when they were accompanied by English dancers. Further, the English Folk-Dance Society is arranging to visit Paris for a demonstration on July 25 in the British Music Society's English week at the Colonial Exhibition, and it is hoped to bring Transylvanian dancers to England next January. An endeavour is also being made to organise an international festival on a large scale, to be held in London in 1936.

A notable advance in naval machinery has been made in the destroyer H.M.S. *Acheron*, of which some particulars are given in an illustrated article in the *Engineer* for June 26. The *Acheron* is one of the 'Acasta' class, being 312 ft. long and of 1330 tons displacement, but whereas the *Acasta* and other vessels have a working steam pressure of 300 lb. per sq. in., the steam pressure in the *Acheron* is 500 lb., with a total steam temperature of 750° F. instead of 600° F. The engines have been built by the Parsons Marine Steam Turbine Co., Ltd., and the hull and boilers by Messrs. J. I. Thornycroft and Co., Ltd. In the *Acheron* there are two sets of turbines, each consisting of one high pressure, two intermediate, and one low pressure turbine, and one astern turbine coupled to the shaft through double-reduction gearing. The designed shaft horse power is about 34,000. The three boilers are of the three-drum Thornycroft type, the drums being of forged steel, machined inside and outside, while the solid-drawn steel tubes are $1\frac{3}{4}$ in. in diameter. Superheaters and pre-airheaters are fitted. In an exhaustive series of trials, the oil consumption at full power was 0·608 lb. per shaft horse power per hour, while the water consumption was 7·77 lb. per shaft horse power per hour. At ten per cent full power, the oil consumption per shaft horse power per hour was 0·92 lb. and the water consumption 12·87 lb.

Thanks to the generosity of S. and H. Behn, the house in which A. M. Ampère, the great French physicist, spent his boyhood and youth has been presented to the French Society of Electricians. The house is situated at Polémieux-les-Mont-d'Or, about nine miles north of Lyons. The society has published an account of the ceremonies that took place on the occasion when they took possession of the house and fixed a plaque at the entrance commemorating the name of Ampère. Speeches were made by well-known physicists and engineers, and Paul Janet gave an interesting account of the life and work of the great physicist. Born in 1775, his youth was spent in troublous times. In 1793, when he was only eighteen years of age, his father was executed on the scaffold—a victim of the Revolution. Ampère's work on the mathematical theory of electricity has been of the greatest help to physicists and engineers. He died at Marseilles in 1836, but in 1869 his remains were transferred to Montmartre Cemetery. The name of ampere has been universally adopted for the practical unit of electric current.

The fifth triennial meeting of the General Assembly of the International Research Council was held at Brussels on Saturday, July 11, when the new statutes were approved and adopted. By these the name of the organisation is changed to that of the 'International Council of Scientific Unions', and full liberty is left to the International Unions to develop their activities in the way best suited to each. Dr. George Hale was elected president in succession to M. Picard, who has retired. The other members of the new executive committee are: General G. Ferrié and Prof. U. E. Norlund, vice-presidents; Dr. P. Pelseneer and Prof. F. A. F. C. Went, members; and Sir Henry Lyons, general secretary.

The Human Betterment Foundation (Pasadena, California) has issued a pamphlet on "Human Sterilisation". It is pointed out that eugenic sterilisation, by means of vasectomy in the male and salpingectomy in the female, carries no stigma or humiliation and does not unsex the individual in any way except in making parenthood impossible. Twenty-five States in the Union now have sterilisation laws on their statute books, and some six thousand operations of this nature have been performed. Following up the cases, it was found that six patients out of seven were satisfied with the operations. Many feeble-minded girls have married after sterilisation and these marriages have been reasonably successful in the great majority of cases. Whereas three-fourths of these girls were sex delinquents before sterilisation, only one in twelve has been a sex offender since. This is good evidence that sterilisation will not increase delinquency when it is made part of a well-organised system of probation and parole. The conditions and safeguards under which sterilisation is performed in Californian institutions are described.

THE following appointments have recently been made by the Secretary of State for the Colonies: Mr. J. De Verteuil, agricultural chemist, Trinidad, to be agronomist, Trinidad; Mr. A. J. W. Hornby, agricultural chemist, Nyasaland, to be assistant director of agriculture, Nyasaland; Mr. W. T. O. Maidment, assistant superintendent of agriculture, Gold Coast, to be agricultural officer, Uganda.

DR. E. C. S. DICKSON, of the Department of Physics, University of Manchester, has written pointing out that the demonstration of the Thomson effect described by Mr. W. Band in NATURE of June 27, p. 975, will also be found in Geiger and Scheel's "Handbuch der Physik", vol. 1, p. 330 (1926), in a large collection of lecture experiments that does not appear to be so well known as it deserves.

THE Swiss Society of Natural Sciences will hold its 112th annual session at La Chaux-de-Fonds and Le Locle on Sept. 24–27, under the presidency of Dr. C. Borel. On the first day, Prof. A. Piccard will give a lecture on his recent ascent into the upper atmosphere in a sealed car attached to a balloon, and Dr. C. Perret will exhibit a film on the life of bees. On Sept. 27, there will be two lectures. The first will be given by Prof. P. Arbenz on the geological history of South Africa and its camp sites, and the second by Prof. Pérez on rhizocephalods parasitic on hermit crabs. Several excursions to places of interest have been arranged in connexion with the meeting. The secretary of the meeting is M. A. Vuille, Numa Droz, La Chaux-de-Fonds.

A DETAILED programme has now been issued for the International Illumination Congress, which is to be held in Great Britain on Sept. 1–19. Provision is made for visits to London, Glasgow, Edinburgh, Sheffield, Buxton, and Birmingham, following which the sessions of the International Commission on Illumination will be held at Cambridge. An item of outstanding interest in the London programme is the proposed trip to the Port of London, returning to the Tower of London and Westminster by river, so that the illuminated buildings on the riverside may be seen. Throughout the visits to the cities named, the technical sessions, at which more than a hundred papers will be presented, will alternate with agreeable trips and social events. During the proceedings at Cambridge a lecture will be given by Sir Arthur Eddington. Membership of the Congress is open to anyone interested in illumination on payment of a registration fee of £2. Those desiring to take part in the Congress should communicate with the honorary general secretary (Col. C. H. S. Evans, 32 Victoria Street, London, S.W.1) without delay.

THE Medical Supply Association, Gray's Inn Road, W.C.1, has issued a catalogue (T.L. 20) of new models of X-ray apparatus and appliances, and electric wax-baths. Ultra-violet light fluorescence cabinets are listed. These consist of a chamber housing a quartz mercury vapour lamp, the rays from which pass through a window of 'filter' glass which screens off the visible or luminous part of the radiation and allows only the ultra-violet or invisible radiation to pass. By this means the fluorescence of various substances may be observed, such as fats, drugs, papers, precious stones, chemicals. It may also be employed for the detection of forged notes, fraudulent erasures, etc., as well as for the examination of certain skin diseases.

THE Ministerio de Agricultura of the Argentine Republic has published a well-illustrated and instructive pamphlet on the commercial breeding of rabbits for the market—"Explotación del Conejo en la Argentina" (1931, 75 pp.). It deals fully with the best methods of housing, feeding, and tending generally the breeds of chinchilla, angora, castorrex, and others, which have become popular in recent years. But, as a furrier expressed it recently to the present writer, you may call the fur what fine name you will, it remains rabbits' fur none the less, with all the weaknesses to which rabbits' fur is heir, from the furrier's point of view.

IN view of the rarity of the book and of its importance to students of the Mollusca, a facsimile reprint of those parts of the "Beschreibung der Naturalien-Sammlung der Universität zu Rostock" by H. F. Link, 1806–8, which refer to Mollusca, is being prepared for issue on Oct. 1. The edition is limited to 150. Copies may be obtained on application to Mr. J. R. le B. Tomlin, 23 Boscobel Road, St. Leonards-by-Sea, Sussex, or to Mr. R. Winckworth, 71 Whitworth Road, London, S.E.25, who are preparing the reprint. The price will be £1 or 5 dollars, post free. Advance subscribers may receive a copy at 15*s*. or 3.75 dollars, post free.

PART 6, fascicle 2, of "Diptera of Patagonia and South Chile", has been published by the British Museum (Natural History). It comprises the families Phoridæ (supplement), by A. Schmitz; Platypezidæ and Pipunculidæ, by J. E. Collin; Sphæroceridæ, by O. W. Richards; and Eplydridæ, by E. T. Cresson, jun. Four new genera and a number of new species are described in detail, the descriptions being accompanied by ten text-figures and a half-tone plate.

THE co-operation of the school child in the matter of personal and general hygiene can only be positively achieved by a simple communication of the outstanding facts about health and disease. For classwork, the series of thirteen coloured health and hygiene charts recently produced by Messrs. G. Philip and Son, Ltd., will be found a help; they have been produced with the aid of Dr. Winslow, of Yale University. A descriptive booklet for the teacher is appropriately written by Prof. V. H. Mottram.

Two 43-page pamphlets record additions made to the Hull Museums. The additions are of many kinds, but records of ancient forms of travel and of the slave trade, and relics of the old-time whaling, for which Hull was famous, predominate. Many of the specimens are illustrated, and are described or commented upon in readable paragraphs, which have been reprinted from the *Hull Daily Mail*. The descriptive paragraphs are to be commended as affording more matter of interest to the general reader, and therefore better museum publicity, than the bare lists of the names of objects which some museums serve up in the daily newspapers.

THE Director of the Peabody Museum of Natural History, Yale University, Dr. R. S. Lull, and the Trustees are to be congratulated upon the excellence of the "Special Guides" to the collections which have just been issued. The first two numbers, the forerunners, we trust, of a longer series, have been written by Dr. Lull to explain "The Evolution of the Horse Family" and "The Evolution of the Elephants and Mastodons". They are simply written, clearly paragraphed, well illustrated, and sell at the modest price of 15 cents (31 and 40 pages respectively). Such pamphlets should do more than blatant propaganda for the spread of knowledge of evolution in the United States.

AN exhibition of publications of the League of Nations opened on July 14 at the Old Court House of Messrs. J. and E. Bumpus, 350 Oxford Street, W.1. The publications of the League, the International Labour Office, and the World Court will be simultaneously on view. During the ten years of its existence the League has already published some 3000 documents and periodicals, and last year alone more than 1,500,000 copies were printed, numbering over 61,000 pages. More than six hundred publications will be exhibited, with historical documents, maps, photographs, etc., and also the latest and most important books relating to the origin, work, and history of the League. During the exhibition, which will be open for a month, short lectures will be given by experts at 3.30 P.M. on Mondays, Wednesdays, and Fridays.

MESSRS. Baillière, Tindall and Cox are publishing shortly for the Bentham Trustees the "International Address Book of Botanists" which has resulted from the resolution of the fifth International Botanical Congress, 1930. This will be on lines somewhat similar to Dorfler's "Botaniker Adressbuch", and will contain the names of 13,000–14,000 botanists and botanical institutions, etc., in all parts of the world. These will be arranged alphabetically by countries, printed in the majority of cases in the language of the country, and provided with an index of personal entries and geographical indices. The low price of 12*s.* 6*d.*, or 13*s.* post free, is rendered possible owing to the assistance the International Committee has received from the Bentham Trustees and the Carnegie Corporation of New York.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant pathologist at the Swansea General and Eye Hospital—The Secretary-Superintendent, General and Eye Hospital, Swansea (July 20). Teachers of science and technical subjects and of woodwork, metalwork, and technical drawing, at the Chelmsford Mining and Technical Institute, Dinnington, Yorkshire—A. Rayner, 151 Cross-hill, Ecclesfield, near Sheffield (July 21). A laboratory attendant and storekeeper in the chemistry department of the University of Leeds—The Registrar, University, Leeds (July 24). A demonstrator in the engineering test laboratory and the physics laboratory of the Royal Naval Engineering College, Keyham—The Adviser on Education, Admiralty, Whitehall, S.W.1 (July 27). A full-time lecturer in zoology at the Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (July 29). A lecturer in architecture at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (July 31). A demonstrator in chemistry in the University of Aberdeen—The Secretary, University, Aberdeen (Aug. 15). A head of the Department of Entomology of the Rothamsted Experimental Station—The Secretary, Rothamsted Experimental Station, Harpenden (Sept. 11). Assistant keepers in some or all of the departments of zoology, entomology, geology, mineralogy, and botany of the British Museum (Natural History)—The Director, British Museum (Natural History), Cromwell Road, S.W.7. A technical assistant for calculation and experimental work in connexion with aero engine investigations under the Directorate of Technical Development of the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants. A technical assistant for experimental metallurgical work under the Directorate of Technical Development of the Air Ministry—No. A. 502, The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants. A lecturer on elementary electrical engineering, for evening classes at the Borough Polytechnic—The Principal, Borough Polytechnic, S.E.1. An assistant master for mathematics and elementary science at the Cambridge and County School of Arts, Crafts, and Technology—The Education Secretary, County Hall, Cambridge. A junior demonstrator in physiology at the University of Durham College of Medicine—The Registrar, College of Medicine, Newcastle-upon-Tyne. A Clothworkers scholar for research in the physical properties of wool and other fibres in the University of Leeds—The Clerk to the Senate, University, Leeds.

ERRATUM.—In the article entitled "Modern Whaling" in NATURE of July 11, p. 56, line 17, for "1925" read "1905".

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Excitation Potentials of Metallic Lithium.

A LARGE amount of work has been published on the excitation potentials of metals (the so-called excitation of soft X-rays). On account of the very great complexity, no precise correlation has been achieved between these experiments and the results of the theory of metal structure. But—especially in view of the scarcity of spectroscopic data on metals—it would seem that there should be, concealed in these results, information of fundamental importance for the theory of metals, if only we knew how to use them. The chief essential for any such use is to attain the utmost possible simplification, and thus, just as the theory of atoms was built up from results on hydrogen, one is led to the study of the excitation potentials of metallic lithium.

It happened that no experimental data on lithium metal exist. Experiments were therefore undertaken. The method used was similar to that of Richardson, with some refinements. The lithium metal was distilled on to a copper anode at a suitably high temperature to prevent so far as possible the condensation of impurities. The radiation from the lithium falls on a copper sphere and the photoelectric current which results is measured by an accurate balance method. Thus one can plot the intensity of the radiation from the lithium, as measured by the photoelectric current, against the voltage of the electrons producing it. A sudden increase in slope in this curve at a definite voltage indicates an excitation potential of metallic lithium.

The photoelectric current was found to start with a voltage of 6 volts. A further break was found at 9 volts. Then the curve runs quite smoothly, and finally almost linearly to 51·5 volts, where there is a very large break, in which the slope is immediately about doubled. A further smaller break occurs at 57·5 volts. Then again the curve runs quite smoothly and no breaks whatever are found so far as has been investigated (up to 400 volts).

Lithium metal consists of a lattice of nuclei each with two K-electrons; the outer electrons of the lithium atoms combine together to form the set of conduction states of the metal, which are known to have a voltage range of the order of 10 volts. It seems fairly safe to assume that the lower breaks obtained correspond to transitions among the conduction electron states.

There remains the K-radiation of the lithium metal, and one is forced to associate this with the breaks at 51·5 and 57·5 volts. By applying a voltage correction of the order of 2 volts, we may allow for the acceleration of the exciting electrons in passing through the surface field of the lattice and state that the minimum excitation potential for the K-radiation of lithium metal is about 53·5 volts.

On the analogy of ordinary hard X-rays, one might picture the excitation process as follows. An electron is ejected from a K-level either through the crystal surface or into one of the upper conduction levels, the deeper conduction levels being assumed to be filled up. The latter process requires the minimum energy. Then an electron may drop back into the empty K-level from any conduction level with the emission of radiation. Thus we might expect a K-spectrum extending over about 10 volts below the critical point; and since probably the emission process involving the least energy would be the most likely, we might suppose that the greatest intensity in the spectrum would be concentrated at the low energy end of the spectrum.

Some experiments on the velocity analysis of the photoelectrons, ejected from the copper by the radiation excited in the lithium by 300-volt electrons, did not confirm this picture. Though rendered slightly inconclusive by the considerable 'loss of velocity' effects which occur in the energy range of the lithium K-radiation, they indicated that the maximum intensity in the K-spectrum is concentrated near the excitation point, namely, at about 53 volts, and there appears to be some radiation up to 60 volts energy, though none beyond.

However this may be, an apparent difficulty certainly arises when we compare the value 53·5 volts of the critical potential with the value of the K-ionisation potential of the lithium atom which has been accurately calculated by Braunbek.[1] The value is 64·6 volts and thus there is a discrepancy of 11 volts to be accounted for. Any attempt to explain it as a perturbation of the K-level due to close packing is out of the question, as it would lead to the spontaneous explosion of the metal.

The low value obtained was therefore surprising and has led to great care being taken in the experiments to verify the result. The fact that the photoelectric current is always proportional to the primary current to the lithium shows that the observed excitation potential corresponds to a single process excitation.

To interpret the result, we must suppose that there are empty levels into which the K-electron can be transferred at the base of the conduction electron system, so that the K-electron does not have to be taken through the energy levels of the conduction electron system, but can stay in a level at the base of the conduction electron levels. In the unexcited state all such levels are certainly filled. But when a K-electron is removed, the state of affairs becomes radically changed owing to the altered screening of the nuclear charge. I am greatly indebted to Prof. Bohr for pointing out that this altered screening will in itself create new levels round an atom in the lithium lattice which will not be filled. The new levels will correspond to a smaller total energy than the normal conduction electron levels. Thus the K-electron can be excited into one of these new levels and a *resonance* radiation will be emitted just as would be the case with free atoms. This process, of course, does not preclude the excitation of K-radiation by ionisation.

We may add that experiments in progress with beryllium metal, though the results are not so simple as with lithium, lead to similar conclusions.

H. W. B. SKINNER.

H. H. Wills Physical Laboratory,
University, Bristol.

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[1] *Zeit. f. Phys.*, 63, p. 156.

Evidence for the Spin of the Photon from Light-Scattering.

IT is well known that in the encounters between molecules and photons, exchanges of energy occur which are rendered evident by the observed changes in frequency of the scattered light. Whenever in such an encounter a molecule gains or loses spin-energy, there is a corresponding change in its angular momentum, which can only be explained on the assumption that there is an equal and opposite change in the spin-moment of the photon. This involves definite consequences for the state of polarisation of the scattered light, and opens up the possibility of demonstrating experimentally the existence of angular momentum in radiation.

The general principle involved is sufficiently illustrated by considering the case of a photon which is circularly polarised and is scattered without change of direction by a molecule the axis of spin of which coincides with the axis of circular polarisation. If the spin of the molecule is unaffected by the encounter, the scattered photon retains its original character. On the other hand, if the molecule gains two additional units of angular momentum, the photon will alter in frequency and at the same time *change over from right-handed to left-handed circular polarisation* or vice versa. The considerations are naturally not so simple in the general case in which the molecule is arbitrarily orientated and the photon is scattered in a direction not coinciding with the primary ray. It may be shown that besides the reversal of the sign of circular polarisation in the forward direction, there would also result a depolarisation of the scattered light, which would be specially evident in directions transverse to the primary rays.

It may be remarked that similar phenomena should also be observed when, as the result of an encounter with the photon, a change in spin-energy of the molecule is superimposed on a change in its vibrational state. On the other hand, a change in vibrational state alone would not give rise to the effects indicated.

It may be noted that certain interesting observations recently reported by Hanle and by Bär[1] find a natural explanation in the considerations set out above. In support of the view that the scattered radiations exhibiting strong depolarisation or reversal of circular polarisation involve rotational transitions, it may be mentioned that the lines exhibiting such effects are usually diffuse, while lines which are well polarised are usually sharp and intense.

C. V. RAMAN.
S. BHAGAVANTAM.

210 Bowbazar Street,
Calcutta (India),
June 15.

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[1] *Die Naturwissenschaften*, vol. 19, pp. 375 and 463; 1931.

Absolute Rates of Heterogeneous Gas Reactions.

FOR a decomposition reaction catalysed by a surface, in which the catalysis depends upon the formation of an adsorption complex (in adsorption equilibrium with the gas phase) and subsequent thermal activation and break-up of the complex into new molecular species which then evaporate, simple analogy with the theory of homogeneous reactions leads to an expression for the rate: $K = f.n.e^{-E/RT}$, where K is the number of molecules reacting per sq. cm. per second, n is the number adsorbed per sq. cm., f is frequency with which an adsorption complex undergoes a change in its total energy content (analogous to collision frequency for a homogeneous reaction), and $e^{-E/RT}$ is an approximate expression for the chance that after any particular energy change the complex is left with energy exceeding E. E is a quantity specific for the complex and not merely for the reaction.

When the complex in question consists of some simple molecule (NH_3, N_2O, HI) attached to the catalyst surface atoms, then every molecule may be supposed to decompose, at least so far that the completion of the act is inevitable, within an interval less than $1/f$ after activation; a reasonable value for the order of magnitude of f is clearly that of atomic vibration frequencies, here taken as 10^{12}.

The application of this is limited to surfaces of known area and uniform activity for the reaction in question. The catalysts which come nearest to fulfilling this condition are smooth metallic surfaces (for example, drawn metal wires). As a practical criterion, when the reaction can be shown to have a constant activation energy over a hundred- or thousand-fold velocity range, there is strong presumption that all parts of the surface which catalyse the reaction at all are uniformly active. The following calculations have been made for reactions on heated wire catalysts where catalyst poisoning by the products is demonstrably absent.

Kinetically zero order reactions: Here n is taken as the number of molecules in a close-packed layer, and E is equal to the Arrhenius constant A.

Reaction.	K. Exp	K. Calc.
NH_3 decomposition on tungsten.[1] $A=38700$ $T=904°$	4×10^{17}	4×10^{17}
NH_3 decomposition on tungsten.[2] $A=41500$ $T=1316°$	2×10^{19}	13×10^{19}
NH_3 decomposition on molybdenum.[3] $A=53200$ $T=1228°$	$5\text{-}20 \times 10^{18}$	2×10^{18}
Dissociation of Pt(CO) complex.[4] $A=31800$ $T=650°$	4×10^{16}	2×10^{16}

There seems to be no reason why the atomic vibration frequency factor should not be applied to the desorption of adsorbed molecules attached by a definite linkage to the surface atoms; to reactions in which the de-sorbed molecule carries with it an atom of the metal; to reactions in which the solid grows at the expense of the adsorbed molecules with which it reacts, as in the deposition of nickel from the carbonyl.

Kinetically first order reactions: It has been pointed out that the Arrhenius constant now requires a correction equal to the heat of desorption.[5] But this may be extended to take into account the absolute magnitude of n as a function of p and T, by means of the Boltzmann e-law for the density of molecules in a region of potential energy L, identifying this region with a layer extending for one molecular diameter (taken as 3×10^{-8} cm.) from the surface. The expression appropriate to the linear adsorption underlying the first order kinetics comes out to

$$n = p_{\text{bars}} \cdot e^{\frac{L}{RT}} \cdot \left\{\frac{2{\cdot}2 \times 10^{8}}{T}\right\}.$$

Then $$K = f \cdot p_{\text{bars}} \left\{\frac{2{\cdot}2 \times 10^{8}}{T}\right\} e^{\frac{L-E}{RT}}$$

and $$\left(\frac{d \log_e K}{dT}\right)_p \times \frac{A}{RT^2} = \frac{E-L}{RT^2} - \frac{1}{T},$$

so that $$K = p_{\text{bars}} \cdot f \cdot \left\{\frac{2{\cdot}2 \times 10^{8}}{T}\right\} e^{-\left(\frac{A+RT}{RT}\right)}.$$

(In hot wire experiments at very low pressures the gas phase concentration round the wire would not vary as $1/T$; the RT term in the energy of activation drops out, and T in the term in curl brackets must be taken as the temperature of the gas phase.)

The use of the Boltzmann expression when the adsorbed molecule has potential energy of vibration relative to the surface, being in fact held to the surface in virtue of just this potential energy, is not strictly justified, but should give the order of magnitude of n

correctly. The important thing is that if n can be calculated in this way it is not necessary to know E and L separately.

Reaction.	K/p_{bars}. Exp.	K/p_{bars}. Calc.
HI decomposition on platinum.[6] $A = 13800 \quad T = 836°$	6×10^{12}	22×10^{12}
N_2O decomposition on gold.[7] $A = 29000 \quad T = 1211°$	4×10^{11}	4×10^{11}

The agreement in all these cases is probably good enough to be significant. The zero order HI decomposition on gold [8] provides a clear-cut exception, the rate being 5×10^4 times greater than the calculated rate of activation. The difficulty of accounting for a *greater* rate suggests that the reversibility of this reaction, in the adsorbed layer before the iodine diffuses away, is the reason—this could have the effect of increasing the apparent value of E.

It should be interesting to repeat this calculation on other suitable catalytic reactions when the material becomes available.

B. Topley.

The Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College,
Gower Street, W.C.1, June 12.

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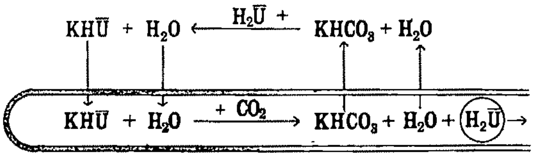
[1] Hinshelwood and Burk, *J.C S*, **127**, 1105.
[2] Kunsman, Lamar and Deming, *Phil. Mag.*, **10**, 1015.
[3] Burk, *Proc. Nat. Acad. Sci.*, **13**, 67.
[4] Langmuir, *Trans. Farad. Soc.*, **17**, 641.
[5] Hinshelwood and Topley, *J.C.S.*, **123**, 1014.
[6] Hinshelwood and Burk, *J.C S.*, **127**, 2896.
[7] Hinshelwood and Prichard, *Proc. Roy. Soc.*, A, **108**, 211.
[8] Hinshelwood and Prichard, *J.C.S.*, **127**, 1552.

Excretion of Uric Acid.

A study of the excretory system of the blood-sucking bug, *Rhodnius prolixus*, has led to the formulation of the following theory of uric acid excretion in that insect:



It is supposed that the upper parts of the four Malpighian tubes secrete a solution of acid urates from the blood into the lumen, and that in the lower parts water and base are re-absorbed, leading to a precipitation of the insoluble uric acid. Thus there is a continuous circulation both of water and of base.

The evidence on which this theory is founded is, briefly, as follows: (1) There are striking histological differences between the upper two-thirds and the lower third of the tube, and uratic granules are confined to the lower third. (2) Neutral red and other vital dyes are taken up from the blood by the cells of the upper segment, and from the lumen of the tube by the cells of the lower segment. (3) Ligation of the tubes at various levels shows that uric acid (or urate) is secreted by the upper segment, and that there is no secretion into the lumen in the lower segment. (4) From 80 to 90 per cent of the uric acid in the urine is not combined with base. (5) Free uric acid is so insoluble that, if it were being excreted in saturated solution in the upper segment, and water re-absorbed in the lower segment, the four Malpighian tubes of this insect (which is 2 cm. long) would have to deal with 20 c.c. of fluid per diem in order to eliminate the daily output. By the mechanism indicated above, they would have to deal with only 0·4 c.c. per diem. (6) The contents of the tubes are faintly alkaline (pH 7·2) in the upper segment, definitely acid (pH 6·6) in the lower segment. A saturated solution of uric acid is about pH 6·5.

A full account of this work will be published shortly; but the object of this letter is to direct attention to the possibility of the same mechanism being employed in the elimination of uric acid by reptiles and birds. The probability of a circulation of water through the excretory system of these animals has long been recognised, and the possibility of a circulation of base is suggested by the following data. Uric acid is present in the blood in the form of urates. In the urine of the snake, Kohler [1] found that 83 per cent of the uric acid was free; and in the urine of hens 90 per cent is free.[2] Therefore, if all the uric acid is derived from a glomerular filtrate, base must have been re-absorbed. On the other hand, if the uric acid is secreted in solution by the tubules, since acid urates of sodium and potassium are from thirty to sixty times as soluble as free uric acid (at least in pure water), the suggested mechanism would afford a substantial economy of work.

It would be interesting to know if there is other evidence for this mechanism.

V. B. Wigglesworth.

London School of Hygiene
and Tropical Medicine.

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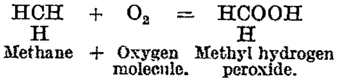
[1] Kohler, *Hoppe-Seylers Zeitschr.*, vol 70; 1910
[2] Szalagyi and Kriwuscha, *Biochem. Zeitschr*, vol. 66; 1914.

The Peroxidation of Hydrocarbons during Combustion in Air.

Prof. Bone has quoted in his letters with regard to the mechanism of combustion several interesting experimental results which he considers confirm the hydroxylation theory. He has recently directed attention to the finding by Dr. D. M. Newitt and Mr. A. E. Haffner of methyl alcohol in the oxidation products of methane and states that this has "shown conclusively that the slow oxidation of methane proceeds throughout in accordance with the hydroxylation theory".[1]

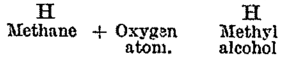
The presence of methyl alcohol in the oxidation products of methane can, however, be explained with equal success by the Engler-Bach peroxidation theory of combustion (1897) recently developed by Callendar and Mardles, Moureu and co-workers, and others (1926). According to the peroxide theory of combustion, the primary reaction is the formation of a moloxide or activated peroxide which catalyses the gaseous reaction and is responsible for autocatalysis and autoxidation.

Callendar and Mardles pointed out [2] that with paraffin hydrocarbons alkyl hydrogen peroxides might be formed by the simple inclusion of the oxygen molecule in a CH grouping, as, for example, in the following equation with methane:



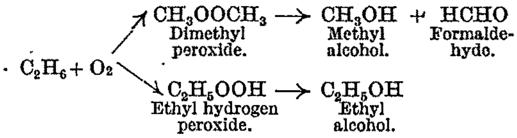
$$\underset{\text{Methane}}{\overset{\text{H}}{\underset{\text{H}}{\text{HCH}}}} + \underset{\substack{\text{Oxygen}\\\text{molecule.}}}{O_2} = \underset{\substack{\text{Methyl hydrogen}\\\text{peroxide.}}}{\overset{\text{H}}{\underset{\text{H}}{\text{HCOOH}}}}$$

It will be observed that in the formation of methyl hydrogen peroxide there is no atomic separation in the oxygen molecule as is required by the hydroxylation hypothesis



$$\underset{\text{Methane}}{\overset{\text{H}}{\underset{\text{H}}{\text{HCH}}}} + \underset{\substack{\text{Oxygen}\\\text{atom.}}}{O} = \underset{\substack{\text{Methyl}\\\text{alcohol}}}{\overset{\text{H}}{\underset{\text{H}}{\text{HCOH}}}}$$

The molecular disruption of the primary peroxide results in the formation of alcohols, esters, glycols, acids, aldehydes, hydrogen, etc. Rieche and Hitz[3] have shown that methyl alcohol can be formed from methyl hydrogen peroxide by decomposition. Similarly, alcohols are formed by the decomposition of ethyl hydrogen peroxide or dimethyl peroxide.[4] These peroxides are formed primarily from ethane during slow combustion according to the Callendar and Mardles hypothesis, namely:



$$C_2H_6 + O_2 \rightarrow CH_3OOCH_3 \text{ (Dimethyl peroxide)} \rightarrow CH_3OH \text{ (Methyl alcohol)} + HCHO \text{ (Formaldehyde)}$$

$$C_2H_6 + O_2 \rightarrow C_2H_5OOH \text{ (Ethyl hydrogen peroxide)} \rightarrow C_2H_5OH \text{ (Ethyl alcohol)}$$

It is interesting to note that methane is unique amongst the paraffin hydrocarbons in having a very low temperature coefficient of gaseous reaction, especially with rich mixtures. This rather suggests that autoxidation by the moloxide occurs to an important extent.

E. MARDLES.

Air Ministry Laboratory,
Imperial College of Science, S.W.7.

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[1] NATURE, 127, p. 481, Mar. 28, 1931.
[2] *Engineering*, Feb. 4, 1927.
[3] *Ber.*, 62, 2460; 1929.
[4] Rieche, *Ber.*, 61, 951; 1928.

Velocity of Sound in Tubes: Ultrasonic Method.

FOLLOWING the experiments of Boyle and Froman,[1] further work has been done on the velocity of sound in liquids contained in tubes, and the experimental observations now appear to be satisfactorily explained.

A theoretical investigation shows that the frequencies, at which selective absorption of the longitudinal wave occurs, correspond to those of the resonant radial vibrations in the column of liquid. The radial frequencies are principally dependent upon the diameter of the containing tube and the properties of the liquid, the material and thickness of the tube wall being of much less importance. The selective absorption is caused by the energy of the longitudinal vibration being converted into a radial vibration. At the absorbing frequency the longitudinal wave is scarcely propagated at all, and the radial oscillation is very strong.

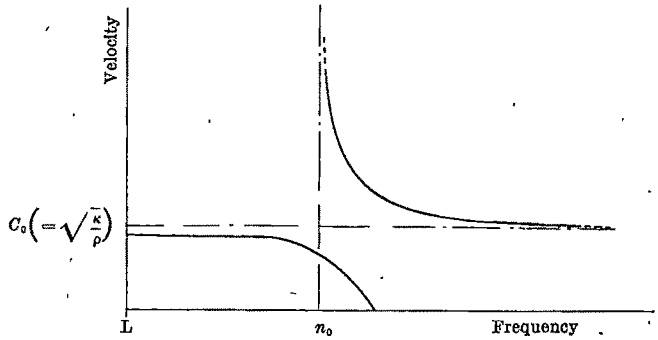

FIG. 1.

The theoretical curve (Fig. 1), which agrees well with experiment, indicates that for a range of frequencies just above the absorbing frequency (n_0) the velocity tends to have two different values, one high and the other low. This explains the experimental difficulty, noted by Boyle and Froman, in obtaining good stationary waves in this region.

The double-velocity effect is due to the fact that the wave-form below the absorbing frequency is different from what it is above, and the low-frequency type of vibration tends to persist slightly beyond the critical frequency. It may be remarked that in the absorbing region the wave is far from plane, but it becomes more and more so as the frequency becomes more removed from this region.

That there are two distinct types of vibration, one before and the other after the resonant radial frequency, has been experimentally verified by measuring the particle velocities for both cases with a Rayleigh disc.

Absorption of the longitudinal wave has also been measured and found to occur not only at the fundamental radial frequency but also at harmonics of it, the experimental and calculated frequencies agreeing very well.

It is to be noted that, following the usual procedure for sound, velocity has been plotted against frequency, whereas in optics (compare curves showing selective absorption) it is customary to plot refractive indices against wave-lengths. The optical method is rather illogical, because changes in refractive index mean changes in velocity and hence in wave-length; it is the frequency which is not affected by the absorbing medium. What is really plotted in optics is the refractive index (corresponding to λ_0/λ) against λ_0, where λ_0 is the wave-length that *would* have obtained if there had been no absorption. Velocity (actual) against frequency (actual) appears to be a much better method of expressing the facts.

Complete papers, covering the theoretical and experimental work outlined above, are shortly to be published elsewhere.

GEO. S. FIELD.

National Research Laboratories,
Ottawa, June 16.

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[1] NATURE, Oct. 18, 1930.

Control of Prickly Pear by the Cochineal Insect.

THE note in NATURE of June 27, p. 989, on the eradication of prickly pear in South Africa suggested that information about the use of *Dactylopius tomentosus* in the tropics might be of interest. The insects were imported by me into South India by courtesy of the Ceylon Government entomologist.

The object was to destroy clumps of *O. dillenii* in which dangerous snakes were harbouring around business premises. The insects would therefore be called, rather quaintly, in Australia 'private cochineal'.

The commencement of attack by a colony is very slow. For about two months in a shady clump, or perhaps twice as long in an exposed clump, no effects are generally visible. A few weeks after the attacks become visible the insects have overtaken the vegetable growth, and this is symptomised by heroic efforts of the plant to produce fruit; collapse quickly follows, and the insects then appear to concentrate upon producing winged males. It almost seems as if this were a consequence of starvation or the changed composition of the decaying juices. A good sign of the extreme selectiveness of the *D. tomentosus* is the fact that grass and weeds spring up untouched immediately a cactus clump collapses. Further evidence of this habit was also obtained when the *D. indicus* destroyed *O. monacantha* without touching the adjacent *O. dillenii*, in South India.

Indian farmers applied to me for infected stems, and cleared many thousands of acres simply by throwing these into objectionable clumps. Official attitude was not enthusiastic, but tolerant; European unofficial opinion was nervous; in fact, conditions were exactly as described in the Australian official papers before the Australian Government had decided to encourage private efforts.

Provided that no enemy (such as the Australian beetle) is found in Africa, it will be advantageous to employ biological control, because it introduces no poisons into the soil, and in the long run it enables a specified amount of labour to deal with the maximum area. For very intensive action, it might pay to cut tracks through dense areas by chemical means to facilitate broadcasting of the insects.

C. T. Jacob.

Glemham, Harpenden Road,
St. Albans, June 28.

The late Sir Francis Ogilvie.

Sir Francis Grant Ogilvie, who died last December, was Principal of the Heriot-Watt College from 1886 to 1900, taking office when the fortunes of the Watt Institution and School of Arts were merged with those of George Heriot's Hospital.

The work which Sir Francis did was of a pioneer character in the College and he laid down the lines which have since been successfully developed. He touched other fields of activity in each of which his scientific knowledge and administrative genius were of great service. In the Royal Scottish Museum, of which he was director from 1900 to 1903, as principal assistant secretary for Science and Art in the Board of Education from 1903 to 1910, as director of the Science Museum, South Kensington, from 1911 to 1920, and as chairman of the Geological Survey, he left his mark on each branch of activity. His work in organising the Forth Division Submarine Miners from 1887 to 1900, and in the Trench Warfare Research Department, 1915 to 1917, gives an indication of the wide range of his interests and the usefulness of his services.

It has been thought desirable by a number of old students that Sir Francis Ogilvie's connexion with the College should be recognised in some definite way. The suggestion of a fund to establish an annual prize has found favour, and I have received donations towards such a fund from a number of old students and members of the College, and from former colleagues and friends of Sir Francis. There are, no doubt, others who would wish to be associated with this memorial fund, and I should be glad to receive and acknowledge any contributions which they might wish to make. In this way the name of the first principal will be definitely brought before future students year by year.

J. Cameron Smail.

Heriot-Watt College,
Edinburgh, June 29.

Alchemical Apparatus.

My colleague Prof. Earp has directed my attention to an article in the *Journal of Hellenic Studies* (vol. 1, p. 109; 1930) by F. S. Taylor, entitled "A Survey of Greek Alchemy", in which the suggestion is made that the apparatus called a 'water bath' (bain-marie) by Berthelot ("Introduction à l'étude de la chimie des anciens", Paris, 1889, p. 146) is really a small charcoal brazier. I had already explained this point in some lectures given three or four years ago in connexion with the course in the history, principles, and method of science in the University of London, and it is quite clearly stated in my book, "Everyday Chemistry" (Macmillan, 1929, p. 68), published in the year preceding Mr. Taylor's paper. The use of the apparatus in the operation of *kerotakis* is connected with the practice of encaustic painting, in which the four colours, black, white, yellow, and red, were (according to Pliny) the first to be used. These four colours are very important in the theories of Demokritos of Abdera, and reappear in an alchemical sense in the traditions ascribed to Demokritos in the earlier treatises, in which the process of transmutation is closely related to painting and dyeing.

J. R. Partington.

East London College,
Mile End Road, E.1.

Forestry Research in Great Britain.

Mr. J. Ramsbottom in a letter in Nature of June 20, p. 927, states that little or nothing has been done in Britain concerning investigations on tree mycorrhiza, and that no one has been wholly engaged in its study. Mr. Ramsbottom has overlooked the fact that Dr. M. C. Rayner has been engaged whole-heartedly on these problems for several years, having previously given much attention to the mycorrhiza of other plants. At the Johannesburg meeting of the British Association in 1929, a research committee was appointed to facilitate Dr. M. C. Rayner's whole-time researches on "Mycorrhiza in Relation to Forestry", and this Committee was reappointed in 1930. Valuable results have been obtained in these investigations, which will be published in due course.

F. T. Brooks
(Chairman, British Association
Research Committee on
Mycorrhiza in Relation to Forestry).

Botany School, Cambridge.

The Editor of Nature has kindly submitted the above letter to me for any comment I may care to make upon it. The object of my letter was to direct attention to the need of greater opportunities for research, which by taking a wider view of the interrelations of different organisms will benefit forestry in the only way which will count with practical men. I took into account the work mentioned by Mr. Brooks, with other investigations which are in progress. In so far as one investigator is 'whole time' (though not in the sense I meant), the necessary small correction may easily be made in my previous letter.

J. Ramsbottom.

British Museum (Natural History),
Cromwell Road, London, S.W.7.

The London Skull.

I have read with particular interest Prof. Elliot Smith's remarks on the 'Lady of Lloyds'' skull in the review entitled "Human Palæontology".[1] When he first described this skull in 1925, I pointed out[2] that on stratigraphical grounds I considered the Terrace in which the skull was found to be that on the surface of which Mousterian working floors have been found at many localities, and that I had shown the Terrace as such (that is, Middle or Taplow Terrace) on the Geological Survey maps. There was, however, some discrepancy between this view, based mainly on the mapping of the deposits, and that of the palæontologists, who assigned the Central London deposits to a post-Mousterian date. When making the geological survey of the area I considered this view and concluded that it was based on grounds insufficient to outweigh the stratigraphy. It is therefore highly satisfactory to me to find that in Prof. Elliot Smith's weighty opinion the human palæontology confirms my decision.

C. N. Bromehead.

Geological Survey Office,
14a Parliament Street, York, June 30.

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[1] Nature, 127, 963, June 27, 1931.
[2] Nature, 116, 819, Dec. 5, 1925.

Research Items.

Cult of the Sacred Bull in Ancient Egypt.—Mr. O. H. Myers contributes to *Discovery* for July an account of the past season's excavations carried out by the Egypt Exploration Society in the Bucheum, or burial-place of the sacred bull, at Armant, near Luxor. The Baqaria, or burial-place of the mothers of Buchis, near by, was also excavated. The Bucheum was functioning from the thirtieth dynasty to the time of Diocletian. Numerous stelæ in the Bucheum, some in situ, make it possible to assign most of the bulls to the ruler who inducted them, and in the Baqaria the evidence from a variety of sources, in conjunction with that from the Bucheum, enables the mothers of many of the sacred bulls to be identified. The Bucheum is roughly T-shaped, the base of the T being the entrance to a sloping ramp. Many tombs are situated half-way down this ramp; but the greater number are along the cross passage. In accordance with Egyptian idiosyncrasy, the earlier tombs are well-made solid sarcophagi cut from one stone and well spaced, but they degenerate through a stage of well-built sarcophagi of neatly dressed blocks to badly dressed blocks and finally to burials in the passage itself. A series of stelæ ranging from the time of Darius III. to Diocletian alleges a personal interest in Buchis on the part of the rulers, including the Roman emperors, and it is stated with doubtful credibility that Cleopatra VI. herself brought the bull up the river from Karnak for his induction. The site has proved disappointing in the matter of the objects found. A Nemes vase in green faience inscribed "Beloved of Osiris Buchis the King Nekht-Hor-Heb" and a fine group of bronzes, including two inscribed situlæ and a Kebeh vase, and stone and faience amulets are the most notable. A good corpus of pottery has been constructed.

Spermicidal Power of Chemical Contraceptives.—Effective birth control by means of chemical contraceptive agents must depend upon their spermicidal power and their mode of application, and such agents must be non-toxic and non-irritating, at least in the concentrations employed. The spermicidal power of chemical contraceptives upon guinea-pig sperms has been the subject of an investigation by Mr. J. R. Baker on behalf of the Birth Control Investigation Committee (see *Jour. Hyg.*, vol. 31, No. 2, April 1931, p. 189). Full details of the technique employed are given, and some comparative experiments indicated that guinea-pig sperms seem to react to spermicides much in the same way as human ones. The killing concentration of 36 substances was determined, this being defined as the lowest concentration in the series 2, 1, 1/2, 1/4 per cent, etc., which suffices to kill every guinea-pig sperm suspended in a special glucose-saline solution (simple saline is unsuitable) in half an hour at body temperature in four consecutive experiments, and the following figures are the killing concentrations per cent. Mercuric chloride and formaldehyde were the most active, 1/256; hexyl resorcinol, 1/64; soaps, 1/32; potassium permanganate, 1/16, and phenol, 1/2. Acetic and lactic acids, 1/32, and citric acid, 1/16; it is the concentration of hydrogen ions which determines the activity of acids. Some of the commonly used contraceptives are relatively inactive; thus, quinine hydrochloride and sulphate, and chinosol, only act at 1/2, while boric acid, magnesium sulphate, and alcohol fail to kill at 2 per cent. Certain very poisonous substances, such as potassium cyanide, prussic acid, and strychnine hydrochloride, have very slight spermicidal power, and active disinfectants are not necessarily good spermicides. Foaming mixtures containing tartaric acid and sodium bicarbonate, as in effervescing pessaries, seem to be active without the addition of a spermicide, and could probably be used alone as contraceptives. Details are given of the structure of the guinea-pig sperm and of the effect of changes in osmotic pressure upon it. Spermicides generally act upon the acrosome in the head of the sperm, and it either becomes shrunken and distorted or swells and bursts. The characters for an ideal chemical contraceptive are formulated.

Air-pressures upon a Bird's Wing.—A very remarkable photograph of a Montagu's Harrier about to land at its nest is reproduced in *British Birds* (June 1931): The upper wing-coverts are ruffled up as if by a breeze blowing from the rear of the bird. Lieut. R. R. Graham, in a short article discussing the photograph, supplements his earlier descriptions of the part played by the feather-arrangements in the wing in regulating air-pressures upon the wing (*British Birds*, June and July 1930). The wing is in a 'stalled' condition, held flat against the air-stream, with the result that eddies of air swirling round the hind margin into a region of reduced pressure, have actually blown up the feathers from behind. The photograph also shows the tips of the primary feathers separated, so that they form a 'slotted' device, comparable to the Handley-Page slot in aeroplanes, which adds greatly to the efficiency of the wing-tips by smoothing out the air-stream passing over the fore margin of the wing.

Transformation of Scales in Goldfish.—In order to discover what changes take place in scales transplanted from any part of the body to the lateral line, Yasumasa Mori has carried out a series of experiments upon goldfish (*Jour. Fac. Sci. Imp. Univ. Tokyo*, Sect. 4, vol. 2, p. 185; 1931). Lateral line scales were pulled out, and in their places scales from an area outside the lateral line were inserted. It was found that the transplanted scale becomes a lateral line scale, acquiring all the organs of the lateral line, a bony sheath, a sense organ in the lumen, a nerve regenerated from the torn stump of a branch of the lateral nerve, blood-vessels, and a pore penetrating the scale. The growth of the new structures generally commences beneath the pore of the preceding scale, and where a series has been transplanted the anterior individual acquires the new organs much more rapidly than those posterior to it. The whole process of transformation generally takes about two months, but in very rapid cases complete transformation has been observed in one month.

Symbiosis of Fungus and Scale Insect.—The relations between the fungus *Septobasidium retiforme* and the scale insect *Aspidiotus osborni* are discussed by J. N. Couch (*Quart. Jour. Micr. Sci.*, vol. 74, pt. 3, 1931). The fungus forms flat patches on the bark of oak and other trees in North Carolina and is entirely superficial, never penetrating the tissues of the tree. Such patches provide a home and protection for the scale insects, which suck the juices of the host plant, grow, and finally reproduce their young in vast numbers. These young may settle down beneath the same fungus under which they were born and repeat the cycle, or they may crawl out to other fungus-insect colonies, or settle on clean bark. These last are responsible for the dissemination of the fungus. Some of the young become infected with the fungus soon after they are born, the infecting fungal cell or cells entering the circulatory system and there developing numerous coils which absorb food from the insect. A number of the insects are finally killed and used up by the fungus; others, though infected, may digest the fungal haustoria and survive to reproduce. While the fungus within the insect's body has been developing, the hyphal threads which make up the fungal floor of one of the patches have more or less overgrown and covered the insect's body. As soon as the insect moults the second time the fungal threads which have grown over its body from the floor pass under the moulted skin, and coiled hyphæ from within the insect's body anastomose with the hyphæ outside. Thus a colony of *Septobasidium* is not descended from a single spore but is composed of many strains. The thick roof of fungus affords protection to the scale insects against extremes of temperature, against drying and the attacks of parasitic hymenoptera. The association of fungus and insect is regarded as symbiotic.

Oranges and Arsenates.—The chemical changes observable in ripening oranges during the last hundred days of their growth have recently been studied in some detail by Copeman (*Trans. Roy. Soc. S. Africa*, **19**, 107; 1931). Particular attention has been paid to the contrast between normal oranges and those from trees which had been sprayed with lead arsenate to combat the attacks of insect pests. The general results agree in showing an increase in soluble solids in the juice during ripening, and this includes nitrogen, ash, and also sugars. Of the latter, sucrose, glucose, and fructose appear to be in equilibrium during this stage of development, since their relative proportions remain constant although the total amounts increase. Acidity, however, progressively decreases, and this decline is much more marked in fruits from trees receiving arsenate sprays. The oranges from sprayed trees thus have a characteristically insipid flavour owing to their low acid content. The effect is considered to be due chiefly to an intensification of respiration produced by arsenates; and since the effects of arsenates are metabolic in character, variations in the mode of application of the spray are not likely to remove the deleterious effects. New methods of combating insect pests in citrus culture must therefore be sought.

The Origin of Acid Igneous Rocks.—The problem of the association of acid and basic rocks (for example, granite with gabbro and rhyolite with basalt) is discussed from a new point of view by Prof. A. Holmes in the *Geol. Mag.*, June 1931. It is pointed out that inside the oceanic province bounded by the circum-Pacific belt, granites and rhyolites are totally lacking, and that these rocks are produced only where pre-existing acid rocks occur of the types that characterise the continental blocks. The distribution of the cone-sheets of such British Tertiary centres as Mull and Ardnamurchan makes it clear that the magmatic reservoirs from which they were fed rose to within three miles of the surface; that is to say, the reservoirs invaded the granite shell through a thickness of four or five miles. Consideration of the problem of what happened to the granitic material that previously occupied the place of the reservoirs leads to the conclusion that it became fused in situ. A source for the necessary heat is found in the upward transfer of heat by convection currents within the deeper basaltic portion of each reservoir. It is shown, by comparing the thermal gradient maintained by convection with that expressing the rise of fusion point with depth, that temperatures well above the fusion point can be reached in the upper part of a reservoir, thus providing an excess of heat, which becomes available for fusing the rock-material of the bounding walls and roof. It is also pointed out that the operation of convection is fatal to the possibility of deriving a granitic differentiate from a parental basaltic magma, though it is not denied that in appropriate circumstances, where convection does not operate, such differentiation may be locally achieved.

Fluctuations in Cosmic Radiation.—It has been reported at various times that the intensity of the cosmic radiation is not constant, but that it depends upon meteorological and extra-terrestrial conditions. A discussion of a number of the supposed fluctuations, based partly upon new measurements of high accuracy made by himself by an ionisation method, is given by G. Hoffmann in the issue of the *Zeitschrift fur Physik* for June 13. There appear to be definitely at least two distinct influences of major importance, one being effective with the more penetrating components of the radiation, and the other with the weaker components, which are cut off by putting a relatively thin shield over the apparatus. With the harder rays, there is a pronounced inverse dependence upon the barometric height; when the graphs for the intensity of this radiation and the barometric pressure are plotted suitably on the same time base, one is closely the mirror image of the other. Presumably it is a question of absorption of radiation of extra-terrestrial origin in the atmosphere, although, as Millikan has pointed out, the dependence upon pressure also involves the temperature of the air. For the more easily absorbed rays, the new measurements of Hoffmann show a variation with the temperature of the air; their intensity increases with increase in temperature, a fluctuation of about ten per cent of the total ionisation going with a change in temperature of ten degrees. This could possibly be connected with movement of emanation and radioactive material in the air, but no correlation between the amount of the soft radiation and the direction or strength of the wind was found. Hoffmann remarks that the problem of establishing unambiguously a dependence of the intensity of the radiation upon sidereal time is a very difficult one.

Propagation of Electromagnetic Waves.—Interesting speculations as to the laws governing the propagation of wireless waves are given by Prof. H. Nagaoka of Tokyo in a paper published by the Institute of Physical and Chemical Research, No. 297 (April 1931, Tokyo). He points out that the presence of a highly ionised layer in the upper atmosphere—the Kennelly-Heaviside layer—has for a long time been assumed as a working hypothesis to explain the phenomena of transmission. It is now generally believed to consist of two or even three layers at different heights. It merely indicates that the number of free electrons varies at different heights in the atmosphere. The reflection of the waves at the bounding surface between gases is not so sharp as that between solids. The wave path turns round sharply, passing through an apex. He proves that at the apex where the wave begins to bend downwards the electron density is proportional to the square of the frequency. The density of electrons varies with the altitude of the sun, and is therefore a function of the latitude as well as of the solar declination. If observations were made for a year in different stations scattered over the world, the nature of the distribution of electrons in the upper atmosphere could be determined. The problem calls for international co-operation. To explain the presence of silent zones in short-wave transmission it is necessary to assume two conducting layers. The electron density which determines the wave-path varies for several reasons. The number of electrons coming from the sun and reaching the earth's atmosphere is much affected by the number of sunspots, by auroral displays, and magnetic storms. The day and night variation can be satisfactorily explained, but sunrise and sunset fading needs further study. Auroræ are a great hindrance to wireless working, as they produce sudden and violent changes in electron density. Meteoric showers have a much smaller effect. Reasons are given for supposing that helium plays an important part in forming conducting layers. There are many natural gas springs in America that have been emitting helium for countless generations.

Production of High Vacua.—For many years certain materials have been used in lamps and vacuum tubes for removal of traces of gas, these being known as 'getters'. Two classes of getters are in use: (i) Those acting as adsorbents (active charcoal, copper oxide, thoria, etc.), (ii) those having great chemical activity (alkali metals, alkaline earth metals, phosphorus). Phosphorus is generally used in lamps. In the May number of the *Journal of the American Chemical Society*, Andrews and Bacon describe comparative experiments on the efficiencies of calcium, barium, magnesium, sodium, and phosphorus, deposited as thin coatings on the walls of bulbs or tubes, from the point of view of the attainment of vacuum. They report pressures of about 10^{-7} mm., the lowest measured pressure yet reached by other workers in the laboratory (of the General Electric Company) being less than 5×10^{-9} mm. in a gauge connected with a large tube of well degassed charcoal immersed in liquid air. The main result of the present experiments was that differences in the previous treatment of the getters are of far greater importance in the removal of gas than differences among the getters themselves. Poorly degassed materials absorb residual gas slowly and reach equilibrium at higher pressures than those attained by more gas-free material. These pressures do not depend on temperature in the range 0°-90°.

The Oxidation of Iodide by Persulphate.—A study of the velocity of oxidation of iodide by persulphate ion, described by King and Jacobs in the May number of the *Journal of the American Chemical Society*, is of interest both from the point of view of experimental technique and the Brönsted theory of reaction velocities as correlated with the Debye-Hückel theory of ion activity. Instead of titrating the iodine liberated, the authors added a small amount of thiosulphate and determined the time of first appearance of iodine by a photoelectric cell circuit with a long absorption cell of solution. This permitted the use of very dilute solutions, to which alone the theoretical equation could be expected to apply. Agreement with a linear curve of the logarithm of the velocity constant plotted against the square root of the ionic strength, as required by theory, was found up to the value 0·06 of the abscissa. Above this, there was an increasing negative deviation. When the ionic strength is made up largely of univalent ions, the best straight line extrapolates to log $k_0 = -1{\cdot}075$, whilst with a large proportion of bivalent ions it extrapolated to $-1{\cdot}06$. The difference is considered to be significant, though small, and it may be due to the inaccuracy of the Debye-Hückel equation for bivalent and tervalent ions, even in very dilute solutions. This deviation has been previously found, and can be qualitatively explained.

Astronomical Topics.

Tree-Rings and the Sunspot Cycle.—The researches of Dr. A. E. Douglass on the correlation between the growth-rings in trees and the sunspot cycle have given a probable sunspot curve for many centuries. A *Science News Bulletin* issued by Science Service, Washington, D.C., dated June 23 announces a further development of his work. He has carried the study of the rings in certain districts back to the date 700 B.C.; by examining the timbers in some ancient Indian buildings he was able to give the dates when the trees were cut, and thus to date the buildings. Dr. Antevs, of the University of Stockholm, has found correlation between the structure of clay layers in ancient lake-beds and the sunspot cycle. Both the tree-rings and the clay layers are supposed to depend directly on the rainfall, so it is really the latter that is correlated with the sunspots.

The work of both Dr. Douglass and Dr. Antevs has been honoured by the award of Research Corporation prizes, given through the Smithsonian Institution.

The Distance of Nova Pictoris.—The April issue of *Mon. Not. Roy. Ast. Soc.* contains a paper by Dr. Spencer Jones, giving the details of this investigation. Direct trigonometrical measures gave the negative parallax $-0{\cdot}009''$, with a probable error of $0{\cdot}007''$. This could only be taken as an indication that the distance is very great. An estimate was reached on the assumption that the increase of light was due to an expanding shell or series of shells of gas emitted by the star. The rate of expansion is assumed to have been uniform between the outburst and the maximum of light; it is also assumed that the effective temperature did not vary during this period. The rate of increase in the radius per day was calculated as 5·77 times the original value, while the spectroscope indicated a velocity of approach of 65 km./sec., which becomes 77 on allowing for the recession of the centre, which is 12 km./sec. Allowing for the fact that this is an integrated value over the whole disc, the parallax is deduced as $0{\cdot}0015''$, and this value is found to be practically independent of the initial temperature. At maximum the radius would be 384 times that of the sun. The absolute magnitude is deduced as 3·15 before the outburst and −7·9 at maximum.

A Possible Cometary Observation by Bessel in 1832.—Bessel observed an object that he described as a nebula on Nov. 8, 1832; its position for the equinox of 1825·0 was $2^h\ 42^m\ 5{\cdot}56^s$, N. Decl. 36° 46′ 46·7″. Many subsequent observers have found a faint star of mag. 9·3 in this place, but none of them could see any nebulosity round it; there is a note to this effect in "New General Catalogue". Prof. Schulhof suggested many years ago that there might have been a comet superposed on the star when Bessel observed it. The writer of this note has recently noticed that, if it was a comet, it may have been Tempel's comet of the November meteors. If so, the date of perihelion would have been Oct. 30, 1832, which is not very far from the date indicated by the recent calculations of the Computing Section of the British Astronomical Association. If this identity should be correct, the next perihelion passage will occur in November or December 1932. If the Bessel object was Tempel's comet, it would have been extremely near the earth at the time; the earth perturbations would probably be large enough to account for the small corrections needed by the elements to make them represent Bessel's observed position. There was quite a rich shower of Leonids in November 1832, though it was apparently surpassed by that of Nov. 12, 1833. Owing to the shift of the node, Nov. 17 is the probable date this year, and Nov. 16 in the two following years. The watch should be kept on neighbouring nights also, as it is difficult to predict the position of the meteors with great precision.

Research in Industry.

IN a lecture on "Research in Industry and Rationalisation", delivered before the Society of Swedish Engineers in Great Britain on May 27, Mr. Axel Y. Enström discussed the way in which research and rationalisation have become indispensable factors for the economic development of industry. Science and research have now come to be marshalled among the working tools of industry in daily use, and the post-War period can supply many examples of the fruitful association of scientific and industrial research. Mr. Enström considers that Sweden's ability to attain a position in the world's markets has largely depended on the purposeful incorporation of scientific research, well-equipped laboratories, and a highly qualified staff with her industrial activity. There are now in Sweden about fifty works' research laboratories, which employ some six hundred persons and represent all the large industrial undertakings. The total cost of the industrial research carried on in Sweden is probably about four to five million crowns.

Discussing the special characteristics of scientific and technical research, Mr. Enström suggested that spontaneous research, such as Röntgen's discovery of the Röntgen rays, is typical of the former, and the systematic research which Hertz based on Maxwell's equations is typical of the latter. Even in systematic research, however, fundamental or scientific research, as well as a high standard of scientific technique, may be essential. Disregard of fundamental scientific principles may lead to enormous waste in technical research, especially in experimental plant work. After such technical investigations on a metallurgical process in Sweden, involving an outlay of several millions, had been abandoned as fruitless, scientific investigations on the interaction of ore particles and gases yielded a solution. The importance in technical research of a thorough knowledge of the fundamental physical and chemical sciences cannot be overstressed, but such a combination is difficult to find.

Other factors in technical research which may eliminate much wastage of time and labour are mathematical analysis of the possibilities at an early stage in the investigations, and the thorough study of the information already existing either in the literature or in technical sources before experimental work is undertaken. Related to these factors is the standard of experimental technique of the investigator and his knowledge of the possibilities and limitations of that technique. Similar qualities are increasingly involved in technical analysis and process control, and the essential factor in all the scientific control and development of industry may thus be briefly described as clear thinking.

In this description it is easy to include rationalisation, which, like technical research, aims at improving, increasing, or cheapening production. While suggesting that discussion as to whether the continued displacement of labour by machinery is justifiable is premature, Mr. Enström considered that rationalisation must progress with natural necessity. We have no general view of the correct proportion between direct production for consumption and production of machinery or tools. Economic history suggests that equilibrium is continually re-established on a fresh basis when the proportion is disturbed. Standardisation is an important element in rationalisation, and the research work on manufacturing processes not only leads to standardisation of processes and improved efficiency but also may frequently have a far-reaching rationalising effect. The application of scientific principles and methods of investigation to industrial problems inevitably leads sooner or later to the application of the same principles and methods to the conduct of the whole industry. Technical research and scientific management are thus two important aspects of rationalisation, and the future of industry largely depends on our ability to produce industrial leaders competent to evaluate these factors, with the economic, social, and other factors involved.

The Flying Fox in Australia.

TWO years ago, Mr. F. N. Ratcliffe was appointed by the Commonwealth Council for Scientific and Industrial Research to obtain for it as complete a picture as possible of the flying fox (*Pteropus* spp.) population of Queensland and New South Wales, its significance and extent, the relations of the different species one to another, the nature and cause of their migrations, the individual and collective habits of the animals, and the extent and value of the economic losses involved. Fruit-growers had at times complained loudly of orchard depredation by this pest and demanded governmental action to exterminate it. The Council was somewhat sceptical about the alleged facts: hence this inquiry, which received financial support from the Commonwealth, New South Wales, and Queensland Governments. Mr. Ratcliffe has now completed his work, and furnished to the Council a report which is not only most interesting reading but also is admirably fearless in its criticism of current ideas and practices.

Four species of flying fox are found in Australia: *poliocephalus*, *Gouldi*, *conspicillatus*, and *scapulatus*. They are practically confined to coastal areas, and their numbers, which cannot be accurately assessed, must amount to many millions in the numerous 'camps' scattered along a north–south stretch of some two thousand miles. There has, no doubt, been a diminution in numbers as settlement has progressed in New South Wales and South Queensland, the present population amounting probably to only about half that of early days. As in the past, so to-day, the principal food of all species is undoubtedly blossom, chiefly of eucalypts, and Mr. Ratcliffe has been forced to the conclusion that the current opinion that the fox is guilty of appalling destruction in fruit plantations is a gross exaggeration, so far at least as the commercial fruit crop of Queensland is concerned. Attacks on orchards are more an indication of general food shortage than evidence that cultivated fruit is an essential part of the animal's food supply. Such fruits as bananas, pineapples, citrus, pawpaws, and apples are, as a matter of fact, too hard for the weak dentition of the little red fox (*P. scapulatus*), which is equal in numbers to all the other species put together. *P. poliocephalus*, however, finds no difficulty in attacking these, when ripe: though here again it is important to remember that normally all these fruits, except perhaps citrus, should be picked for market while still unripe and therefore unattractive to the foxes. In other words, if the growers harvest these particular crops in satisfactory fashion, the loss to the commercial fruit industry in Queensland resulting from flying fox infestation should be almost trifling.

One must not forget, however, that what may be called 'back garden' fruit is usually left on the trees until almost, or quite, ripe, and therefore is far more attractive to, and more readily attacked by, the bats than the greener product. This probably accounts for far more general popular outcry against the animals than the actual economics of the situation justify. Still, looking at the matter merely from a business point of view, if the fox is not a menace to the large-scale commercial industry, there would seem to be little valid reason for any considerable expenditure of public money on its control.

Nevertheless, big losses occasionally occur, notably where soft fruits (figs, peaches, nectarines, etc.) are grown. The problem presented by these is much greater in New South Wales than in Queensland. Hence Mr. Ratcliffe has felt it necessary to discuss critically various methods which have been proposed for coping with the trouble. Control through direct destruction by shooting, he rules out as a physical and economic impossibility. Attack by contagious or infectious disease is probably hopeless. There is now such a mass of experience indicating the improbability that control can ever be brought about in this way that it seems not worth while even to initiate experiments. The use of poison gases in the camps is almost impracticable and, on good evidence, ineffective. Flame guns are useful to an extent, but objectionable in many respects, including that of the cruelty involved. As for the 'scalp bounty' system, as adopted by Queensland, Mr. Ratcliffe's condemnation of it is as emphatic as it is just. He shows that in one important area, if every penny of the money provided by the Pests Destruction Board as bounty were spent solely on foxes, at 3*d*. per animal, the total destruction would probably be less than 1 in 200 of the normal population. Even then, *P. scapulatus*, because the least intelligent species, would usually be the most heavily hit: as it is also the least troublesome, money spent on it would be sheer waste.

Apart, however, from attempts at mass control, much protection might be afforded in small localised areas by systematic use of deterrents and poisons by the fruit-growers, and recommendations are made for the encouragement of such practices.

It seems, then, that the economic significance of the bat trouble in Australia is not really very great; it has certainly been exaggerated. The fox is a nuisance rather than a pest, affecting chiefly the small home grower and not the commercial fruit industry. Possibly, as Mr. Ratcliffe suggests, the reason for the prevalent exaggeration is partly psychological. The bat is nocturnal, noisy and smelly, and usually infested with parasites; in fact, decidedly detestable. It is no wonder, perhaps, that Mr. Ratcliffe found astonishing numbers of individuals prefacing their information regarding the foxes with a statement that they were "stinking, lousy brutes". Such an attitude is not without significance when one is seeking an unbiased assessment of the economic importance of a nuisance.

Be that as it may, the upshot of this very interesting inquiry should be to convince Australia that one, at least, of her pests is not so bad as it has been represented, and is not likely to become any worse. This will be some comfort to the Council for Scientific and Industrial Research, which finds decreasing funds and increasing responsibilities to be matters of grave embarrassment at the present time. A. C. D. R.

Young's Theory of Colour Vision.*

Although Thomas Young is well known as the founder of a theory of colour vision, his contributions to the theory are limited to two or three short paragraphs, and there is no evidence that he himself attached much importance to them. He was the first who, starting from the well-known fact that there are three primary colours, sought for the explanation of this fact, not in the nature of light, but in the constitution of man. He wrote: "Now, as it is almost impossible to conceive each sensitive point of the retina to contain an infinite number of particles each capable of vibrating in perfect unison with every possible undulation, it becomes necessary to suppose the number limited, for instance, to the three primary colours—red, yellow, and blue . . . and each sensitive filament of the nerve may consist of three portions, one for each principal colour." He afterwards took red, green, and violet as the three primary colours. His other statement regarding colour is in connexion with Dalton's colour-blindness, of which he says: "It is much more simple to suppose the absence or paralysis of those fibres of the retina which are calculated to perceive red".

Although the three component theory as developed by Clerk Maxwell, Helmholtz, and others accounted well for many of the facts of colour mixture, it had also to account for other phenomena of vision, such as visual acuity, the luminosity curve, hue discrimination, simultaneous and successive contrasts, and colour-blindness. Recent work by Hecht and others has succeeded in solving many of these problems.

The determination of the luminosity curve, which physicists still persist in calling the 'visibility' curve, has been the subject of such accurate investigation that it can now be regarded as one of the soundest scientific data in the whole realm of vision.

Dalton may be regarded as initiating the scientific study of colour vision, and later work by Seeback and Clerk Maxwell strongly supports the view expressed by Young that cases of colour-blindness are reduced forms of normal vision. On this theory, the neutral points of the spectrum as seen by protanopes and deuteranopes are excellently explained by the points of decussation of their two remaining curves.

The fact that yellow is psychologically as distinctive a colour as red, green, or violet, and physiologically shows no evidence of composite character, was long regarded as a strong argument against the trichromatic theory, until Hecht proved conclusively that the sensation of yellow could be experienced by fusing binocularly the sensations produced by appropriate red stimulation to one eye and green stimulation to the other.

Research since Young's day has done nothing to bridge the gap between the physiological and the psychological response, but considerable progress has been effected by Holmgren, Kohlrausch, Lucas, and Adrian in elucidating the physiological response itself. The results of these workers on the photochemical reaction of the visual purple, and the accompanying changes in electrical potential of the retinal structures, all tend to show that the fundamental phenomena of vision all manifest themselves in the retina.

Finally, the researches of Pieron, especially those on colour responses to black and white stimuli, and those of Allen on induction effects as shown on the persistency curves resulting from previous stimulation of the retina by monochromatic light, all have a distinct confirmation bearing on Young's theory.

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* Substance of a paper read by Sir John H. Parsons, F.R.S., before the Optical Society on June 11.

Taste and Chemical Constitution.

THE relationship between physiological action and chemical constitution has been investigated for a number of compounds by animal experiment, when it is easy to compare and contrast the effects on a variety of systems of closely related substances. In spite of much work on the subject, no wide generalisations are yet possible, although it has been frequently shown that a very slight alteration in the molecule may enhance or decrease a particular physiological action: as an example may be mentioned the varying pressor effects of adrenaline and compounds closely related to it. The question is still less susceptible to investigation when the relationship between chemical structure and taste or smell is considered, since the experimental subject must be man and the investigator has to rely upon his subject's subjective sensations and cannot measure objectively the effect of his stimulus.

There is no generally accepted classification of odours, but tastes are usually divided into four groups —sweet, sour, salt, and bitter. No comprehensive generalisation has yet been discovered, however, for the relationship between taste and chemical constitution. It has usually been supposed that different people will taste the same compound, although perhaps with different degrees of intensity. A. L. Fox, of Wilmington, Delaware, U.S.A., has, however, recently found that whereas some people find that phenyl thiourea has an extremely bitter taste, others will state that it has no taste at all. As a result of numerous trials, he has found that about 60 per cent can taste it, whilst to the other 40 per cent it has no taste. The intensity of the bitter taste in the former group varied considerably. The division into the two groups was not a question of sex, age, race, colour, or family: of a pair of identical twins, one tasted it, the other did not.

A variety of thioureas was then examined: all had a bitter taste to some people, no taste to others: the list included *p*-ethoxy phenyl thiourea, and a number of other phenyl thioureas, naphthalene thioureas, diphenyl thiourea, and 2, 2′ dimethoxy, 5, 5′ dimethyl diphenyl thiourea. With diorthotolyl thiourea, however, the group of non-tasters was large, since some of those who had tasted all the previous compounds failed to taste this. With di-para-tolyl thiourea the taste was first sweet, then bitter. Dicrotyl thiourea and dibenzyl thiourea were also bitter to the tasters, but thiourea itself had an unpleasant taste to both groups, and tetramethyl thiourea appeared sour to both. The bitterness, therefore, appeared to be associated usually with compounds containing a benzene or naphthalene ring and thiourea: removal of the sulphur atom and replacement with oxygen can completely alter the taste, since *p*-ethoxy phenyl urea has a very sweet taste.

The failure of certain people to taste the bitterness of these thioureas is analogous to the failure of people to smell certain verbenas, as observed by Blakeslee. Some people found certain verbenas very fragrant, whilst to others they appeared to have no smell. With other verbenas, however, the two groups were reversed. It is, in fact, a well-known phenomenon that the sense of smell is very capricious, certain people being much more sensitive to some odours than others. It is obvious that this inability to smell or taste must be borne in mind when experiments are carried out on the relationship between the sensation and chemical constitution: errors may be avoided by the use of a sufficient number of subjects.

University and Educational Intelligence.

ABERDEEN.—At the graduation ceremony held on July 8 the honorary degree of LL.D. was conferred, among others, upon Prof. John Garstang, John Rankin professor of the methods and practice of archæology in the University of Liverpool. The ordinary degree of D.Sc. was conferred upon W. A. Carr Fraser, for a thesis entitled "Critical Studies in Hæmocytometry".

LONDON.—The external degree of D.Sc. in chemistry has been conferred on Aruppillai Kandiah (private study), for a thesis entitled "Studies in Dicyclic Systems. Part I. The Chemistry of 2-Substituted cis- and trans-Hexahydrohydrindenes. Part II. The Influence of cis- and trans-Hexahydrohydrindene Nuclei on the Carbon Tetrahedral Angle".

DR. T. J. DRAKELEY, head of the Chemistry Department and School of Rubber Technology at the Northern Polytechnic since 1919, has been appointed principal of the Polytechnic in succession to Dr. R. S. Clay, as from Jan. 1, 1932.

A VACATION course for teachers will be held at Bingley Training College on July 29–Aug. 12. The opening lecture, entitled "The Educational Revolution and its Steps of Progress", will be given by Prof. Patrick Geddes, on the first evening. Other evening lectures include Prof. T. H. Pear on "Learning how to Study" and Dr. G. H. Green on "Racial Bias and International Understanding". In the work of the senior school, the question of biology will be dealt with by Prof. R. D. Laurie throughout the course, and Sir Percy Nunn will deal with mathematics. A summer vacation course for physical training will be held at the Grammar School, Ilkley, on Aug. 3–15. Application for entrance to either course should be made to the Education Officer, County Hall, Wakefield, Yorks.

THE directors of Messrs. H. K. Lewis and Co., Ltd., booksellers and publishers, held a reception on July 9 to inaugurate their new building at the corner of Gower Street and Gower Place, adjoining University College, London. Designed by Mr. J. R. Moore Simpson, the new building is of steel-framed construction, faced with stone to harmonise with the adjoining College buildings, and part of the accommodation on the upper floors is reserved for the use of the College. Sir Gregory Foster, who presided over a large company, including many of the staff of University College, wished success to the firm in their enlarged undertaking. He was supported by Prof. Thane, who discussed 'text-books', stressing their increasing size in recent years, an increase not fully justified. Messrs. Lewis, established in 1844, now include, in addition to their main activity of bookselling, a publishing department, circulating library, and second-hand book department. As publishers they have specialised in medical books, and their catalogue includes many honoured names in the medical world, such as Jenner, Burdon Sanderson, Lister, and Osler. In addition to books, scientific journals are published, including the *British Journal of Dermatology*, *British Journal of Experimental Pathology*, and the *Clinical Journal*. A large stock of anatomical models, diagrams, and charts is available. The record of the firm is one of continuous growth, with every indication of acceleration owing to the new accommodation. A pleasing feature of the reception was the general recognition of the work of booksellers, publishers, and librarians as contributors to scientific and educational progress.

Birthdays and Research Centres.

July 12, 1863.—Dr. L. Ch. Albert Calmette, For.Mem.R.S., sub-director of the Pasteur Institute, Paris.

I am conducting researches on snake venoms, antivenomous serums (1892–1900); bubonic plague and serotherapy; tuberculosis, mechanism of infection, and preventive vaccination of babies with B.C.G.

July 22, 1865.—Sir Richard A. S. Redmayne, K.C.B., consulting mining engineer, professor of mining in the University of Birmingham, 1902–8, and H.M. Chief Inspector of Mines, 1908–20.

My object of chief investigation now in progress is the freeing of coal from the seam by non-inflammable means. The importance of this is obvious when one considers the great loss of life in gassy and/or dry and dusty coal-mines from explosions initiated by the flame of explosives.

A commercially possible process for the liquefaction of coal is a subject worthy of investigation. Were it possible to liquefy coal profitably the whole outlook of the coal-mining industry of the world, and Great Britain in particular, would be transformed for the better.

The commercial production of beryllium is also a subject to which attention might usefully be given. The importance of beryllium as a valuable alloy with copper, aluminium, and other metals has emerged recently.

The devising of an economical method of extracting alumina from bauxite containing 8 per cent and more of silica; as well as the extraction of alumina from lower grade ore generally, including clays, deserve attention. The high-grade ores of aluminium (bauxite) are not very extensive, and it is in the highest degree desirable with the greatly increasing importance and output of aluminium that a practicable and profitable means of extraction of alumina from the lower grade ores and, if possible, from clays generally should be found.

July 24, 1856.—Prof. Émile Picard, For.Mem.R.S., member of the French Academy, and permanent secretary of the Paris Academy of Sciences.

J'ai de l'intérêt pour l'analyse mathématique. la théorie des fonctions et la théorie des nombres. J'ai publié divers ouvrages sur l'histoire et la philosophie des sciences.

Societies and Academies.

London

Geological Society, June 17.—**Olaf Holtedahl**: Some general structural features of the arctic and adjacent regions. The huge region comprising the Canadian and the Baltic Shields and the areas lying between them represents a sort of structural unit which may be more or less symmetrically divided by two lines, one north and south, the other at right angles to it, crossing each other in the central part of Greenland. Although Baffin Land and the western zone of Fennoscandia had a somewhat different history in ancient geological times, yet each may be regarded as the reflected image of the other, both consisting of mountain ranges with the highest elevation on the side bordering the adjacent deep sea area. In the northward continuation of these two zones, in Ellesmereland and Spitsbergen respectively, and at the north end of Greenland, are other zones where the distribution of the various formations tells of a somewhat similar inclination of the earth's crust; an inclination away from central Greenland, the previously mentioned structural centre. Thus there is, in a roughly ring-shaped belt, an inclined elevation of recent, probably younger Tertiary, date, and it seems a natural conclusion that this particular elevation has been of fundamental importance in the gathering of snow, which in Quaternary time developed into the modern ice-fields, the centre of which coincides with the above-mentioned structural centre.—**James Archibald Douglas** and **William Joscelyn Arkell**: The stratigraphical distribution of the cornbrash: (2) The north-eastern area. Attention has been chiefly confined to the brachiopod zones, and their distribution throughout the area is indicated by a detailed account of many typical exposures. Further readjustment of Buckman's zonal table has been found necessary in respect of the zones of *Tegulithyris bentleyi* and *Obovothyris stiltonensis*. The evidence for and against penecontemporaneous erosion is discussed.

Paris.

Acedemy of Sciences, May 26.—**Charles Nicolle** and **Ugo Lumbroso**: The immunity following a natural attack and cure of trachoma against an experimental re-inoculation of the virus.—**A. F. Holleman** was elected *Correspondant* for the section of chemistry.—**Long**: The *W* surfaces.—**Maurice Potron**: A fundamental theorem of the theory of finite continued groups of transformations.—**Marcel Winants**: Determination of a function of functions by means of an integral equation.—**Teissié-Solier**: The conditions of use of a Pitot tube and the impulse of a turbulent jet on a plate.—**J. Le Roux**: The impossibility of a law of gravitation for an aggregate comprising only two material points.—**Ch. Sadron**: The ferromagnetic saturation of elements other than iron, nickel, and cobalt, and the periodic system.—**L. Bull** and **Mlle. Suzanne Veil**: The optical study of the secondary Liesegang rings.—**L. Bert** and **R. Annequin**: A new method of synthesis of einnamic aldehyde and its homologues substituted in the nucleus. $C_6H_5 . . CH_2 . CH : CHCl$, ω-chlorallylbenzene is converted into $C_6H_5 . CH_2 . CHCl . CHCl_2$ (or the corresponding bromine compound), and this, by heating with sodium ethylate in excess, into the diethyl acetal of cinnamic aldehyde. The reaction is general, and can be applied to the preparation of homologues of cinnamic alhehyde.—**J. D. Strelnikov**: The influence of the solar radiations on the temperature of the bodies of insects. The body temperature of insects is raised by exposure to the sun, and the organism of an insect is very sensitive to slight changes in the surrounding medium.—**Michel Polonovski** and **Albert Lespagnol**: Two new sugars from human milk, gyrolactose and allolactose. In the course of analyses of human milk by the ordinary polarimetric and reduction methods the divergences found suggested the presence of sugars other than lactose. Two new sugars have been isolated as the result of a long series of fractional crystallisations, and these have been named gyrolactose and allolactose. The properties of these two sugars are found to explain the abnormalities found on analysis.

Cape Town.

Royal Society of South Africa, April 15.—**B. Farrington**: Vesalius on vivisection. This paper is a translation of the last chapter of the *De Humani Corporis Fabrica* of Vesalius, which bears the title "Some Observations on the Dissection of Living Things". Though Vesalius did not advance the study of physiology to anything like the same degree as he did the science of anatomy, his book is, none the less, in the words of Sir M. Foster, "the beginning not only of modern anatomy but of modern physiology". The physiological experiments described by Vesalius have a direct connexion with the series of observations on living animals that enabled Harvey to demonstrate the circulation of the blood.—**J. H. Power**: On the herpetological fauna of the Lobatsi-Linokana area. An unexpected result of the author's collecting at Linokana was the discovery, in many cases, of different species, of certain genera, from those found at Lobatsi. The two localities are connected by a narrow valley between two ranges of hills, seemingly an admirable condition for ensuring that the reptile and amphibian faunas should be the same. The list of species collected materially extends the range of many species. The relationships of *Gerrhosaurus flavigularis* and *G. nigrolineatus*, and *Bufo tuberculosus* and *B. regularis gutturalis*, are discussed.—**J. W. C. Gunn** and **D. Epstein**: The reaction of *Xenopus* to digitalis. It has been stated that in *Rana* there are unexplainable variations in the response to digitalis as shown by the differences in the minimal lethal doses in individual animals on any one day, in groups of animals from day to day and in other ways. Such variations are not seen with *Xenopus* even when kept in captivity for several months. It is therefore superior to *Rana* for the biological assay of digitalis by any of the frog methods.—**D. Epstein, J. W. C. Gunn, E. Epstein**, and **G. Rimer**: The adrenal secretion of *Xenopus lævis*. Morphologists claim that no adrenal bodies are present in *Xenopus*, and various hypotheses have been brought forward to account for the absence of these glands. The authors have shown experimentally the presence of adrenaline in extracts of the kidneys of *Xenopus*. The kidney tissue itself contains no adrenaline, but the active substance is derived apparently from thin yellow streaks present on the ventral surfaces of the kidneys. These streaks probably represent the adrenal glands of *Xenopus*. This has been confirmed histologically by the demonstration of chromaffin tissue.

Cracow

Polish Academy of Science and Letters, Feb. 9.—**J. Fridrichson**: The fluorescence of manganese vapour.—**Mlle. M. Ney**: The enlargement of diffused lines without change of frequency in the Raman effect. A study of the lines diffused in quartz and in benzene shows that a marked widening of the lines occurs in benzene, but in quartz at 180° C. and at 500° C. no such widening can be observed.—**T. Tucholski**: The spectra of metals obtained by explosive reactions. Studies of the spectra obtained by the explosion of metallic picrates. Explosion spectra are essentially flame spectra, but with some additional characteristic features. The explosion temperatures are between 1900° C. and 3200° C.—**T. Banachiewicz**: An application of the periodograms of Sir Arthur Schuster.—**W. Swietolawski, Mme. M. Rybicka**, and **Mme. W. Solodkowska**: An adiabatic microcalorimeter adapted to the measurement of the specific heat of solid and liquid substances. A study of the conditions of working with the microcalorimeter, with special reference to the correction for the gas contained in the apparatus and to the error introduced by evaporation or adsorption of water.—**W. Swietoslawski** and **Mlle. E. Bartoszewiczowna**: (1) The application of the adiabatic microcalorimeter to the determination of the heat of adsorption and of vaporisation. The quantity of liquid required in these determinations is 0·01–0·1 gm., and the errors are 0·2–0·7 per cent for heat of vaporisation and 0·6–1·7 per cent for heat of adsorption.—(2) The determination of the heat of vaporisation in the fatty alcohol series with the adiabatic microcalorimeter.—**W. Jacek**: The velocity of the solution of marble in acids.—**M. Karasinski**: The determination of fluorine as CaF_2 according to the method of Berzelius. Instead of adding sodium carbonate to secure an easily filtrable precipitate, the author attains the same result by evaporation to dryness and gentle ignition, followed by extraction with water.—**K. Dziewonski** and **J. Moszew**: The synthesis of α-ethylacenaphthyl ketone.—**St. Kreutz**: Heulandite occurring in the Tatra granites and the volcanic rocks in the neighbourhood of Cracow.—**St. Kreutz**: Crystals of topaz from Jahodenka in the neighbourhood of Horoszki (Wolhynie).—**S. Kozik**: The optical properties of mixed crystals of ammonium and sodium tartrate and of rubidium and sodium tartrate.—**J. Broder**: The diabases of Niedzwiedzia Góra and the formations which accompany them. Chemico-petrographic study.—**J. Zerndt**: Megaspores, characteristic fossils of the productive carboniferous strata.—**W. Szafer**: The ancient diluvial flora of Hamernia on the Lubaczówka.—**Mlle. M. Ziemba**: Biological researches concerning the flowers of the eastern Carpathians.—**M. Gieysztor**: Contribution to the knowledge of the Rhabdocœles of Spain.—**St. Markowski**: Researches concerning the helminthological fauna of the Corvidæ of Poland.—**A. Kulczycki**: The physiological degeneration of the striated muscles.—**Mlle. S. Vrtel**: Histological researches concerning the thyroid gland. The thyroid gland of selacians.—**J. Tur**: New studies on diplogeneses with abortive centres.—**St. Wajda**: Cytological researches on the secretion of the thread-producing glands of the larvæ of Trichoptera.—**J. Wilburg**: The development of the blood-vessels in the foot and toes of *Sus scrofa domestica*.—**M. Rose**: The cellular structure of the cortical substance of the brain of the rabbit.—**W. Heinrich** and **T. Strzembosz**: The function of the capillary vessels with respect to concentration of attention.

Geneva.

Society of Physics and Natural History, Mar. 5.—**Fern. Chodat** and **Suzanne Kann**: Study of the diurnal course of transpiration of two alpine plants. These experiments were made at the Bourg St. Pierre alpine garden at an altitude of 1650 metres. For *Eryngium*, the authors have detected two clear maxima at 10.30 A.M. and 3.30 P.M. respectively. *Adenostyles alliariæ*, a plant requiring shade, has, on the contrary, constant transpiration from morning to evening.—**Fern. Chodat**: The action of light upon cellular permeability. The author interprets the experiments described above as being due to the higher proportion of rays of short wave-length at high altitudes. This explains the difference which exists between the transpiration of plants at low and high altitudes.—**Louis Deshusses** and **Jean Deshusses**: The distribution of the pyrethrins in the pyrethrum flower. The stems contain from a tenth to a fourteenth of the total pyrethrins found in the flower of the same growth. Hence, in the preparation of pyrethrum insecticides in the form of extracts or powders, it is necessary to take this fact into account: this is very important from the point of view of the toxic power of the product obtained.

Leningrad.

Academy of Sciences (*Comptes rendus*, No. 19, 1930).—**B. Segal**: A generalisation of Brun's theorem.—**I. Balanovskii**: The computation of rectangular coordinates of basic stars on astrophotographic charts.—**E. Semičev**: The fundamental features of electrodynamic relations in electromagnetic machinery. In no electrodynamic process is the electromagnetic energy completely transformed into mechanical work. In other words, every electrodynamic process in which the system accomplishes positive, or negative, mechanical work is characterised by some reactive energy taking part in it.—**I. Kablukov** and **F. Perelmann**: The heat of combustion of certain organic halogenic compounds. Determinations of the heat of combustion of dichlorethylene, chloroform, chlorbenzene, dibromethylene, bromoform, and brombenzene.—**N. Williams**: Hydrogenation of some derivatives of furfurane.

Comptes rendus, No. 20, 1930. — **F. Loewinson-Lessing, V. Mitkevitch**, and **A. Turcev**: Experiments in the artificial magnetisation of limonites. Limonites submitted to magnetisation in the electromagnetic field of 2500 gauss, after having been heated to 400°-500° C., do not exhibit any proportionality of the intensity of the magnetisation and the content of the ferrous oxide. The magnetisation depends on the degree of trituration and is more intense in the case of powdered substances. There is a direct relation between the intensity of magnetisation and the manganese content.—**B. Brunovski** and **K. Kunasheva**: The radium content of certain plants.—**V. Vernadskii**: The concentration of radium by plants. Determinations of the radium content of *Lemna* and of the water in which it lives proved that the plant concentrates up to 200 and even 477 times as much radium as is in the water, there being a great difference between plants from different localities. In some cases, it is impossible to detect radium in the water, but its concentration in the plant is very high.—**N. Prokopenko**: The deposits of solid kaolin in the Dzhungarian Alatau.—**E. Litchko**: Observations on the regeneration of the extremities in the axolotl under the influence of X-rays. Local radiation for 60 minutes does not affect the regenerative abilities. When the whole animal was subjected to the radiation for 16 minutes but one foot was screened, that foot was able to regenerate, though the animal could not survive more than two months.

Comptes rendus, No. 21.—**S. P. Kostychev, V. Gvaladze**, and **P. S. Eliasberg**: The formation of pyruvic acid in lactic fermentation. A method is described for the isolation of the pyruvic acid in the presence of sugar.—**V. Gulevitch**: Methyl-guanido-oxalic acid (creaton) as a constituent part of muscles. The formula of the creaton was found to be $HN : C (NH_2) . N(CH_3) . CO . COOH$. It is possible that creaton, like glutathione, takes part in the oxidation processes of the organism.—**L. Kantorovitch**: Certain developments of the polynoms of S. N. Bernstein.—**B. Numerov**: The interpretation of gravimetric observations in the case of a single surface of contact.—**B. Numerov**: The construction of isograms after observations with a gravitational variometer.—**B. Barovskii**: Description of a new species of the genus *Macrolycus* Waterh. (Coleoptera, Lycidæ). *Macrolycus æmulus*, sp. n., is described from the Ussuri region and Manchuria.

Comptes rendus, No. 22.—**A. A. Borisiak**: Charles Depéret (obituary).—**N. Nasonov**: On *Acrorhynchus baicalensis* Rubtzoff (Turbellaria, Rhabdocœla) from Lake Baikal. This species does not belong to the genus *Acrorhynchus* and is more closely allied to *Kainocystis*, so that it cannot be considered a representative of marine Rhabdocœla.—**M. A. Menzbier**: The combination of factors to which the origin and the development of terrestrial vertebrates is due. Free movement of the head is connected with the replacing of the branchial apparatus by lungs, this leading to the final victory of aerial over aquatic respiration.—**L. Kantorovitch**: Certain developments of the polynoms of S. N. Bernstein (2).—**N. Terebinskii**: Experimental studies of the faults of cardiac valves.—**N. O. Olenev**: Scientific results of the expeditions in 1928 and 1929 to Kazakstan for the study of parasites of domestic animals. A list of parasites, with their hosts, is given.

Comptes rendus, No. 23.—**A. Tugarinov**: A fossil ostrich from Transbaicalia. Fragments of ostrich eggs have been found in several localities. The structure of the shells shows some relation to the recent North African ostrich, but there are considerable differences.—**V. Barovskii**: Description of a new species of the genus *Pyropterus* Muls. (Coleoptera, Lycidæ) from Transcaucasia. *Pyropterus shelkonnikovi*, sp. n.—**A. A. Birula**: A preliminary communication on the rodents from the quaternary deposits in the Crimea. The quaternary fauna included 18 species of rodents, while at present there are only 14 in the Crimea.—**B. A. Kusnečov**: A new species of jumping mouse (*Alactagulus shitkovi*, sp. n.) from Semiretchie.—**P. Schmidt**: Two rare Japanese sharks, *Proscyllium habereri* Hilgendorf and *Apristurus macrorhynchus* Tanaka. Synonyms and supplementary description of the two species mentioned.

MELBOURNE.

Royal Society of Victoria, April 9.—**O. A. Mendelsohn**: Some observations on the bacterial count of sea-water as determined by samples taken at intervals on a voyage between Australia and Europe.—**R. B. Withers**: On the development of the tabulate coral, *Pleurodictyum megastomum*. The author works out the mode of growth of the *Pleurodictyum megastomum*, Dun, Yeringian (Upper Silurian) of Victoria, Australia. To the eighth corallite, growth proceeds on a definite plan by budding from the initial corallite. This neanic stage is followed by the ephebic stage, when the corallum enlarges without further addition of corallites. The gerontic stage is characterised by the irregular growth of a second ring of corallites, and the insertion of others by intermural gemmation. *Pleurodictyum lenticulare*, Hall sp., Lower Helderbergian (Lower Devonian) of North America, develops in a similar manner.

PRAGUE.

Czech (Bohemian) Academy of Arts and Sciences (Second Class, Natural Sciences and Medicine), Dec. 12.—**M. Pelíšek**: The rolling of a helix on a congruent helix.—**R. Lukes**: The action of Grignard's reagent on *N*-methyl pyrrolidon; new synthesis of substituted pyrrolines. Chief products were *1*-methyl-2-alkyl-pyrrolins next to *1*-methyl-2 . 2-dialkyl-pyrrolidins. The former were isolated as perchlorates, the latter as picrates.—**V. Prelog**: The sapogenin of beetroot. Chromic acid oxidises sapogenin to a ketonic acid and di-hydroxy-lactone. With sulphuric acid it yields carbon monoxide, hence its carboxyl is bound to a quaternary carbon atom; the action with tetranitro-methane indicates inactive double linkages.—**L. Šimek**: Graphical solution of reactions and axial forces in a special plane system of rods.—**L. Seifert**: A system of surfaces of third order which touch a given surface of third order in points of plane intersection.—**B. Brauner**: A philological note concerning some terms of modern scientific nomenclature.

Jan. 16.—**F. Záviska**: Notes on the study of universal ether. Critical remarks on the theory propounded by V. Posejpal.—**K. Domin**: Geobotanical excursion to the mountain Vysoká in the Little Carpathians.—**F. Němejc**: Seeds of *Alethopteris rubescens*.—**A. Glazunov**: The nature of a crystallisation centre. From one crystallisation centre grows a series of crystals forming one, usually heterogeneous, grain (crystallite).

Mar. 6.—**J. Petrbok**: Molluscs of the Pleistocene terrace of the Danube near Russe in Bulgaria.—**K. Petr**: The separation of roots of algebraic equations according to the real parts.—**B. Dratvová**: The problem of causality.—**Hrubý**: Biometric observations on blossoms of *Anemona nemorosa* L.—**L. Borovansky and Pexiderová**: The growth of the body and the progression of ossification in girls from birth to eighteen years of age.

Official Publications Received.

British.

A Vertical Optical Bench and its use in Practical Light. By Prof. Mohd. A. R. Khan. Pp. 20. (Madras: Diocesan Press, Vepery.)

Proceedings of the Royal Physical Society, Sessions 1928–29, 1929–30, 1930–31. Vol. 22, Part 1. Pp. 74. (Edinburgh: Oliver and Boyd.) 6*s*; to Fellows, 5*s*.

Madras Fisheries Department. Administration Report for the Year 1929–30. By Dr. B. Sundara Raj. (Report No. 1 of 1931, Madras Fisheries Bulletin, Vol. 25.) Pp. vii+104+6 plates. 14 annas. Report on a Systematic Survey of Deep-sea Fishing Grounds by S.T. *Lady Goschen*, 1927–28. By Dr. B. Sundara Raj. (Report No. 3 of 1929, Madras Fisheries Bulletin, Vol. 23.) Pp. 153-187+8 charts. 1.8 rupees. (Madras: Government Press.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4, New Series, No. 5, May. Abstracts Nos. 748-959. (London: H.M. Stationery Office.) 9*d*. net.

The Indian Forest Records. Entomology Series, Vol. 16, Part 3: Immature Stages of Indian Coleoptera (8). (Cerambycidae, contd.) By J. C. M. Gardner. Pp. 41+3 plates. (Calcutta: Government of India Central Publication Branch.) 1.2 rupees; 2*s*.

The Scientific Journal of the Royal College of Science. Vol. 1: containing Papers read during the Session 1930–1931, before the Imperial College Chemical Society, the Royal College of Science Natural History Society, the Royal College of Science Mathematical and Physical Society. Pp. 158. (London: Imperial College Union.) 8*s*. 6*d*. net.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 17, No. 2, June. Pp. 277-615. (Plymouth.) 12*s*. 6*d*. net.

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 54. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. iii+215+9 plates. (Adelaide.) 14*s*.

The Civil Servant's Share of the National Income. By G. D. Rokeling. (Reprint of three Articles from *State Service*, April, May, June, 1931.) Pp. 20. (London: The Institution of Professional Civil Servants.) 3*d*.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 42, Part 2, June 25th. Pp. 87-216. (London: Edward Stanford, Ltd.) 5*s*.

The Journal of the Institute of Metals. Vol. 45. Edited by G. Shaw Scott. Pp. xii+429+59 plates. (London.) 31*s*. 6*d*. net.

Hull Museum Publications. No. 170: Roman Pottery and Kilns at Throlam, near Holme-on-Spalding Moor, East Yorkshire. By Philip Corder and Thomas Sheppard. Pp. 85. No. 171: The Architectural Gems of East Yorkshire. By Thomas Sheppard. Pp. 32+8 plates. No. 172: Recent Additions. Edited by T. Sheppard. Pp. 19. No. 173: Exhibition illustrating the Architecture of Modern Transport, in the Mortimer Museum, Carr Lane, June 1st to July 12th, 1931. Pp. 16. (Hull.)

Records of the Geological Survey of India. Vol. 65, Part 1. Pp. 187. (Calcutta: Government of India Central Publication Branch.) 2.12 rupees; 5*s*.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 17, No. 6: The Effect of some Meteorological Conditions on the Growth of Punjab-American Cotton. By Trevor Trought. Pp. 137-154. (Calcutta: Government of India Central Publication Branch.) 7 annas; 9*d*.

Proceedings of the Royal Irish Academy. Vol. 40, Section A, No. 1: The Spectrum of the Cathode Glow in Nitrogen and other Gases. By Dr. K. G. Emeleus and Olive Hall. Pp. 10. (Dublin: Hodges, Figgis and Co; London: Williams and Norgate, Ltd.) 6*d*.

The National Central Library, formerly the Central Library for Students. 15th Annual Report of the Executive Committee, 1930–31. Pp. 48 (London.)

Journal of the Chemical Society. June. Pp. vi+1313-1627+x. (London.)

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 5, June. Pp. 203-260+xliv. (London.)

Foreign.

Instituts Nationaux à l'Étranger. Pp 124. (Paris: Institut International de Coopération Intellectuelle) 15 francs; 2*s*. 6*d*.

Meddelande från Lunds Astronomiska Observatorium. Ser. 2, Nr. 57: Streams among Stars with large Proper Motions. By W. Gyllènberg. Pp. 87. 2 kr. Lund Observatory Circular No. 3, May 31. Pp. 35-66 Annals of the Observatory of Lund. No. 2: On Structural Properties of Open Galactic Clusters and their Spatial Distribution; with an Appendix containing a Catalogue of 471 Objects. Academical Dissertation by Per Collinder. Pp. A64+B62+16 plates. (Lund.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No 23: Gemiddeld aantal regendagen op Java en Madoera in de vier opeenvolgende, voor iedere plaats droogste maanden van het jaar. Door Prof. Dr. J. Boerema. (With English Summary: Average number of rain-days in Java and Madoera during the driest four consecutive months of the year.) Pp. 25. (Batavia: Landsdrukkerij.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. Angolan Birds collected during the Gray African Expedition, 1929. By W. Wedgwood Bowen. Pp 263-299. (Philadelphia.)

Transactions of the San Diego Society of Natural History. Vol. 6, No. 22: Descriptions of New Birds from the Mountains of Southern Nevada. By A. J. van Rossem. Pp. 325-332. (San Diego, Calif.)

Suomen Geologinen Toimikunta: Geologiska Kommissionen i Finland: Bulletin de la Commission Géologique de Finlande. No. 91: Pre-Quaternary Rocks of Finland; Explanatory Notes to accompany a General Geological Map of Finland. By J. J. Sederholm. Pp. 47, with Map. (Helsinki.) 30 Fmk.

Bulletin of the American Museum of Natural History. Vol. 59, Art. 7: Pleistocene Exploration and Fossil Edentates in Florida. By Walter W. Holmes and George Gaylord Simpson. Pp. 383-418. Vol. 61, Art. 7: South American Lizards in the Collection of the American Museum of Natural History. By Charles E. Burt and May Danheim Burt. Pp. 227-395. (New York City.)

State of Connecticut: State Geological and Natural History Survey. Vol. 9, Bulletins 43-48, 1923–1930. Pp. iii+100+168+32+97+294+94+95 plates. (Hartford, Conn.)

Japanese Journal of Physics. Transactions and Abstracts, Vol. 6, No. 1-2. Pp. v+15+32+3 plates. (Tokyo: National Research Council of Japan.)

Science Reports of the Tokyo Bunrika Daigaku. Section A, Nos. 7-12: On Vector Quantity, 2: Vector Quantity is Reducible from a kind of Probability, by Suminosuke Ono; On the Relative Intensities of the Balmer and Paschen Lines, by Uzumi Doi; Large Displacements in the Spectrum of Singly Ionized Oxygen, by Kwan-ichi Asagoe; Some Peculiar Types of the Secondary Lichtenberg Figures, by Kwai Umeda and Mitsuo Shôyama; On the Reversal-like Phenomena of the Balmer Lines of Hydrogen, by Hideo Nagashima; A Method of Laboratory Device to record the Period of a Pendulum Motion, by Mituo Syôyama. Pp. 85-147+plates 5-11. 90 sen. Section A, No. 13: On the Modulus of some Integral. By Iôichi Kakeya. Pp. 149-157. 15 sen. (Tokyo: Maruzen Co., Ltd.)

Zoologica: Scientific Contributions of the New York Zoological Society. Vol. 9, No. 13: Growth and Age in the Great Tortoise of the Galapagos. By Charles Haskins Townsend. Pp. 459-474. (New York City.)

Carnegie Institution of Washington. Publication No. 406: The Temple of the Warriors at Chichen Itzá, Yucatan. By Earl H. Morris, Jean Charlot, Ann Axtell Morris. Vol. 1. Pp. xix+485. Vol. 2. Pp. viii+170 plates. (Washington, D.C.: Carnegie Institution.) 20 dollars.

Catalogues.

Catalogue of Fine Chemical Products for Laboratory Use; including Organic and Inorganic Chemicals, Analytical Reagents, Standard Stains, Indicators. (July 1931.) Pp. 132. B.D.H. Ureamometer Outfit. Pp. 4. (London: The British Drug Houses, Ltd.)

Electro-Chemical Apparatus embodying Electro Analysis of Metals, Electrometric Determination of Hydrogen Ions, and Conductivity of Electrolytes. (List No. 80c.) Pp. 44. Catalogue of Surplus Stock Apparatus including Balances and Weights, Glassware (Graduated and Ordinary), Hardware, Metal and Porcelain Ware. (List No. SS 101H.) Pp. 20. (London: A. Gallenkamp and Co., Ltd.)

Diary of Societies.

FRIDAY, July 17.

Institution of Municipal and County Engineers (South Midland District Meeting) (at Winchester Street, Acton), at 2.15.—W. G. Cross: Some Recent Works in Acton.—S. W. Slight: New Sewage Pumping Station.—H. Atkinson: New Works Depot.

TUESDAY, July 21.

Royal Society of Medicine, at 5.30.—General Meeting.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—Informal Meeting.

CONGRESSES.

July 17 to 25.

British Medical Association (at Eastbourne).

July 24 to 30.

British Commonwealth Education Conference (at Bedford College).—Subject: Education in a Changing Empire:—

Education in India.
Individual Education.
Modern Psychology in Education.
Examinations and Tests.

July 26 to 31.

International Congress on Radiology (at Paris).

SUMMER MEETING.

July 18 to 23.

Institution of Electrical Engineers (in Northern Italy and Western Switzerland).

SATURDAY, JULY 25, 1931.

CONTENTS.

PAGE
Sterilisation and Mental Deficiency 129
Unofficial Moments of a Great Archæologist. By S. R. K. Glanville 131
Historical Aspects of Biology. By Prof. Lancelot Hogben 132
Physics for Students 134
Short Reviews 135
Helium and its Properties. By the Right Hon. Lord Rutherford, O.M., F.R.S. 137
A. M. Liapounov, 1857–1918. By A. J. Pressland . 138
Two Historic Electric Power Stations . . . 140

Obituary:

Major T. F. Chipp. By A. W. H. . . . 141
Baron Kitasato, For.Mem.R.S. By W. B. . 142
News and Views 143

Letters to the Editor:

Constitution of Lithium.—Dr. F. W. Aston, F.R.S. 149
Polarisation of a Beam of Electrons by Scattering.—E. G. Dymond 149
A Curious Phenomenon shown by Highly Charged Aerosols.—W. Cawood and H. S. Patterson . 150
Temperature Stability and Denaturation of Serum Albumin.—Dr. Kai O. Pedersen . . 150
A New Relation between Electrical Resistance and Energy of Magnetisation.—Prof. Walther Gerlach and Erno Englert 151
Wires drawn through Rotating Dies.—H. Greenwood and Prof. F. C. Thompson . . . 152
Diamagnetism of Liquid Mixtures.—V. C. G. Trew and Prof. James F. Spencer . . . 152
Excretion of Uric Acid.—Dr. Joseph Needham . 152
The Slow Combustion of Acetylene.—R. Spence 153
Diamagnetism and the Colloidal State.—S. Ramachandra Rao 153
The late Mr. Herbert Tomlinson, F.R.S.—J. Johnston Abraham 153
Research Items 154
Astronomical Topics 156
Jubilee Celebrations of the Society of Chemical Industry. By Dr. H. F. Gillbe 157
Congress of Universities of the Empire, 1931 . . 158
Annual Conference of the Museums Association . 159
Imperial Sugar Cane Research Conference, 1931 . 160
University and Educational Intelligence . . . 161
Birthdays and Research Centres 162
Societies and Academies 162
Official Publications Received 164
Diary of Societies 164
Recent Scientific and Technical Books . . Supp. v

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Sterilisation and Mental Deficiency.

THE conditions which exist in a modern organised community are so exceedingly complicated that ability above the ordinary is demanded of those who would cope with them. The environment which man has created is not the optimal for many biological types, and this is certainly true of the certifiable mental defectives, whose numbers have doubled during the last twenty years, and of whom it is estimated there are now no less than 300,000 in England and Wales alone (Report of the Mental Deficiency Committee of the Boards of Education and Control, 1929). It has long been recognised that these require a special environment of their own in which they are not forced to compete with their normal fellow-men, and where they are out of harm's way; and so, for them, appropriate institutional accommodation has been devised. But the country is not prepared to find the money wherewith to provide such segregation for 300,000. In fact, only about 25,000 are thus sheltered. A further 50,000 are under guardianship, whilst the rest are scattered amongst the general population, relatively uncontrolled and unprotected, to constitute a most serious social problem.

The survey of the Royal Commission on the Care and Control of the Feebleminded (1908) was necessarily imperfect and incomplete, but this cannot explain away the startling fact that in twenty years the incidence of this incurable condition has increased from 4·6 to 8·56 per thousand. It is certain that there has been an actual increase of appalling magnitude. Since there is evidence to show that in a great many instances mental deficiency is genetic in origin, it is reasonable to assume that the increase is due, partly or largely, to the production of mentally defective offspring by mentally defective parents and by others who, though they themselves are not mentally defective, nevertheless transmit the corresponding hereditary factors. If this is so, then it must be expected that the incidence of mental defect in the population will continue to increase, unless the production of mentally defective children is checked; and the only sure method of reducing it is that of denying parentage to all who are likely to produce offspring exhibiting the condition.

Until we know exactly the genetic basis of hereditary mental defect, we cannot possibly deny parentage to the normal who carry the genetic factors corresponding to it in their hereditary constitutions. We can only teach and plead that any normal couple who have produced a men defective child should have no more children. But if the condition is genetic in many or all cases, no matter what the exact genetic basis of it may be, we cannot be mistaken in attempting to deny parentage to the certifiable mental defectives. To the eugenist, who holds the view that the condition is most commonly the expression of a biologically and socially undesirable hereditary constitution, the Report of the Mental Deficiency Committee of the Boards of Education and Control is as writing on the wall, foreshadowing the decay and doom of our human stock: for, since there must be harmony between the size of a population and the resources of its country, if the mental defectives increase, normals must decrease proportionately. No wonder there is a widespread interest in this matter, and that statesman, economist, sociologist, and biologist are in favour of legalising the voluntary sterilisation of mental defectives as provided for in a Bill brought before the House of Commons by Major A. G. Church on July 21; though unfortunately leave was not given for the Bill to be printed, so that it will not have a second reading.

Mental deficiency cannot be cured. The only possible treatment is the segregation of the mental defectives in appropriate institutions. If some or much mental deficiency is genetic in origin, as much care must be given to the children of the next generation as to the mentally defective individuals of this. So long as institutional treatment implies non-propagation, all is well; but if such segregation is insufficient or incomplete, then that portion of society which cares for the future as well as for the present must claim the right to prevent propagation on the part of the certifiable mentally defective. So long as medicine cannot cure the condition, society must claim the right to prevent the repetition of an hereditary blunder which yields individuals who cannot, in virtue of their organic inheritance, adapt themselves to prevailing social conditions, and who, because of their helplessness and lack of restraint and responsibility, hinder the further evolution of man and of society. The majority of rationally-minded people are agreed that every individual, including mental defectives, shall enjoy as much personal liberty as is consonant with the well-being of society, but insist that society can claim the right to protect itself, by all means at its disposal, from all those forces which threaten its existence.

The object of this Bill is to make the sterilisation of mental defectives, by such operative interference as vasectomy or salpingectomy, a lawful act, upon their own application or that of their parents or guardians. Its purpose is the sterilisation of mental defectives prior to their discharge from institutions; it also makes it possible for a defective to be sterilised voluntarily, with the sanction of the Board of Control, without being sent to an institution. The voluntary nature of the Bill is illustrated by the following safeguards: before an operation for sterilisation may be performed, the patient's consent must be given, if he or she be capable of expressing willingness or otherwise; secondly, the spouse or parents or guardians have to agree; the consent of the Board of Control must be obtained; and, finally, the operation must be approved by some judicial authority, such as a bench of magistrates. Only when these conditions have been observed can the judicial authority authorise the performance of the operation.

Undoubtedly, it is very necessary in this community to assume that any Bill dealing with such a matter as this will meet with considerable opposition, for personal opinions based on emotional bias are commonly more welcome than rational argument in accord with established fact. We may thus assume that the promoters of the Bill are presenting their minimum demands, fashioned in such a way as not to offend those whose opinions on this matter are really of no account but whose votes are important. The Bill is a soft-metalled pocket-knife which is to be used to hack away the steel ropes of mental deficiency which now entangle society. It cannot reduce the incidence of mental deficiency in Great Britain with any reasonable speed. Relatively few of the 300,000 mental defectives will be sterilised until spouses, parents, guardians, judicial authorities, as well as mental defectives themselves, have been persuaded that sterilisation by vasectomy and salpingectomy is to be desired, not only from the point of view of the patient, but also, and especially, from the point of view of society.

It is to be noted that the promoters of the Bill do not suggest that sterilisation should replace institutional segregation. They rightly hold the view that since institutional treatment is not available for all, and is commonly incomplete, sterilisation should be an auxiliary method of preventing propagation by mental defectives. Too much stress must not be laid on the suggestion that sterilisation will greatly diminish, if not entirely eliminate, mental defect. Until we know that mental defectives of one generation are responsible for more mental defectives in the next than are normal individuals carrying the genetic ingredients of this condition, it is impossible to form an accurate estimate of the reduction in the incidence of mental deficiency which would follow upon sterilisation of all mental defectives in a single generation. Nevertheless, whatever be the size of the contribution of mental defectives of one generation to mental deficiency in the next, so long as there is a contribution, then we are justified in advocating sterilisation of the certifiable mental defective if non-propagation can thus best be ensured.

It is not claimed in this Bill that the wholesale practice of sterilisation would remove the necessity for institutional treatment. Sterilisation would not make a defective more efficient, or lessen in any way his or her social incapacity. It is impossible to contemplate the release of the bulk of mental defectives from a sheltered environment into an unsympathetic world, there to become the prey of the unscrupulous. Sterilised or not, they must drift into crime and destitution. Institutional treatment must be maintained and extended: there can be no return to the evil days when the mentally deficient pursued a wretched existence on the streets or in the workhouse and prison. Sterilisation is to be regarded as a means whereby the accommodation in institutions and the number of mental defectives may be brought into harmony. From the point of view of economy, it is probable that institutional treatment is in the end the cheapest method of dealing with a type that must always be economically a burden. A point of some importance is that it is generally taught that the mentally deficient lead a somewhat uncontrolled sexual life. If mental defectives known to be sterilised were widespread in the community, it is not improbable that promiscuous sexual intercourse would be increased and the spread of venereal disease thereby extended. Is it not possible that vasectomy increases sexual libido? Certainly it does not diminish it.

For these reasons, it is doubtful whether sterilisation as a general policy and as a wholesale measure to be applied to all defectives can command universal approval. Undoubtedly, on economic, humanitarian, and preventive grounds, segregation as a general policy is preferable, and, if complete and continuous, it prevents propagation. No one seems to urge that such institutional inmates should be castrated, yet this is the only method of removing the sexual urge which, according to many authorities, is exaggerated in this condition and must lead to personal distress. But there is no doubt whatsoever that in special cases sterilisation is the ideal treatment. There are many defectives, for example, who are relatively stable, and for whom, after training in an institution, a suitable place can be found in the general population. In the case of such, there is only one problem—the problem of destroying their reproductive ability.

To the layman the safeguards which surround the Bill would seem entirely sufficient, but it has to be remembered that, if and when sterilisation is legalised, there will be a very considerable increase in the number of applications, from parents and others responsible for maintenance, for the discharge of patients in institutions; and, unless the very greatest care is exhibited, there will be a very real danger of the operation being extended to defectives who are quite unsuited to outside conditions, for the sole reason that someone wishes to save money. Though sterilisation will not reduce the need for further institutional accommodation, when it has been legalised, it will be used as an argument by local authorities for the non-provision of such accommodation.

From many points of view it is to be regretted that this Bill was presented before the conclusions of the presently functioning Mental Deficiency Committee of the British Medical Association have been made known. The medical profession is heavily involved in this projected scheme, and Major Church would be in a much stronger position if, in addition to the support of the Eugenics Society, he knew that he had behind him the official endorsement of medicine.

Unofficial Moments of a Great Archæologist.

A Season's Work at Ur: al-'Ubaid, Abu Shahrain (Eridu), and Elsewhere; being an Unofficial Account of the British Museum Archæological Mission to Babylonia, 1919. By Dr. H. R. Hall. Pp. xxii + 300. (London: Methuen and Co., Ltd., 1930.) 25*s.* net.

DR. HALL'S last book was published ten days after his sudden and premature death. His friends may derive some consolation, and his readers at large satisfaction, from the fact that here for the first time in his writings he has given the world a narrative which is largely of personal experience. The tragic circumstance may also excuse a reviewer who pays more attention to this aspect of the book than to the scientific.

Practically all the scientific results had indeed been more fully published elsewhere—by Hall himself in archæological journals and the British Museum official publication "Al-'Ubaid" (written in collaboration with Woolley and Gadd), pass of which are quoted at some length. Here and there he revises an opinion on a small point of detail; and in the chapters on Abu Shahrain and al-'Ubaid contributes, with some interesting plates of his own finds, a summary of the much-discussed painted pottery of the Near—and Far—East. But though almost half his space is devoted to a description of his own excavations, his main intention even here is to enable the reader to visualise the conditions and interest of his work in the field, rather than to offer him an archæological text-book.

As the full title indicates, however, there was a great deal more to this one Mesopotamian venture of Hall's than excavating alone. He was sent to report on, and take steps to safeguard, such antiquities in Iraq as he could reach; and he made the most of his mandate. He was a born traveller; scarcely a place he visited which failed to awaken some memory of stored-up knowledge; to many, unvisited before, he brought a more real acquaintance from his reading than others had got from the place itself. Allusion is the essence of his mental background—allusion which is safe from the charge of superficiality because of the amazing catholicity of his learning and the accuracy of his memory. The broken and, to-day, uninspiring arches of Koldewey's Hanging Gardens at Babylon suddenly take on the wooded appearance of the Zagros, as we follow Hall's apt comparison with the Mappin Terraces. Reaching Naṣirīyyah, which the British troops occupied after hard fighting in a July heat (1915), he recalls that though this was a " perfectly incredible time of the year for military operations . . . yet their grandfathers fought harder at Chillianwalla and Sobraon, wearing the same uniforms they would wear in London, with cross-braces constricting the chest ". A holiday spent on the Albanian coast and " a thorough acquaintance with Miss Durham's books " enabled him to talk (in Arabic) of people and places they both knew, to a Serb, who was one of the Turkish prisoners working for him at Ur. These are random examples, but typical of his attitude throughout his mission.

Hall has a very strong sense of fun, which is never suppressed for long at a time. A favourite theme is his efforts to obtain for himself, by cajoling, impudent bullying, or ' scrounging ', facilities and comforts which were not due to his rank as captain. But though he laughs at military methods, his gratitude to the several senior officers who helped him in various ways is generously expressed. He pokes fun at the large text printed in Gothic letters, the celluloid cuffs, and other relics of the German excavators, which he discovered in Koldewey's deserted headquarters at Kwairēsh. But his sallies are robbed of malice by the memory of happy times in Germany before the War—memories which he had revived during several visits in recent years.

Hall's constant reference to the kindness of officials who helped him in Iraq is matched by his frequent tributes to other workers in his own field: to Taylor and Thompson and others who had dug before him; to Woolley and Mallowan, his successors at Ur and al-'Ubaid; and to the cuneiform scholars, especially Sidney Smith and Gadd, without whom the work could not have been carried on, nor much of his book written.

Finally, the book is profusely illustrated with photographs, largely of his own taking, which in Hall's case invariably meant snap-shots. Some of his pictures are not perfect technically, but they never fail to have point or to help the text. Frequently they express his impish humour, for example, Fig. 9, called " 'Mespot' from the Tigris "; or his informal observation of things entirely outside his work, such as the photograph of the " German and L.S.W.R. locomotives " (Fig. 24); besides his delight (common to most excavators) in recording for his personal amusement every stage in his official work, even down to the transport of his boxes of antiquities (Fig. 256).

These are the qualities which will place " A Season's Work at Ur " on the shelves of specialists, to whom the bulk of the archæological material contained in it is already familiar. For the general reader the book supplies as well not only a very handy account of the history of excavation at Ur and al-'Ubaid down to 1929 and of the results thereby obtained, but also an admirable introduction to the most important ancient monuments of southern Mesopotamia.

S. R. K. GLANVILLE.

Historical Aspects of Biology.

A Short History of Biology: a General Introduction to the Study of Living Things. By Charles Singer. Pp. xxxv + 572. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 18*s*. net.

WRITERS on the history of science are too often addicted to anecdote, ancestor worship, and undue preoccupation with the blind alleys of scientific inquiry and speculation. Dr. Singer's new book has none of these defects.

He has traced the elucidation of the problems of contemporary biology to their earliest beginnings, keeping the problems rather than individuals to the forefront. Consequently, his book will provide, for many readers with no previous biological knowledge and a predilection for historical studies, an attractive introduction to the science of living matter. In adopting this course, he necessarily discloses his own views on many controversial topics. His perspective is inevitably influenced by what he regards as the most significant contemporary issues. It would therefore be easy for a reviewer to single out many passages for adverse criticism. It would also be an ungrateful act to do so. Few readers will always share all Dr. Singer's opinions. There can be no two opinions concerning Dr. Singer's erudition, the usefulness of this book, and the desirability of making its contents accessible to a wide circle of readers.

Teachers of elementary biology will welcome, in Dr. Singer's "Short History of Biology", an indispensable volume, packed with information and admirably illustrated. The style is engaging. The exposition is clear. It is divided into three parts, of which the last is the longest. The first is occupied with the history of early descriptive anatomy and natural history. It covers the period when biological knowledge embraced most of what was known of familiar terrestrial objects, before physics and chemistry had as yet emerged as experimental sciences. It includes three chapters, one devoted to Greek natural science, one dealing with the Alexandrian school and the scholastics, and one laying the foundations of the modern period in the work of the German herbalists, the "De Fabrica" of Vesalius, and the researches of Harvey. This section, in which the author pertinently discusses the relations of natural science and decorative art in the Renaissance, might have been more entertaining had Dr. Singer written with less consideration for the feelings of our eminent contemporaries who are anxious to reinstate the natural sciences in their former tutelage to ecclesiasticism. Dr. Singer dismisses the contention that the progress of natural inquiry was impeded by the growth of Christianity, though he does not overstate the favourable contrast between the world of Moslem and Christian Europe in the twelfth and thirteenth centuries. It is, of course, true that the decline of interest in natural science began long before Hypatia was butchered by the monks of St. Cyril. It is not less difficult to credit Dr. Singer's paradoxical belief that the growth of natural science was eclipsed because "the Romans were an essentially practical people". The temper and method of science are essentially practical. The seedling planted by the Greek materialists was already languishing on Greek soil before the Greek States lost their independence. Greek curiosity had been diverted into other channels, before the Roman conqueror incorporated the personnel of Greek superstition in its pantheon. Secular in its earliest beginnings, it became more and more engrossed in Persian mysticism and the mystery religions of the East. If Christianity was not chronologically the death-knell of Greek natural science, Platonism, from which Christianity borrowed the arithmetical refinements of its theology, was the signal and symbol of its decline.

In the second part, Dr. Singer deals with the historical foundations of modern biology. This section includes a discussion of the influence of Cartesian philosophy on the growth of experimental physiology, the progress of classificatory systems, the rise of comparative anatomy, the foundations of modern knowledge of the distribution of animal and plant species in space and time, and the revival of evolutionary speculation at the end of the eighteenth century. Among the more interesting features of this section are the discussions of the part played by the discovery of the microscope and the inauguration of the learned societies as factors in the separation of biological studies as a group of independent sciences outside the Aristotelian framework of the scholastic system. Chap. vii., which deals with "Distribution in Space and Time", is specially readable.

In the third part, Dr. Singer abandons the chronological method completely to trace from their beginnings in the seventeenth and eighteenth centuries the emergence of the main themes of inquiry which have occupied biological inquiry during the last seventy-five years. Separate chapters are devoted to the cell doctrine, biogenesis, the chemistry of the body, the process of development, sex, heredity; and the history of the nervous reflex is dealt with in the chapter entitled "The Relativity of Functions". Here Dr. Singer writes with a very evident bias towards the introspectionist point of view. Whether he has maintained his determination to avoid undue attention to unprofitable lines of inquiry is a matter for doubt. Time alone will show whether the writings of Lloyd Morgan deserve prominence in a history of science, except as evidence of the survival of Aristotelianism in the machine age.

In its plan and method Part 3 is the best section in the book. The separate paths which have been followed in the attempt to elucidate the main contemporary themes of biology do not as yet coalesce. To treat biology in the latter half of the nineteenth century as a single unit of human inquiry would have been disastrous. Dr. Singer has felt compelled to introduce much that is topical in this section, to clear the ground for the reader who is not a highly trained biologist. Had he done otherwise he would certainly have been less intelligible to many who, it is to be hoped, will read his book. On the other hand, those who are trained biologists will be disappointed to find that the historical aspect of this section is rather overshadowed by the exposition of elementary principles and all too familiar facts. Dr. Singer can atone for this shortcoming by writing another book more especially for the specialist. The book he has written contains much matter which will be suggestive and instructive to many who are biologists, and it should kindle the interest of still more who are not biologists.

It may be hoped that this book will add to the growing dissatisfaction which is felt towards present methods of teaching elementary biology in Great Britain, where the 'type system' still discourages many students from pursuing the study of animal life. Dr. Singer perhaps goes rather too far in subscribing to the doctrine that "l'histoire de la science c'est la science même". It is quite possible to understand the principle of segregation, to use it as an instrument to interpret and predict the results of breeding experiments, and to extend its scope without knowing anything about the studies which an Austrian abbé conducted in a quiet monastery garden seventy years ago. It is unlikely that the progress of modern genetics would have been impeded if de Vries, Correns, and Tschermak had remained ignorant of the fact that their discoveries had been forestalled forty years earlier. It is also true that no one can contribute to an intelligible exposition of the present status of the evolutionary hypothesis if he is unfamiliar with the metamorphosis which the word 'selection' has undergone, as it has passed in turn through the hands of Darwin and Wallace, Weismann and Galton, Morgan and J. B. S. Haldane. Without attention to its history the teaching of science provides a poor equipment for the understanding of a civilisation which owes its special peculiarities to the utilisation of scientific knowledge. The history of science is the major part of a philosophy attuned to the civilisation to which we ourselves belong.

Dr. Singer himself believes that there is a legitimate field for philosophy transcending the synthesis of all scientific knowledge. Those who question the usefulness of applying the term 'knowledge' to anything which lies outside the scope of mathematics and experimental science may look forward to a time when the subject he has done much to advance will enjoy a greater share of public esteem than he would claim for it. In the newer secular universities, departments of the history and method of science staffed by workers trained in the historical and natural sciences might well displace the teaching of a subject whose only *raison d'être* is its historical rôle as the rationale of a discredited supernaturalism.

Lancelot Hogben.

Physics for Students.

(1) *Physical Principles of Electricity and Magnetism.* By Prof. R. W. Pohl. Authorised translation by Winifred M. Deans. Pp. xi + 356. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1930.) 17*s.* 6*d.* net.

(2) *A Survey of Physics for College Students.* By Prof. Frederick A. Saunders. Pp. x + 635. (New York: Henry Holt and Co., 1930.) 3.75 dollars.

(3) *General Physics.* By Prof. Wm. S. Franklin and Prof. G. E. Grantham. Pp. xvi + 705. (Lancaster, Penn.: Franklin and Charles, 1930.) 4 dollars.

(4) *Intermediate Physics.* By Dr. R. A. Houstoun. Pp. xviii + 638. (London, New York and Toronto: Longmans and Co., Ltd., 1930.) 10*s.* 6*d.*

(1) AN unqualified welcome can be given to this excellent translation of the second edition of Prof. Pohl's book, of which the original edition has already received appreciative notice in Nature. Here is given, with a completeness and mastery unapproached in any English work of the kind known to the reviewer, a lucid and systematic account of the physical principles of electricity and magnetism. While the treatment is everywhere didactic, it is shown how the ideas involved and their development are always based on experiment, Prof. Pohl's ingenuity and resource in this direction being most notable. There is very little reference to persons or history, the closely knit argument being almost completely untrammelled by tradition and unhampered by customary modes of presentation; and while the mathematics used is almost negligible, the strict logic and quantitative treatment make the presentation very thorough, and

the wealth of illustration and clarity of statement result in a wholly delightful book.

(2) Prof. Saunders' survey also produces a very favourable impression. Without being superficial, or straining for effect, the author has succeeded in giving an account of the subject matter of physics covering a surprisingly wide field, the writing being accurate and restrained, but never lacking in interest. The scope of the book may be realised when it is mentioned that, to take only a few haphazard examples, the mass spectrograph and isotopes, quanta, the Raman and Compton effects, spectrum series, atmospheric electricity and cosmic rays, acoustics of buildings, solar radiation, and Bernouilli's principle are among the many matters dealt with.

The author does not lose sight of the essence of physics as a coherent and systematic body of thought; indeed, the distinction of his work lies in the way this is apparent, while at the same time up-to-date practical applications, theory, and research all find their place. The clear diagrams and well-chosen illustrations merit a word of commendation. It is a pleasure to find a book of this kind which, instead of being a heterogeneous compilation, either childish or incomprehensible, is such an admirable example of what this sort of thing should be.

(3) Profs. Franklin and Grantham have prepared an elementary treatise, most of the 694 pages of which are taken up with work of a standard nature, although more advanced and comparatively recent ideas are incorporated—unfortunately, not always too clearly. The volume is interspersed with short essays or paragraphs of a general character with titles such as "The Wisdom of Ignorance", "The Illusion of Activity", "Wave Mechanics", and "The Modern Idolatry", which do not appear to add materially to the value of the book.

Features worthy of mention are the liberal sprinkling of problems in connexion with the text, and the analogy of electrostatic with electromagnetic quantities and that existing between the latter and mechanical units. The book is primarily intended for American students; whether it has any particular value in Great Britain is doubtful.

(4) With the completion of the section on sound, Dr. Houstoun has been able to collect the various parts of his "Intermediate Physics" into one volume. The subject matter is presented in the direct, clear manner which one has learned to associate with the author, and a reliable, convenient textbook is thus made available.

Short Reviews.

A Brief History of Medicine in Massachusetts. By Dr. Henry R. Viets. Pp. xii + 194 + 8 plates. (Boston and New York: Houghton Mifflin Co., 1930.) 4 dollars.

THIS work, which is issued on the occasion of the tercentenary celebration of the settling of the Massachusetts Bay Colony and the one hundred and fiftieth anniversary of the founding of the Massachusetts Medical Society, is divided into seven chapters. The first is an introduction, in which a sketch is given of contemporary medicine in Europe in the sixteenth and seventeenth centuries. The second chapter deals with the colonial period dating from the landing of the pilgrims from England on Dec. 21, 1620, to the end of the seventeenth century, during which the bond between the clergy and the medical profession gradually became severed. In the third chapter, which is concerned with the eighteenth century to the American Revolution in 1775, the author shows that medicine in Massachusetts during that period was characterised by severe epidemics of small-pox, partially controlled by the introduction of inoculation in 1721, strict enforcement of quarantine in the fort of Boston, improvement in the tone of medical practice, the establishment of a medical society, the appearance of sporadic medical literature, and the divorce of medicine from the influence of the ministers.

In the fourth chapter, the effects of the American Revolution and the formation of the Massachusetts Medical Society and the Harvard Medical School are described. The fifth chapter is concerned with the early nineteenth century, during which Benjamin Waterhouse introduced vaccination into the United States, the Massachusetts General Hospital and *Boston Medical and Surgical Journal* were founded, Jacob Bigelow published his work on self-limited diseases, and Oliver Wendell Holmes his classical paper on puerperal fever. The sixth chapter is devoted to an account of the discovery in 1846 of ether anæsthesia by the dentist, W. T. G. Morton, described by Dr. Viets as the most important advance in medicine made in the United States. The last chapter contains a sketch of the contributions by Boston men to medicine and surgery from 1847 to the present day.

The work is illustrated by several portraits and a list of references is appended.

Environment and Plant Development. Being "Klima und Boden in ihrer Wirkung auf das Pflanzenleben". By Prof. Dr. Henrik Lundegårdh. Translated and edited from the second German edition by Eric Ashby. Pp. xii + 330 + 8 plates. (London: Edward Arnold and Co., 1931.) 24*s.* net.

THE keynote of this book is the author's invitation to the student to go out into the field and to study the living plant in its natural surroundings as well as the natural environment of the plant. He pays full tribute to investigations which have been conducted in the laboratory, but he carries laboratory research in plant physiology, with its many limitations, into the field, where the life processes of plants, though more difficult to study, can be investigated under entirely natural conditions. He emphasises that records obtained of a plant's behaviour at any given time or at stated intervals do not reveal the many fluctuations which the plant undergoes during the whole period of the day, for plant environments experience more widely different ranges and variations of climate than those recorded by the usual meteorological instruments.

Suggestive ideas, often based on isolated investigations and experiments, indicate to the field ecologist the many avenues of research still awaiting him. The interpretations suggested for many well-known phenomena will prove of considerable interest and value to the botanist, horticulturist, agriculturist, and forester, and illustrate the part that botany plays as a basic science for all these forms of study of plant life.

The last chapter, devoted to principles of experimental ecology, contains an interesting and suggestive "Survey of Adaptation Forms": a contribution to the classification of plants on ecological principles. The field botanist is left to develop this scheme and complete the 'key' to plant life in relation to ecological characters. The author closes with the remark, which by now will have been impressed upon his reader, that "the detailed ecological analysis of an association is, however, an extremely troublesome and tedious undertaking".

The translation has been rendered into simple language which enables the arguments to be followed readily by any student of botany.

Cancer and Scientific Research. By Dr. Barbara Holmes. (Sheldon Books of Popular Science.) Pp. 160. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1931.) 3*s*. 6*d*. net.

ACTIVE research into the cause of cancer is now running mainly along two lines. Laboratory workers are particularly concerned with the experimental production of cancer by tar and other similar irritating agents, and with the fowl tumours which may be transmitted from bird to bird by an ultramicroscopic agent. Statisticians and hygienists, on the other hand, are attentively and fruitfully examining the relation between modes and habits of life and the occurrence of malignant tumours. Particularly encouraging is the fact that these two methods of approach have in recent years converged to the common conclusion that much cancer is due to external influences rather than to any inherent vice in the body, and should therefore be preventable.

We do not know of any short semi-popular publication in which the important facts—and some of the theories—are set out so plainly as they are here, and with as good an instinct for grain rather than chaff. The common significance of the human and animal experience is well brought out. Dr. Holmes wisely confines herself to the causes of cancer, and scarcely mentions treatment. We can commend her book to biologists in general even more heartily than her father does in the preface.

A Brief Introduction to the Use of Beilstein's Handbuch der organischen Chemie. By Prof. Ernest Hamlin Huntress. Pp. viii + 35. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 5*s*. net.

THIS is an interesting booklet designed to help the young student in mastering the intricate system of classification used in the last edition of Beilstein's "Handbuch". A very comprehensive account of this is given at the beginning of vol. 1 of the "Handbuch"; but the system is naturally so complicated and difficult to understand that properly to assimilate it requires a better knowledge of German than most young students possess. Notwithstanding the excellent compendia that exist, Beilstein is still the best and most used source of information on organic compounds, and it is essential that anyone intending to specialise in organic chemistry should be able to find his way in it easily and rapidly.

The booklet under review gives a very concise, clear, and intelligible account of the system of classification of the alicyclic and homocyclic divisions, and concludes with a number of examples to illustrate the fundamental points involved.

The printing is good and is singularly free from typographical errors. Its sole disadvantage is the price, which is high for a 35-page booklet.

The Monadology of Leibniz: with an Introduction, Commentary and Supplementary Essays. By Dr. Herbert Wildon Carr. Pp. ix + 213. (London: The Favil Press, 1930.) 10*s*. net.

THE popularity of Leibniz in recent years gives an added interest to this new critical edition of the masterly epitome of the great philosopher's views. A running commentary accompanies each paragraph of Prof. Carr's translation, and illuminates the condensed thought of the "Monadology". The elucidations of Leibniz himself on the origin and meaning of the theory of monads, on the reform of the ontological argument, on the definition of matter, on the nature of free-will and the theory of pre-established harmony, together with Prof. Carr's supplementary essays on the monadology, are a useful help to the understanding of this work, which is but a small part of Leibniz's philosophy. T. G.

How You Work: an Introduction to the Human Body. By Dr. Isabel Wilson. Pp. xi + 178. (London: Gerald Howe, Ltd., 1930.) 3*s*. 6*d*. net.

THIS delightful little book is so attractively written and couched in such simple language that no child ought to be denied the opportunity of hearing, from teacher or parent, about the working of its little body. There can be no better exercise for the attainment of human understanding and happiness than that of starting to think biologically at an early age.

Helium and its Properties.*

By the Right Hon. LORD RUTHERFORD, O.M., F.R.S.

THE history of the discovery of helium presents some features of unusual dramatic interest. During an eclipse in 1868, Jansen and Lockyer noticed that the visual spectrum of the sun's chromosphere showed a bright yellow line of unknown origin. Later it was found that this line and others that accompanied it appeared not only in the sun, but also in many of the stars. Lockyer suggested that these lines were due to an undiscovered element, to which he gave the name helium.

Shortly after the discovery of argon, Sir Henry Miers sent a letter (Feb. 1, 1895) to Ramsay pointing out that the American analyst Hillebrande had observed that a considerable quantity of gas, supposed to be nitrogen, was liberated by solution of certain minerals containing uranium. Miers suggested that the gas might prove to be argon and not nitrogen. Following his suggestion, Ramsay purchased about a gram of the mineral cleveite from a dealer for three shillings and sixpence and proceeded to purify the gases evolved and to examine their spectra. A number of new lines were observed and a spectrum tube containing the new gas temporarily called crypton by Ramsay was sent to Sir William Crookes for a detailed study of its spectrum. Crookes reported tersely, "Crypton is Helium ; come and see it". Less than two months had elapsed from the receipt of Miers's letter to the announcement in the Paris Academy of Sciences, on March 26, 1895, of the discovery of helium on the earth—a discovery of profound significance to the development of physics. It was soon shown that helium is a monatomic gas of density about twice that of hydrogen and of atomic weight 4. We now know that it is the first of that remarkable group of inert monatomic gases, namely, helium, neon, argon, krypton, xenon, and the radioactive emanations, which have played such an important part in helping to fix the arrangements of the electrons in the outer atom.

In 1903, Ramsay and Soddy found that helium was produced by the transformation of radium, and, as a result of a series of researches, Rutherford showed that the α-particles which are ejected with great velocity from radioactive atoms are identical with helium nuclei. It is probable that the greater part, if not all, of the helium found in the earth and in the natural gases escaping from the earth owes its origin to the α-particles expelled from the radioactive elements during their transformation in the earth's crust.

It now seems clear that the helium nucleus of resultant charge 2 is remarkably stable and is in some way built up by the combination of four protons and two electrons. The loss of mass in this combination shows that a very large amount of energy, probably in the form of penetrating γ-rays, is emitted during the process. It can be calculated that the energy released in the formation of one pound of helium from hydrogen corresponds to the energy liberated in the complete combustion of 10,000 tons of coal. There can be no doubt that helium is formed from hydrogen under some, as yet unknown, conditions in the stellar system. However, it has not yet been found possible to produce helium from hydrogen under laboratory conditions. Millikan claims that the absorbable part of the cosmic rays must be attributed to the radiation emitted in the formation of helium in the depths of space.

The α-particle or helium nucleus has proved of great importance in extending our knowledge of the structure of nuclei, and it is now believed that the nuclei of the heavier elements are composed mainly of α-particles and electrons, although a few free protons may also be present. The bombardment of light elements by swift α-particles has given us the first definite proof of the transformation of some of the ordinary elements by artifical methods.

Helium is the most difficult of all gases to produce in liquid form. This was first accomplished by the late Prof. Kamerlingh Onnes in his laboratory at Leyden in 1908 by using liquid hydrogen as a cooling agent. Helium liquefies at a temperature of about 4° absolute, and is a clear colourless liquid of density about 0·15. In recent years, by using helium under pressure, Prof. Keesom, of Leyden, has succeeded in solidifying helium. By the evaporation of liquid helium at low pressure, temperatures so low as 1° absolute have been obtained.

Liquid helium thus provides a suitable method for the study of the effect of low temperatures on the properties of matter. One of the most striking observations is that certain metals become superconductors at such low temperatures and show little if any resistance to the passage of an electrical current. Several cryogenic laboratories have been instituted for the study of the effects of low temperatures on matter. Apart from the well-known and well-equipped laboratory at Leyden, Prof. J. C. McLennan liquefied helium in the University of Toronto in 1923, while in 1925 a similar department was instituted in the Reichsanstalt, Berlin. Researches in the properties of matter at the lowest possible temperatures have already added widely to our knowledge in a number of important directions.

Helium is present in our atmosphere in small quantity, about one part in 185,000 by volume. In the early days, most of the helium used for experimental purposes was obtained by heating radioactive minerals and particularly the mineral thorianite from Ceylon. It was also found that helium is often present in considerable quantity in the gases escaping from hot springs and the natural gases from the earth's crust.

In 1914, Sir Richard Threlfall suggested to the

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* Abstract of the Friday evening discourse delivered at the Royal Institution on March 27.

Board of Inventions of the Admiralty that, on account of its lightness and non-inflammability, helium might prove of great service for balloons and airships. Prof. J. C. McLennan was asked to initiate experiments to see whether helium could be separated in quantity from the natural gases escaping from the earth in certain districts of Canada which were known to contain about 1 per cent of helium by volume. Arrangements were made on a semi-commercial scale to purify the helium by liquefying the methane and other gases present. The impure helium was concentrated in the non-liquefying portion. In this way, many thousands of cubic feet of helium were prepared and transported in cylinders at high pressure. About the same time, the Bureau of Mines of the U.S.A. began similar experiments on a large scale, using the natural gases of Texas, which are rich in helium. Large quantities of helium were separated by liquefaction methods, and the cost of the helium was found to be sufficiently low to use it in airships in the place of hydrogen. Apart from the cost of transport, the expense of separation of helium decreases with the concentration of the helium in the natural gases. The commercial prospects of the use of helium in airships and other purposes have led to a search for rich concentrations of helium.

While most natural gases contain less than 1 per cent of helium, much richer mixtures have been recently found by boring. One source in Grand County, Utah, has a helium content of 7 per cent. Another was found in Colorado yielding as high as 8 per cent. The gas appears at a depth of about 950 feet in what is known as the Wingate sand. The Helium Company has erected a plant at Thatcher, Colorado, for purification of the helium obtained from this source. Analysis shows that the gas contains 15 per cent carbon dioxide, 8 per cent helium, 1·75 per cent methane, and the rest nitrogen. The plant installed has a capacity of about 600,000 cubic feet of the gas per day, corresponding to a possible annual production of 12 million cubic feet of helium. With such a rich helium mixture, the cost of separation should be much less than in the plants treating the natural gases of much lower helium content.

It is possible that similar rich concentrations may be found on the eastern slopes of the Rocky Mountains in Canada. A small gas field was found a few years ago not far from Toronto which had a content of 0·8 per cent helium. The rights of those wells have been secured for the University of Toronto in order to have an ample supply of helium for cryogenic experiments in the laboratories.

At the time of its discovery, helium was considered to be a rare gas and a litre of helium was a precious possession. The helium originally employed by Kamerlingh Onnes for the liquefaction of helium was painfully obtained by heating radioactive minerals. This is in striking contrast to the position to-day, when the annual production of helium is measured by millions of cubic feet, and where sufficient quantity will be available at a comparatively low cost for filling several large airships now in course of construction.

A. M. Liapounov, 1857–1918.

By A. J. PRESSLAND.

FROM time to time, French versions of the writings of A. M. Liapounov have become available to the scientific public; but the obituary notice in the *Proceedings* of the Academy of Sciences in Leningrad (1919, p. 367, by Stekloff), and other papers, are in Russian. Quite recently the Academy has published two brochures, one a biography and the other a general survey of Liapounov's work on Chebichev's problem, and the following is a digest of this material.

A. M. Liapounov, the eldest son of M. V. Liapounov and a grandson of V. A. Liapounov, registrar of the University of Kazan, was born on May 25, 1857. Six of his immediate kinsmen attained to academic eminence. His father, an astronomer of repute, died in 1868, leaving a young family. So the boy was brought up for a time by a married aunt, in whose house he increased his acquaintance with people of intellectual distinction. In 1870 he entered the third class of the gymnasium of Nishni-Novgorod, where he was taught Latin, Greek, and elementary science. He read widely, Buckle, Draper, Humboldt, Réclus, and Karl Ritter being his favourite authors, and he developed a love for exact science. The national idealism that was then popular did not appeal to him, but he was attracted by the study of economics and the theory of the struggle for existence.

In 1876 Liapounov passed out of the gymnasium with the highest distinction and matriculated at St. Petersburg, where at first he attended the lectures of Mendeléeff, which he soon forsook for those of Chebichev. To the latter is due the inspiration of Liapounov's researches. Chebichev laid stress on *Anschauung* and *Realien*, holding that research work was valuable only when it lent itself to application, and theory useful only when it emerged from a consideration of particular cases.

Chebichev directed Liapounov to the problem of determining the free surface of a liquid gravitational mass that was rotating about an axis. He had already proposed the problem to prominent students such as Zolotarev and Sophia Kovalevskaya, but no one of them seems to have made noteworthy progress. The problem has a long history. Newton noted that an ellipsoid of revolution can be a surface of equilibrium, but Maclaurin was the first to give it serious consideration; on this account an ellipsoid of revolution which is a form of equilibrium is called an ellipsoid of Maclaurin. D'Alembert showed that for every angular velocity less than a given limit there were two Maclaurin ellipsoids, each compressed in the direction of the axis of rotation. Laplace showed that, as the moment of angular momentum increased, the smallest axis of the ellipsoid decreased until the angular velocity reached its maximum, after which the angular velocity decreased to zero and the ellipsoid flattened out, becoming ultimately a thin disc of infinitely large radius. Hence for each value of the angular velocity there will be two Maclaurin ellipsoids, and Lagrange was of the opinion that these were the only two possible ellipsoids of equilibrium. But Jacobi proved that the ellipsoid with three unequal axes was also a possible form.

Jacobi's solution was examined by Meyer and Liouville. The latter showed that in certain cases a long thin ellipsoidal spindle might be obtained, the largest axis of which increased without limit and the other two approached zero in magnitude and unity in ratio. So it can be proved that, within certain limits of the value of the angular velocity, there may be three ellipsoids of equilibrium—two of Maclaurin and one of Jacobi; within other limits, two only each of Maclaurin, and the latter may coincide giving one only, of Maclaurin.

Chebichev told Liapounov that easy but novel problems which could be solved by well-known methods were of no value in testing the powers of a young research student. Such a student required something that presented obvious difficulties. So the problem was enunciated thus: "It is known that for certain values of the angular velocity the ellipsoidal form no longer serves as a surface of equilibrium for rotating homogeneous liquids. Does it change into some new form of equilibrium which, for small increments of angular velocity, differs but little from an ellipsoid?"

Domestic misfortune interrupted Liapounov's university career; but he won a university prize, and after graduation chose as the subject of his M.A. dissertation "Some Particular Aspects of Chebichev's Problem", which he defended before a board of which Bobilev and Korken were members. In 1885 he was recognised as a *privat-dozent* and was preparing to lecture on the theory of potential when he received a call to the chair of mathematics at Kharkov. His new duties, which were increased by work at the local technical institute, were so strenuous that he had to defer the presentation of his dissertation for the doctorate, for five years. The subject was "Some General Aspects of Chebichev's Problem". These two dissertations were translated into French and published by Davaux in 1904, 1908.[1]

In 1901 Liapounov was elected a member of the Academy of Sciences at St. Petersburg and thus secured the leisure and the freedom from financial cares that enabled him to resume his work on the problem. He soon discovered that to the first approximation there were no new forms and that a second approximation was hard to obtain. In his M.A. dissertation he had discussed the stability of the ellipsoids of Maclaurin and Jacobi and had found that when Maclaurin's became unstable they changed into those of Jacobi, and that the latter when they became unstable appeared to change into a new figure having algebraic surfaces of the third degree (Poincaré's pear-shaped figure).

Within a year of the publication of the M.A. thesis Poincaré mentioned in *Comptes rendus* that he had been in correspondence with Lord Kelvin on the subject. Lord Kelvin had arrived at results but had given no proofs. Poincaré reached the same results as Liapounov but by less stringent methods, and Poincaré assumed that the figures sought really existed. In answer to Liapounov's inquiry, Poincaré replied that he had not proceeded beyond the first approximation and that the methods of successive approximations did not provide a proof of the existence of the figures, since the difficulty of finding a second approximation was insurmountable. His assertion, that the figures sought existed, seemed to Liapounov to be based on intuition, and when Poincaré's memoir appeared in *Acta Mathematica*, Liapounov was dissatisfied with it.

When Liapounov, twenty years later, resumed consideration of the problem, he soon found where the difficulty of the second approximation lay. Poincaré and Liapounov, when seeking the new figure that differed but little from the given ellipsoid, had compared it with the given ellipsoid. Liapounov now overcame the difficulty by introducing an ellipsoid confocal with the given one and passing through that point of the surface sought at which the potential of the attracting liquid is under consideration. By this means Liapounov easily obtained approximations to any given order and was able to prove the series convergent. Thus Liapounov was able to give a rigorous proof of the existence of those forms of equilibrium already known and to show that there were no intermediate forms.

There are other special solutions of the general problem. Poincaré and Sophia Kovalevskaya have treated an annular form such that the section of it made by a plane through the axis of rotation is approximately an ellipse. There are also cylindrical forms of equilibrium which provide material for mathematical problems. Liapounov directed attention to the case of two liquid masses separated from one another and each rotating round an axis, which passes through the common centre of gravity and is perpendicular to the line joining the centres of gravity of the two separate masses, and found that when they were sufficiently far apart their surfaces of equilibrium differed but little from ellipsoids; and he proved that for homogeneous liquid the pear-shaped figure is unstable.

This result is at variance with the results obtained by Poincaré and Darwin, each of whom found difficulty in obtaining a second approximation. Poincaré found one by a special process which yielded no further approximations. Darwin adopted the result, which supported his theory of cosmogony. Liapounov, however, declared that Poincaré's methods were not rigorous, since they were based on approximate formulæ, whereas his own were obtained by exact formulæ.

The stumbling-block had been an expansion of the potential due to Lagrange and Laplace. No proof had been given that this expansion was admissible. Liapounov replaced it by a new expansion having a smaller parameter, established the admissibility of the new expansion, applied the methods of successive approximations, showed how to find these approximations to any required order, proved that his approximations were convergent, and generalised his investigations.

Liapounov's papers on Chebichev's problem are contained in four volumes published between 1906 and 1914, written in French and extending to 768 folio pages. It is understood that Liapounov left a large amount of manuscript which will be published when circumstances permit. This remark applies also to the papers of Leonard Euler. In 1902, the Academy of Sciences proposed to mark the bicentenary of the birth of Euler (1907) by the issue of a complete edition of his works. A committee consisting of A. A. Markov, B. B. Galitzin, and A. M. Liapounov was appointed to deal with the matter. It is possible that the latter has left papers dealing with the subject.

It is painful to describe the last days of Liapounov. Russia was involved in political and social turmoil, and it was at one time feared that Liapounov might suffer like Lavoisier. This fear happily was unfounded. His wife was attacked by tuberculosis and he was threatened with cataract. They went to Odessa in search of health, and there his wife died. A few days later, on Nov. 3, 1918, he died in Leningrad as the result of a voluntary act.

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[1] Ann. T(oulouse), 2 ser. t. 6; 1904. Ann. T., 2 ser. t. 9; 1908.

Two Historic Electric Power Stations.

AT an ordinary general meeting of the Newcomen Society held in London on April 15, and at the seventh annual meeting of the American members held in New York on April 16, two papers were presented dealing with two historic electric power houses. One of the papers was by Mr. G. A. Orrok and dealt with the Pearl Street station in New York, the first central station in the world; the other was by Col. R. E. B. Crompton and gave a history of the first installation of house-to-house electric supply in England, the power house of which was described as "the parent generating station of Great Britain". It was the invention of the incandescent light, the perfecting of the dynamo, and the invention of the multiple arc system, with its corollary in the feeder system and three-wire system, which brought the central station into being as a means of furnishing a means of transmitting light, heat, and power in any amount and to such distances as might be required. In the early 'eighties, many private installations of electric lighting plant were laid down, and generating plant was supplied to individual buildings and ships, but the two stations referred to at the meeting of the Newcomen Society were the first stations in the United States and England respectively to supply electric current to customers in the same way that gas and water had been supplied.

The Pearl Street station was due to the genius of Edison, from whose note-books of 1878 and 1879 can be gathered some of his earliest ideas on electric power generation and distribution. The Edison Electric Light Co., the parent company of all the Edison companies, was incorporated early in 1880, and the Edison Electric Illuminating Co. of New York, the local company, held its first meeting on Dec. 20, 1880.

To the latter belongs the credit of erecting the Pearl Street station, which began operations on Sept. 4, 1882, and by the end of 1883 had 455 customers and more than 11,000 lamps installed. The original plant consisted of four Babcock and Wilcox boilers of 200 h.p. each, supplying steam at 120 lb. pressure to Porter-Allen high-speed engines of 125 h.p. each, directly coupled to the famous 'Jumbo' dynamos. As the station was half a mile from the river, it was a non-condensing station and the coal consumption at first was about 10 lb. per kw. hour. A serious fire on Jan. 7, 1890, interfered with its operation for a time, and five years later this pioneer station was closed down and the property disposed of.

Many interesting particulars of the electrical equipment of the station were given by Mr. Orrok. From the dynamo brushes the current was led by round copper bars to spring-controlled switches, the design of which was taken from the short-circuiting switch under the telegraph key. The station bus bars were fixed to wooden insulators bolted to the walls. There were neither voltmeters nor ammeters, as such things had not been invented.

Crude as many of the devices were, they met the situation and enabled central station companies to do business. Referring especially to Edison's chemical meter, in which each unit of current invariably removed a definite amount of zinc from one metal plate to another, Dr. Orrok said: "Was there ever a more beautiful combination of parts—each dependent on a simple physical or chemical law—than was presented in this ingenious commercial device for translating first the lamp-hour, then the ampere-hour, and finally the kilowatt-hour values into dollars and cents? . . . It is no exaggeration to say that no single device in the whole system did more to lay the solid foundation for the commercial and financial success of the Edison stations from the first than the chemical meter."

The first central station in Great Britain, dealt with in Col. R. E. B. Crompton's paper, was situated in Kensington and was erected by the Kensington Court Company, afterwards the Kensington and Knightsbridge Company, started by Col. Crompton to supply electricity to the houses they erected on a site which had been cleared by the company promoter, Baron Grant, but which had passed into the hands of the Land Securities Company.

In the generating station were installed two

Babcock and Wilcox boilers, supplying steam to seven generating sets. The dynamos were coupled directly to Willans central-valve high-speed engines. Three sets were designed to give 500 amp. at 100 volts and four sets 500 amp. at 200 volts. Vibration troubles were avoided by fixing the sets to massive concrete foundations kept clear of the buildings.

Meters were rented to customers and the current was distributed by bare copper strip conductors fixed to porcelain insulators in subways in the streets. To ensure continuity of supply, a large battery of accumulators was installed. Current was supplied to a certain number of houses in 1886, by 1887 the company was making a profit, and later on another station was erected at Chapel Place, Knightsbridge. As the demand increased, a still larger plant was built at Wood Lane, Shepherd's Bush. This was put into operation in 1901, and soon afterwards the original steam plants in Kensington and Knightsbridge were shut down.

Obituary.

MAJOR T. F. CHIPP.

IN writing an account of the life and labours of those who truly may be said "to have finished their course", after having enjoyed the allotted span and seen the fruit of their work, there is, despite the sadness, an element of satisfaction and the fitness of things. But in the case of one of much promise, suddenly removed in the prime of life and with every prospect of a distinguished and useful career in the future, feelings of grief and sadness predominate and render the task of writing any adequate tribute both painful and difficult.

The tragically sudden death of Major Thomas Ford Chipp, assistant director, Royal Botanic Gardens, Kew, is such a case. Born on Jan. 1, 1886, he died on Sunday evening, June 28, at 9 P.M., shortly after returning to his house. Chipp was thus in the prime of life, tall, strong, vigorous, always happy and cheerful, filled with enthusiasm for his work, and deeply interested in the many duties which fall to the lot of Kew's assistant director. Through his varied colonial and War experiences he had gained a wide knowledge of men and affairs, and in addition he was a man of sound judgment and commendable tact; he was endowed with a very pleasant personality, which, during his nearly nine years' service at Kew as assistant director, had endeared him not only to his scientific colleagues but also to all the student gardeners and the whole of the Kew staff. In the larger botanical world both at home and abroad he was highly esteemed, and this was clear at the International Botanical Congress held last year at Cambridge, and is also borne out by the many letters which have reached Kew. The untimely death of a man of his calibre and powers, when men of this type are all too rare, is a greater loss than Kew has ever before been called upon to bear. His death will be equally a very severe loss to the botanical work of the Empire centred at Kew.

Chipp was the son of Edward Thomas Chipp, chief constable of Gloucester. He received his early education at the Royal Masonic School, Bushey, and there he quickly developed his taste for natural history and served as secretary to the school natural history society. This inclination towards science led him to look to horticulture for a career, and, after a period of service in the gardens of Syon House, he entered Kew in 1906 as a student gardener. After a few months in this capacity, he was selected, owing to his marked ability, for one of the temporary technical assistant posts in the herbarium, where he remained until 1908. During this period he prepared himself, in his spare time and with very limited means, for the B.Sc. examination, University of London, which he passed in 1909 with honours in botany. He then received an appointment as demonstrator in botany at Birkbeck College, and in 1910 was appointed an assistant conservator of forests in the Gold Coast. Before proceeding to West Africa, he spent a year studying forestry in Germany and the Federated Malay States.

In 1914, Chipp was appointed assistant director of the Botanic Gardens at Singapore, but the War starting while he was in England *en route* for the Straits Settlements, he at once sought permission to rejoin his territorial regiment, the 8th Middlesex, in which he had held the rank of captain. With his regiment he proceeded to Gibraltar and afterwards to France, where he served continuously until 1919, being ultimately attached to the staff with the rank of major, and was awarded the Military Cross. In 1919 he went to Singapore to take up the post of assistant director to which he had been appointed five years earlier.

Chipp's good work while assistant conservator of forests in the Gold Coast had been duly noted, and in 1921 he accepted the invitation from the Gold Coast to be deputy conservator of forests in the colony. His career both at home and in the colonial service had naturally also been closely followed at Kew with interest and appreciation, and on the retirement of Sir David Prain in 1922 and the promotion of the present director, Major Chipp was invited to occupy the vacant post of assistant director of the Royal Botanic Gardens, Kew, and assumed office on Aug. 1, 1922.

Chipp was never idle, and his first scientific contribution of importance, "A Revision of the Genus *Codonopsis*", was made to the Linnean Society of London in March 1908. His university studies and forestry training during the next few years prevented him from carrying out any original work of importance, but on reaching the Gold Coast he soon produced the very useful "List of Trees, Shrubs and Climbers of the Gold Coast, Ashanti and the Northern Territories", in 1913, and a similar "List of the Herbaceous Plants and Under Shrubs" in the following year. Shortly after his return to the Gold Coast, in 1921, he published a "Forest Officers' Handbook of the Gold Coast, etc." (1922), which won him the London degree of Ph.D. The War period naturally precluded any possibility of scientific activities, but it is characteristic of Chipp's unbounded energy that, directly he took up his duties at Singapore, he set to work and contributed many articles to the *Gardens Bulletin* of the Straits Settlements; among the more important of these are his papers on "The Fungi of the Malay Peninsula".

When he became assistant director at Kew, in 1922, Chipp used any spare moments for carrying on the researches he had initiated during his second period of service in West Africa, and published some useful papers in the *Kew Bulletin*. He became a recognised authority on vegetation studies, and was honorary secretary of the British Empire Vegetation Committee. In this connexion he edited, with Prof. A. G. Tansley, the very valuable book, "Aims and Methods in the Study of Vegetation" (1926), which is recognised as the leading book on the subject. To this book he contributed the chapter relating to the tropical countries. As honorary secretary of this Committee, he devoted much labour to reading, digesting, and reviewing numerous publications relating to the vegetation and ecology of the Empire. His more recent book, "The Gold Coast Forest: a Study in Synecology", published in 1927, is a valuable contribution on original lines. This work formed his thesis for the degree of D.Sc.

At the beginning of 1919, Chipp was sent to Cyprus and the Sudan by the director of Kew, on the invitation of the respective Governments, and the reports on his visits were of great value and highly appreciated. While in the Sudan, he was able to ascend the scarcely known Imatong Mountains, on the Uganda border, making a careful study of the flora and bringing home large collections. An account of the botany of the region was published in the *Kew Bulletin* in 1929, and a more general account of his tour, entitled "Forests and Plants of the Anglo-Egyptian Sudan", appeared in the *Geographical Journal* for February 1930.

Chipp was co-secretary, with Mr. F. T. Brooks, of the Fifth International Botanical Congress, held at Cambridge last year. The organisation of this large Congress and the subsequent editing of the various reports entailed a vast amount of labour for the secretaries, and the perfection of the arrangements, and the smoothness with which the heavy programme was carried through, showed again the care and thoroughness which appeared in all Chipp's work. The preparation and publication of a new International Address-book of Botanists, decided upon by the Congress, was entrusted to an international committee consisting of Major Chipp, Prof. Diels of Berlin, and Dr. Merrill of New York. A great deal of the work of collecting information, and all the labour of final collation and the arrangements for publication, had been almost completed by Chipp with his usual ability just before his death, and the work is now in the printer's hands.

Early last year, after attending the French Government celebrations in Algeria, Chipp was invited to accompany Mrs. MacIver's expedition into the Central Sahara, and made a careful study of the vegetation; his account of the scientific work of the expedition will be found in the August number of the *Geographical Journal*.

Chipp by his extensive travels in northern and western Africa had thus become one of the recognised authorities on the botany of this extensive region. His last paper, "The Vegetation of Northern Tropical Africa", which is about to be published in the *Scottish Geographical Magazine*, was delivered in the form of lectures given in March last at Edinburgh, Dundee, Aberdeen, and Glasgow. His untimely death is thus not only a great loss to Kew but also to botany. He was indeed a man whose like it will not be easy to find.

A. W. H.

BARON KITASATO, FOR.MEM.R.S.

BY the death of Prof. Kitasato on June 14, Japan has lost its foremost bacteriologist and the medical world one of its most successful workers.

Kitasato made several discoveries of first-rate importance. In 1889 he cultivated, for the first time in a pure state, the bacillus of tetanus, and clearly demonstrated the pathology of the disease, lockjaw, to which it gives rise. In 1890, Kitasato, conjointly with Emil Behring, made the great discovery of antitoxin in the blood of animals immunised against tetanus toxin, and thus laid the basis of serumtherapy. In 1894, Kitasato discovered, isolated, and cultured, for the first time, the bacillus of plague, and in a very exact manner and in an incredibly short time worked out the chief features of this organism so completely as to leave little for his successors to do on the pure bacteriology of plague. Kitasato published many other researches in German and Japanese. In all of his works available to readers of European languages he had always something fresh, and his results, obtained by exact methods, well recorded, have stood the test of time.

Shibasaburo Kitasato was born in December 1852 in the Kumamoto præfecture on the island of Kiushiu. He died in his seventy-ninth year. He studied medicine at Tokyo and graduated there in 1883. He was early a man of promise and (1885) was sent by the Japanese Government to Europe to study bacteriology and epidemiology. He settled at Berlin in the Hygienisches Institut under Robert Koch, then in the zenith of his powers. Kitasato remained six years with Koch. He was a man of exceeding diligence and worked in a room by himself all day and every day. He soon made himself master of the very exact bacteriological technique elaborated by Koch, and he owed a good deal of his subsequent bacteriological successes to his training in Berlin. During the German period of his life, Kitasato published a long series of bacteriological researches. They were almost uniformly good and some were brilliant. Kitasato set himself problems, performed the necessary, often laborious, experiments for their solution, made the correct inferences, and set out his results in model form for others to study and repeat. There was nothing 'woolly' about his work.

On his return to Japan in 1891, he founded a private bacteriological institute in 1892, and a year later it was subsidised by the Government of Japan. From 1899 until 1914 this great bacteriological institute—the Imperial Japanese Institute for Infectious Diseases—was directed by Kitasato with skill and success. Many of his pupils have attained a wide reputation in Europe.

For his valuable services to his country, Prof. Kitasato was chosen a member of the Japanese House of Peers in 1916, and was raised to the peerage with the title of Baron in 1923.

The impression he made was one of great dignity and seriousness, but he talked freely in German on bacteriological subjects. His knowledge of English was negligible.

Kitasato has created for himself by his high-class scientific work an enduring name not only in Japanese medicine but also over the whole world. He was admitted a foreign member of the Royal Society in 1908.

W. B.

WE regret to announce the following deaths :

Lieut.-Col. Sir Charles Bedford, formerly director of the Central Excise Laboratory for India, known for his work on the manufacture and excise control of alcohol in India, on July 8, aged sixty-five years.

Dr. E. G. Echeson, known for his work in electrometallurgy and chemistry, formerly assistant to Edison, on July 6, aged seventy-five years.

Prof. C. H. Kauffman, emeritus professor of botany and emeritus director of the herbarium of the University of Michigan, on June 14, aged sixty-two years.

News and Views.

ON July 25 occurs the centenary of the death of the astronomer, Fearon Fallows, the first director of the observatory founded at the Cape of Good Hope through the action of the Commissioners of Longitude. Born in July 1789, at Cockermouth, Cumberland, the birthplace of Dalton, Fallows was brought up to his father's trade of weaving, but by study and the assistance of a clergyman was able to become a school teacher and then to proceed to Cambridge. Entering St. John's College, he graduated as third Wrangler in 1813, Sir John Herschel being Senior Wrangler, and became mathematical lecturer at Corpus Christi College. On Oct. 20, 1820, he was chosen director of the proposed observatory at the Cape, and to him fell the lot of choosing the site and of installing the first instruments. Immediately on arrival in 1821, with small instruments made by Dollond and Ramsden, he began observations of the principal southern stars, the results of which are contained in his catalogue of 273 stars contributed to the Royal Society in 1824. Later on, he published an account of a series of pendulum experiments. His work was done with but little assistance and in discouraging circumstances. He himself suffered from the effects of sunstroke, and his death at the early age of forty-two years was brought about through scarlatina and dropsy. He died at the naval base, Simons Town, but his grave, marked by a slab of black Robben Island stone, is near the observatory. He left some four thousand observations, which were afterwards reduced by Airy. His successors at the Cape have included Henderson, Maclear, Stone, and Sir David Gill.

ON July 17, in the Public Library of Kingston-on-Thames, a portrait memorial tablet was unveiled to commemorate the work of Eadweard Muybridge, one of the pioneers of modern cinematography. Born at Kingston-on-Thames in 1830, Muybridge emigrated to America, and, joining the staff of the United States Coast and Geodetic Survey, he rose to be director of the photographic surveys. About 1872, a discussion arose among some horse-lovers at the Sacramento racecourse, California, as to whether a horse ever had all four feet off the ground at once. A wager having been made, Muybridge was asked to settle the point with the aid of the camera. Placing on one side of the track a long white screen and on the other twenty-four cameras, he stretched threads across the track which were broken by the horse and released the camera shutters. The results were conclusive and showed that a galloping horse did, at times, have all four feet off the ground. Muybridge's interest was stimulated by this work and he carried on his investigations, publishing a book, "The Horse in Motion", and inventing apparatus for projecting pictures at rates between 12 and 32 pictures a second. In 1880 he invented his zoopraxiscope; in 1881, in Paris, where he met Marey, he also produced moving pictures, and the following year he lectured on the subject at the Royal Institution. He died twenty-seven years ago, bequeathing his zoopraxiscope and lantern slides to Kingston Museum.

AT the ninety-ninth annual meeting of the British Medical Association held at Eastbourne on July 17–25, the president, Dr. W. G. Willoughby, Medical Officer of Health of the town, took as the subject of his address, "Public Health—To-day and To-morrow". Respecting to-day, the situation is not altogether satisfactory, for the Registrar-General's returns for England and Wales demonstrate that there are still far too many deaths at early ages; and that, though the vitality of the nation has steadily improved, the expectation of life is still only fifty-five years for males and fifty-nine years for females. Coincidently with the 40,000 annual deaths of children who escape the risks of infancy, there must be a large amount of sickness among the survivors, causing much indifferent health and permanent physical defects. That this is so is confirmed by the reports of national health insurance and by the wholesale rejections of would-be recruits for the fighting services. In the outlook for the future, owing to the reduction in the birth and death rates, we now have to deal with a population increasingly older than in the past; and as the population becomes older the prospect of a further reduction in the death rate become less, so that if the present course of birth reduction continues, the excess of births over deaths will disappear.

UNFORTUNATELY, as Dr. Willoughby pointed out, there is a greater proportionate reduction in the number of births among the better types of the race than among the less satisfactory, resulting in a mental and physical disadvantage to the race as a whole. The proportion of mental defectives in the population has increased from about four to eight per 1000 in twenty-five years. Birth control is at its minimum among these people, who seem especially fertile. In a minor way, accidents and perilous occupations exact an increasing toll from the nation. There never was a time when so much was expected from the State without individual effort, and lack of such effort and want of employment tend to the acquiring of habits that are not conducive to health. Fortunately, some of the changes that are occurring are favourable to the health of the population, such as improved education. In the later portion of his address, Dr. Willoughby dealt with the relation of the medical profession to the public health, to post-graduate medical study and research, and to the auxiliary medical services.

A COMMUNICATION from Sir Aurel Stein in the *Times* of July 16 gives the first detailed account of the events which led up to the abandonment of his expedition of archæological and geographical exploration in Chinese Turkestan. Every effort had been made to conciliate the Chinese authorities. A memorandum describing the object and scope of the expedition was submitted and fully explained to the Ministry of Foreign Affairs when application was made for a permit; the wish was expressed that a Chinese scholar and topographer should accompany the party, and an undertaking was given that no object of archæological interest would be removed from the country without the previous consent of the Chinese Government. It is obvious that from the very outset a determined effort was made at every possible point to delay the expedition, in order that no work could be undertaken during the coming winter, the only season when archæological exploration is possible in the desert. The party was halted on the frontier of Hsin Chiang while permission to enter the province was obtained, although this had already been granted. This was only the first of a series of difficulties and delays, and in the end it was not until mid-November, some weeks late, that the expedition was allowed to leave Kashgar for Khotan. Even so, Sir Aurel was met at Keriya with the announcement that no digging was permitted, though this had been specifically sanctioned before he left Kashgar. Notwithstanding these obstructions, by the end of April the Tarim basin had been completely circumambulated and much valuable information acquired. At this point the request for a detailed memorandum of the objects of the expedition proved the last straw. As there seemed no prospect of any cessation of vexatious obstruction, Sir Aurel Stein returned to Kashmir.

AN extraordinary meeting of the Institut International d'Anthropologie will be held in Paris on Sept. 20–27 in connexion with the Colonial Exhibition under the honorary presidency of M. Paul Doumer, President of the Republic, and Marshall Lyautey. This special meeting is to be regarded as the fifth Assemblée Générale of the Institut and the fifteenth Congrès International d'Anthropologie et Archéologie prehistorique. The Congress, in accordance with previous practice, will meet in five sections, under presidents as follows: morphological anthropology and study of races (Drs. Vallois and MacAuliffe); human palæontology and archæology (M. le Comte Begouen); eugenics and heredity (Dr. Vignes); psychosociology and criminology (Drs. Papillaut and Paul Boncour); ethnography, folklore, and human geography (M. Louis Marin). Special attention will be directed to topics relating to the French colonies, and in particular to extra-European archæology, a subject which the promoters of the Congress point out is becoming of increasing importance in the archæological field. Reports on problems in this province will be presented from MM. Reygasse, Joleaud, Patte, Laforgue, Benoit, Begouen, Père Koehler and others. Visits to museums, collections, and other places of interest to members of the congress are being arranged. Applications for membership should be addressed to the Secretariat of the Institut International d'Anthropologie, 15 rue de l'Ecole de Médecine, Paris, from which further details may be obtained.

A RECENT communication to the Société Préhistorique Française by Mr. Ludovic MacLellan Mann, in the fourth part of the Society's *Bulletin* for the current year, deals with his discovery of an apparently unique site and a new culture of pre-Chellean age in the gravels of Stanstead, Upper Caterham, Surrey. Systematic excavation in the summer of 1930 brought to light what is claimed to be evidence of human occupation and a flint factory at a depth of 7 metres beneath strata of alluvium, sand, and gravels which are absolutely sterile. Mr. Mann has found material which he regards as a series of implements, finished and unfinished, two hearths, and animal bones. The pressure of the immense mass of superincumbent material and moisture have rendered the flint extremely fragile, and some implements, in addition to artificial fracture, show subsequent natural fracture due to pressure. The number of unfinished implements far exceeds that of the finished, and the small implements are more numerous than the large. The unfinished large implements, which show every stage of manufacture and exhibit what is apparently a new technique, have certain characteristic forms, of which that with a horseshoe cutting-edge is the most typical. The small implements have a wide variation in form, some of them resembling those of the last phase of the stone age. Mr. Mann admits that the implements are difficult to find and identify; nevertheless, he claims that here is unquestionably a workshop site of a new pre-Chellean culture (for which he suggests the name "Stansteadian") of late Pliocene or early Pleistocene date.

THE B.C.G. ('Bacille Calmette-Guérin') vaccine is a culture of a bovine strain of the tubercle bacillus which by cultivation for a number of generations upon a glycerine-bile medium has become non-virulent and is tolerated by bovines. Animals treated with this vaccine become relatively insusceptible to tuberculosis, and vaccination of human beings is now being attempted. Numbers of children have been vaccinated in France, and according to Calmette the incidence of tuberculosis among them is much less than among non-vaccinated children in similar environments. Experiments by Calmette and Wilbert at the Pasteur Institute, French Guinea, upon chimpanzees and monkeys, showed that of vaccinated and control animals kept with infected monkeys, none of the vaccinated and all of the controls became tuberculous. A. Stanley Griffith has carried out a further series of experiments on the protective power of B.C.G. vaccine against tuberculosis in monkeys (Med. Research Council: *Spec. Rep. Series*, No. 152. H.M. Stationery Office, 9*d.* net). His conclusions are that the strain of B.C.G. vaccine used in these experiments can produce local tuberculous lesions in the rhesus monkey, but these are always benign and do not lead to generalisation. Vaccination with it, however, whether by feeding or by injection, has failed to afford the complete protection to monkeys claimed by Wilbert, but may in some instances have produced a low grade of relative immunity. Full details are given of the experiments performed and of the results obtained.

THE ninth International Dairy Congress was held in Copenhagen on July 13–17. The Congress was attended by more than 1600 delegates, of whom 800 came from Denmark, 200 from the other Scandinavian countries, and the remainder from other parts of Europe, the United States, and other parts of the world. About 200 representatives of various agricultural, dairying, manufacturing, and scientific interests attended from Great Britain and Ireland and the Dominions. More than thirty governments sent official representatives. The Congress was officially opened on the afternoon of July 13 by the president, Mr. S. Overgaard, in the presence of His Majesty King Christian X. In the evening the Congress was entertained by the Mayor of Copenhagen in the world-famous Town Hall. The four mornings of the Congress were devoted to sectional discussions of papers covering an extremely wide range of dairying interests: public health legislation and administration, bacteriology, animal husbandry, genetics, biochemistry, dairy machinery, and other interests were all thoroughly represented. The afternoons were devoted to a series of tours to points of interest within a radius of about fifty miles from Copenhagen. These included experimental farms and dairies, bacon factories, typical Danish agricultural units, milk distributing centres, as well as a number of places of less technical interest. A National Dairy Exhibition was also held at the Forum during the Congress week.

HISTORICALLY, perhaps the most important happening at this particular Congress was the formation of a special branch of tropical dairying within the dairy federation. The slow but steady increase of tropical dairying has brought with it its own problems, and congresses like the one just held, even were they to serve no other purpose, would be invaluable in affording opportunities for the discussion of such special problems and for the creation of the machinery necessary to secure the permanent interchange of experience and views about them. The next International Dairy Congress is to be held in 1934 in Berlin, and an invitation was extended by His Excellency Baron G. Acerbo dell' Aterno, the Italian Minister of Agriculture, for the 1937 Congress to take place in Italy.

THE Empire Forestry Association, founded in 1921, has recently issued a small brochure entitled "Forests, an Imperial Treasure", which briefly puts the case of the importance at the present day of the forests of the Empire and their proper development; a personal appeal is also made for more funds, in the shape of additional subscriptions to the membership of the Association. At first sight, the value and the possibilities of propaganda and active assistance to the cause of forestry in all its branches open to such an Association would appear to be of the first magnitude. In some Continental countries the membership of similar associations comprises professional forest officers, private owners of forests, timber merchants, and representatives of many other important industries the raw products of which come from the forest. The trouble in the British Empire has been, and still is, that our people, from cabinet minister downwards, do not possess that instinctive recognition of the value of the forest to the countryside and the benefits, direct and indirect, which the possession of areas of well-managed forests confer upon a country and its people. The brochure of the Empire Forestry Association rightly recognises the enormous potential value of existing Empire forests, a value which, in the opinion of many, has become greatly enhanced as a result of the War. In spite of all substitutes, timber still remains of prime importance. The brochure states, "Timber cannot be immediately produced. . . . It is a question of years—of slow, steady growth, and careful tending from sapling to the forest giant", and the same remains true for the controlling forest staff. It takes time to secure a fully trained and organised forest staff with a graduated service of from 1 to (say) 30 or 35 years. Irregularities in recruiting, cutting down in hard times, and over-recruiting in periods when revenue is abundant, may be a sound policy in the spending departments. But when applied to a forest department, it spells disorganisation both in administration and, more important, out in the forests, where the loss in potential forest revenue is accumulative. The brochure does not make specific mention of this aspect, the foundation of all successful forest management.

THE introduction in 1869 of a number of egg clusters of the gipsy moth into the United States led to no serious consequences until twenty years later. In 1889 the larvæ of this insect caused severe defoliation of trees in the neighbourhood of Boston, Mass., and the rapid spread of the pest into other States led to Congress making an appropriation in 1906 to enable adequate control measures to be taken. The brown-tail moth was first found in 1897 in Somerville, Mass., and its initial spread was more rapid than that of the first-mentioned species. The two kinds of insect demand very similar methods of control, and the whole subject is reviewed by Mr. A. F. Burgess in *Farmer's Bulletin,* No. 1623, issued by the U.S. Department of Agriculture in December. The Federal Government is largely concerned with checking the spread of these insects into uninfested areas, while the affected States themselves aim at reducing the infestations within their own administrative territories. The Government of Canada and several of the Provinces have also organised control and eradication measures within the Dominion. In so far as Canada is concerned, the gipsy moth appears to have been eradicated and the brown-tail moth is found in decreasing numbers. In the United States, the brown-tail moth has also declined very appreciably, and imported parasites have been responsible for a considerable proportion of the good results obtained. Other factors, including spraying operations, have also played their part. With the gipsy moth, imported natural enemies have reduced its numbers in many localities ; but they are not equally effective over the entire infected area, and the best mechanical and chemical methods of control have to be energetically applied. The establishment of a barrier zone, 25-30 miles broad, is an important measure in an attempt to check the westward spread of the insect, and, so far, this appears to have accomplished its purpose.

IN northern Italy the Italian State railways electrified many railway lines with three-phase supply at the low frequency of 16⅔ cycles per second. To increase the output of their converter sets in substations or placed in the open beside the railway, they possess a number of portable substations. These can help any substation that is overloaded or even replace a unit which is temporarily out of commission. The output of a substation must be sufficient for the greatest traffic load even although it occurs very rarely. With portable substations these peaks can be provided for, and so the size of the requisite buildings and machinery for these substations can be reduced. In southern Italy the State railways are now being electrified with 3000 volts direct current. Very favourable results with this system have been obtained on the Benevento-Foggia line, which is being extended to Naples. Further main line railways are being electrified on this system. For example, the railway connecting Bologna and Florence and the railway between Rome and Naples. With direct current obtained from a three-phase supply, the use of portable substations is particularly convenient, as mercury arc rectifiers can be used which occupy little space and are not too heavy. A full description of one of these portable rectifier substations capable of converting 2000 kilowatts, which has been constructed for the Italian State railways, is given in the *Brown Boveri Review* for June. The rectifier is fitted with a high vacuum pump, and so the set can be put into use at once even after a long journey. A photograph is given in the *Review* of a portable rectifier substation, two of which will be in operation this year.

THE generation of water gas by blowing a coke bed alternately with air and steam has an industrial importance which has increased since the process came to be used for preparing hydrogen on a large scale for synthetic and other purposes. This has led to a considerable study of its thermal economy by the Institution of Gas Engineers and by the Fuel Research Board. The preparation of accurate heat balances of a process which consists of a series of rapid alternations of operations at a high temperature presents much difficulty. One method of checking the measurements is to equate, if possible, the heat set free in the 'air blow' with the heat absorbed in the 'steam run', and the results of such a study made at the Fuel Research Station are described in a paper, "The Water Gas Process: a Study of the Carbon and Thermal Balance" (*Technical Paper* No. 30, H.M. Stationery Office, 9*d*. net). Great attention was given to devising methods for metering the gas streams involved and measuring the hitherto indeterminate quantities. In spite of the difficulty of the task, it was possible to account as heat absorbed on the 'run' for 90 per cent of the heat evolved in the 'blow'. The remainder unmeasured is equivalent to about 3·3 per cent of the coke fed into the generator. It is of the same order as estimated losses during clinkering and by radiation.

WE have received the first number of a new publication, "Occasional Notes of the Hong Kong Horticultural Society" (No. 1, February 1931), edited by Dr. G. A. C. Herklots. In a foreword, the editor points out that within the small territories of Hong Kong very diverse conditions prevail, from the point of view of the gardener, from Victoria Peak with its winter fogs and cool nights to the warmer conditions of the lower levels and Kowloon. It is proposed in the new journal to deal with the special problems relating to the cultivation of particular plants in Hong Kong (sweet peas are dealt with in this number) and also to describe various genera of interesting plants, species of which have been introduced to Hong Kong gardens, and five species of *Thunbergia* are thus dealt with and illustrated in four simple line drawings. Mr. R. A. Nicholson contributes notes on the cultivation of various garden favourites, roses, carnations, dahlias, etc., under Hong Kong conditions; whilst the editor contributes a note upon the soils of the Hong Kong territories. These soils, formed by the weathering of igneous rocks under tropical conditions with relatively heavy rainfall, tend to be of the red laterite type, poor in the necessary salts and becoming acid in reaction. This note is useful as pointing the way both to empirical manurial treatment and also to a more thorough scientific study of the soils of the territories when the workers are available. If this new journal can fulfil the task it has set itself, it should prove a very useful medium for spreading information and stimulating inquiry and research upon horticultural problems both in Hong Kong and in a wider field.

THE annual report of the Smithsonian Institution upon its "Explorations and Field-work" for 1930 reveals again that energy and lavish expenditure which are the envy of other countries. Field expeditions, not content with concerning themselves with twenty-three of the States of their own country, touched upon every continent and upon many islands. The subjects of the expeditions were as different as their objectives; they included the radiation of the sun, the ancient Eskimo culture of Alaska, Indian music, the fauna and flora of central China, birds of Spain, fossil horses in Idaho, and so on. It might be said that the scientific value of the expeditions varied also. That to Spain, for example, must have partaken rather of a collecting excursion for the replenishing of cabinets, for European zoologists have already done pretty well by the birds of Spain; one feels, indeed, that such a theme might well be left to them, and that energies should rather be concentrated on work lying to hand likely to yield fresher results. Many of the expeditions, however, were of fundamental importance; we need only cite Dr. J. W. Gidley's collecting in the fossil bone deposit at Hagerman, Idaho, which seems to have been a watering place for the wild creatures of the region, so many hundreds of skeletons remain there. Sufficient material of the rare extinct horse, *Plesippus*, was collected to build three or four complete skeletons.

WHILE progress has been made in Great Britain in the study of oil-paintings by microscopic analysis, largely through the work of Prof. A. P. Laurie, experts on the Continent have also been turning their attention, with great effect, to this recent and fascinating branch of research. The variety of aims and methods employed is so considerable that an International Conference, organised by l'Office International des Musées, was held on Oct. 13-17, 1930, in Rome, "for the study of scientific methods applied to the examination and preservation of works of art". With commendable promptitude the papers read at the Conference have been published in the journal of the International Office of Museums, *Museion* (vols. 13-14, 1931). Subjects of discussion included the optical examination of paintings, the chemical and micro-chemical analysis of paintings and mural decorations, the importance of the use of X-rays and its limitations; and an introductory paper by J.-F. Cellerier deals generally with scientific methods and usages in the examination of paintings. Otherwise the magazine contains much information of interest to curators of art collections. There is a short summary in English of the chief papers.

"POSITIVE Eugenics in Practice" is the title of an article in the April issue of the *Eugenics Review* (vol. 23, No. 1). The writer, Mr. Alfred Dachert, conceived the idea many years ago of founding a township for the express purpose of housing couples who would be likely to raise healthy families. In 1921 the city of Strasbourg, realising the significance of the work, placed a site at his disposal, and with funds contributed by the company he managed, building was commenced and 140 houses are now completed, specially planned so as to avoid unnecessary labour for the young housewife. As tenants for the purpose in view, it was necessary to find healthy, vigorous, and comely young couples who really wanted children, and a system of selection was adopted, based upon the application, an interview, visitation of the present home, and medical examination. The experiment seems to be an unqualified success, the birthrate is much higher than in the city of Strasbourg itself, and the behaviour of the citizens has been exemplary. To maintain its purpose, infertile couples have to be replaced by others, but this has been necessary only in nine instances during the seven years since the birth of the township.

VITAMIN A has been shown by Green and Mellanby to be of value as an anti-infective agent when given in large doses. The British Drug Houses, Ltd., London, N.1, have recently put on the market a preparation made from mammalian liver under the name of Avoleum, which, unlike their original product, Radiostoleum, contains no added vitamin D. As mammals, unlike fish, do not store the latter in their livers, the concentrate may be considered to be free from the anti-rachitic factor. The blue value by the antimony trichloride test is about ninety times higher than that given by an average good codliver oil. The concentrate is also standardised in rats by its power of promoting growth and preventing and curing xerophthalmia in comparison with a known sample of codliver oil. Avoleum is suitable for administration in acute conditions in which massive doses of vitamin A are required and also in cases in which vitamin D is contra-indicated. It is issued in capsules, each containing 3 minims of the solution: the dose is 1–3 capsules daily.

IT is announced in *Science* that the Roosevelt Memorial Association, New York, has awarded a Roosevelt Medal to Dr. C. Hart Merriam, chief of the U.S. Biological Survey from 1885 to 1910, and since then research associate of the Smithsonian Institution.

THE following have been elected to fill the vacancies which will occur in the Council of the Institution of Electrical Engineers on Sept. 30: *President*, Capt. J. M. Donaldson; *Vice-Presidents*, Mr. J. M. Kennedy and Mr. F. W. Purse; *Hon. Treasurer*, Mr. E. Leete; *Ordinary Members*, Lieut.-Col. A. G. Lee, Mr. C. le Maistre, Mr. H. A. Ratcliff, Dr. E. H. Rayner, Mr. R. H. Schofield, Mr. J. W. J. Townley, and the Viscount Falmouth.

THE International Congress of Mathematics will be held at Zurich on Sept. 4–12, 1932. There will be general discussions on the present position of mathematics, also short papers of recent research work. In connexion with the Congress, receptions and excursions are being arranged. Further details will be available in October.

REFERRING to a paragraph that appeared in NATURE for July 4 (vol. 128, p. 15), the Rev. J. P. Rowland, *S.J.*, informs us that, with the aid of addiditional records (the total number used being twenty), he has made a new determination of the position of the epicentre of the North Sea earthquake of June 7. This he finds to be in lat. 53° 57′ N., long. 1° 25′ E., or about 22 miles to the north-east of the position previously assigned, the corresponding time at the origin being 0 h. 25 m. 24 s. G.M.T.

THE London Natural History Society has recently published a pamphlet describing its constitution and activities. Founded in 1858, its present headquarters are at the London School of Hygiene and Tropical Medicine. The president is the Right Hon. Viscount Grey of Fallodon. Members of the Society enjoy the privileges of admission to all lectures, use of the Society's collection and library, receipt of the annual copy of the *London Naturalist*, and access to places of interest. The Society is divided into archæological, botanical, entomological, ornithological, plant galls, and rambling sections. The annual subscription is 7*s.* 6*d.*, with an entrance fee of 2*s.* 6*d.* Application for membership should be made to the Secretary, 91 Queen's Road, Buckhurst Hill, Essex.

THE Empire Marketing Board has made a grant of £15,790, spread over five years, towards a scheme for the development of rice research in India which aims at increasing the yield and improving the quality of Indian rice. The scheme is organised by the Imperial Council of Agricultural Research of the Government of India. The Empire Marketing Board has offered to bear half the cost of developments in Burma, the principal rice-exporting Province, and Bengal, where Patna rice is grown for export. Schemes for development of research in the remaining five Provinces are to be financed entirely by the Imperial Council. About 33,000,000 tons of rice are produced annually in India, of which only a small proportion is exported. The scope for research is immense. Improvement may come through breeding better varieties of rice already grown in India, or through establishing there new and better kinds of rice from other countries. A beginning has already been made and more than a million acres are under improved varieties.

THE Ministry of Health has published a "Review of certain Present Aspects of Smallpox Prevention", which deals with the subject particularly in relation to the vaccination acts (*Reps. on Pub. Health and Med. Subjects*, No. 62. H.M. Stationery Office. 1*s.* net). It is concluded that in spite of the fact that England and Wales, of the population of which some forty per cent are unvaccinated, are intrinsically more vulnerable to the serious and rapid spread of severe epidemic smallpox than are countries where the population is compulsorily vaccinated and re-vaccinated, the protective methods which are part of ordinary British administration should prove efficacious in protecting the community from invasion. Post-vaccinal encephalitis is also discussed, and the vaccination requirements of certain European countries are summarised.

THE *Annual Report* of the Calcutta School of Tropical Medicine, Institute of Hygiene, and the Carmichael Hospital for Tropical Diseases, 1930, recently issued (Calcutta: Bengal Government Press, 1931), contains summaries of the work, routine and research, carried out in the laboratories and wards. Lieut.-Col. Acton, the director, in his introduction, after alluding to some of the administrative difficulties of the post, gives a useful review of the recent advances in tropical medicine. Recent investigations indicate that epidemic dropsy, vast epidemics of which have occurred in Calcutta from time to time, is connected with the consumption of badly stored rice, and is related to beriberi. Promising results have been obtained in the treatment of oriental sore with local injections of a 2 per cent solution of acid berberine sulphate. The growth of the *Leishmania* parasite of this disease in culture is completely inhibited by a dilution of 1 : 80,000 of this drug.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master for science and engineering at the Oswestry Technical Institute—The Clerk to the Governors, Technical Institute, 18 Arthur Street, Oswestry (July 26). A lecturer in civil engineering in the Faculty of Engineering of the University of Bristol—The Secretary and Acting Registrar, University, Bristol (July 27). A temporary investigator under the Department of Agriculture for Scotland, in connexion with an investigation of the marketing of grain and grass seeds in Scotland—The Establishment Officer, Department of Agriculture for Scotland, Queen Street, Edinburgh (July 29). A lecturer in biochemistry (fermentation industries), at the Heriot-Watt College, Edinburgh—The Secretary, Heriot-Watt College, Edinburgh (July 31). A part-time assistant in the Department of History and Method of Science of University College, London—The Secretary, University College, Gower Street, W.C.1 (Aug. 4). A veterinary education officer under the Derbyshire Education Committee—The Director of Education, County Education Office, St. Mary's Gate, Derby (Aug. 5). A head of the Building Department of Woolwich Polytechnic —The Principal, Woolwich Polytechnic, S.E.18. A master for manual instruction, principally in woodwork, under the Middlesex Education Committee—The Secretary, Education Offices (H), 10 Great George Street, S.W.1. A teacher of carpentry and joinery at the Tottenham Polytechnic—The Principal, Tottenham Polytechnic, High Road, N.15. Teachers of electrical science, workshop calculations, workshop drawing, workshop science, and engineering drawing at the Guildford Technical College—The Director, Technical College, Park Street, Guildford. Part-time instructors in practical work in the engineering shop, practical geometry, engineering drawing, mathematics, chemistry, physics, and mechanics at the Watford Junior Technical School in Engineering—The Principal, Technical School, Watford. A temporary scientific assistant at the Air Defence Experimental Establishment—The Superintendent, Air Defence Experimental Establishment, Biggin Hill, Kent. A laboratory attendant in the senior physical laboratory of Oundle School—W. Llowarch, 6 Milton Road, Oundle.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Constitution of Lithium.

THE first measurements of the relative abundance of the isotopes 6 and 7 of lithium were made by Dempster with his magnetic spectrograph.[1] As the instrument indicated ratios so high as 37 and so low as 4·8 with means around 7–10, the results are of little value. Morand,[2] using a heated anode and measuring simultaneously the currents carried by Li^6 and Li^7, arrived at the figure 14·9, a ratio agreeing well with the atomic weight 6·94 on the assumption that the atoms had exact whole number masses. Costa's measurements (1925) recalculated from my own results[3] indicate the masses to be 6·012 and 7·012 ($O^{16} = 16$) respectively. This reduces the ratio calculated from the chemical atomic weight to about 13. Quite lately, v. Wijk and v. Koeveringe,[4] from observations on band spectra, calculate the ratio to be 7·2.

Recent improvements in technique have enabled me to apply the principle of accelerated anode rays to my high resolution mass-spectrograph. Using the method of intermittent exposures and correcting for the position of the lines, I find a provisional value of the ratio to be 10·2 ± 0·5, which gives:

$$\text{Atomic weight of Li} \geqq 6{\cdot}923 \pm 0{\cdot}006.$$

The correction for position is unfortunately a maximum, about 20 per cent, for the lithium lines. In addition, it must be noted that the velocity of the Li^6 atom exceeds that of the Li^7 atom by about 8 per cent, and will certainly enhance its photographic effect. Any correction for this will increase the ratio, and although it seems unlikely that it could bring it up to the high value given by Morand, it can only accentuate the very serious discordance between the ratio calculated from band spectra and the more direct results of the mass-spectrograph. It seems highly desirable that measurements similar to those of Morand should be made with an instrument of higher resolving power; the magnetic spectrograph of Bainbridge would seem to be admirably suited to the purpose.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, July 12.

[1] *Phys. Rev*, **18**, p. 415; 1921.
[2] Thesis for Ph.D, Paris (1927).
[3] *Proc. Roy. Soc.*, A **115**, p. 509, 1927.
[4] *Proc. Roy. Soc.*, A **132**, p. 98; 1931.

Polarisation of a Beam of Electrons by Scattering.

MOTT[1] has predicted that a polarisation of an electron beam is possible under certain conditions. These conditions are that a fast electron shall be scattered successively by two heavy nuclei through large angles. The intensity of the twice-scattered beam should then depend on its azimuth with respect to the original unscattered beam. Many attempts have been made to detect such an effect, with either negative or inconclusive results; but in none of them have the conditions laid down by Mott all been fulfilled. Chase,[2] who finds a small positive result, scattered β-rays through 90° from solid targets. The scattering in a solid target is multiple, that is, consists of a large number of small angle collisions, and Mott's theory is completely inapplicable. The same criticism applies to the work of Langstroth,[3] who, moreover, uses too small a velocity (due to an error in Mott's paper) for the polarisation to be detectable. In the recent work of Rupp[4] and Rupp and Szilard the arrangement is still further removed from that considered by Mott.

When the conditions of nuclear scattering are satisfied, it appears from the work described below that there is a small polarisation of the beam, in the direction predicted by the theory. Electrons of velocities up to 70 kilovolts (0·47 of the velocity of light) are scattered through 90° by a target of the thinnest commercial gold leaf (thickness $< 10^{-5}$ cm.). The scattered beam, defined by suitable diaphragms, meets an exactly similar target, and is scattered again through 90° to a Faraday cylinder, where it may be measured. The second target and Faraday cylinder can rotate about an axis joining the two targets. A thin aluminium foil (thickness 8×10^{-5} cm.) placed between the second target and collecting cylinder, holds back all slower secondary electrons, but allows the greater part of the scattered beam to pass. Precautions were taken to exclude all electrons coming from other parts of the apparatus than the two targets, and also all photoelectrons produced by X-rays.

The difference in intensity of the scattered beam in the two positions, parallel and antiparallel to the original beam, proved very small and of the same order of magnitude as the natural asymmetry introduced by the apparatus itself. In order to eliminate the latter, the difference in the polarisation produced at 70 kv. and at 20 kv. has been observed. The results are given in the accompanying table, where the differences in the intensities of the two scattered beams are shown as percentages of the antiparallel beam. The table represents some 140 determinations at each velocity; each group represents a taking down and reassembly of the apparatus to replace the filament or one of the foils. One group is omitted which gave a result, discordant with all the others, of 9 per cent.

Group.	Difference in Polarisation 70 kv.-20 kv. (per cent).
A	1·60 ± 0·77
B	2·48 ± 0·75
C	3·66 ± 1·12
E	0·59 ± 0·62
F	3·93 ± 0·65
G	1·36 ± 0·37
	0·65 ± 0·48
H	1·57 ± 0·58
J	3·80 ± 1·24
O	2·09 ± 0·42
Weighted mean	1·74 ± 0·32

The theory of Mott indicates that the amount of polarisation should depend on the square of the atomic number of the scattering nuclei. In order to check whether the very small effect found is not entirely instrumental, one of the gold foils was replaced by aluminium (thickness 8×10^{-5} cm.). The total scattered intensity was too small to allow both scatterers to be of aluminium. The result found (for the difference at 70 kv. and 20 kv. again) is 0·01 ± 0·23 per cent, justifying the view that a real polarisation effect has been observed.

The work of Mott indicates a value of 0·4 per cent (with an arithmetic mistake on p. 439 of his paper corrected) for gold, as the difference in the polarisations at the two velocities used; this is one quarter of that actually found, but I am assured by Mr. Mott that for an atomic number so high as 79 his series cease to converge and the final formula loses all validity. The problem requires working out to a higher approximation before the results can be applied to scattering by the heavier nuclei.

It should be mentioned that the experimental result of 1·74 per cent is more likely to be low than high. The foils used were highly inhomogeneous, and multiple scattering, which is not expected to contribute to the polarisation, from the thicker parts is certainly present, but to an unknown degree.

It is hoped to publish a fuller account of the experiments in the near future.

E. G. DYMOND.

Cavendish Laboratory,
Cambridge,
July 7.

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[1] Mott, *Proc. Roy. Soc.*, A **124**, p. 425; 1929.

[2] Chase, *Phys. Rev.*, **36**, p. 1060; 1930.

[3] Langstroth, NATURE, **127**, p. 891; 1931.

[4] Rupp, *Naturwiss.*, **19**, p. 109; 1931. Rupp and Szilard, *ibid.*, p. 423.

A Curious Phenomenon shown by Highly Charged Aerosols.

IN the course of investigations on the electrification of aerosols, a curious phenomenon was noticed. The aerosols were volatilised in a glass chamber of about four cubic metres capacity. During the dispersal a unipolar discharge was produced by connecting one pole of a large electrostatic machine to a metal brush inside the chamber. The contents of the chamber were agitated by an electric fan during dispersal and for a minute or so afterwards.

Whenever this type of aerosol is produced in our chamber, a striking phenomenon makes its appearance. Directly the fan has stopped, large particles begin to arrive in the centre of the chamber, and these gradually draw together to form a large, loose, more or less spherical cluster about 20 centimetres in diameter, the particles, however, retaining their individuality. The particles composing the sphere appear to be highly electrified, since, if a charged wire is pushed towards it, the sphere as a whole is rapidly attracted and absorbed when the wire is of one sign and repelled by the other. In this way the sphere may be pushed right across the chamber, though it may be distorted in the process. If now the wire is removed, the sphere tends to return again to the centre.

The greater number of particles when examined by the electric cell, which we have previously described,[1] are seen to be very highly charged to the same sign as the brush discharge. The particles composing the sphere, on the other hand, are highly charged to the opposite sign. Thus if the aerosol is charged positively by a positive brush discharge, the sphere is made up of negatively charged particles and vice versa. The phenomenon is exhibited by all aerosols which we have examined, but is especially striking in the case of a dyestuff such as *p*-xylene-azo-*β*-naphthol. An aerosol of this material when dispersed at a concentration of about 15 mgm. per cubic metre is greenish blue in a Tyndall beam, and after electrification retains this colour. The sphere which forms in the centre of the chamber, however, is bright red, this being the colour of large particles of the material.

By inserting a cover-glass into the cluster, it was found possible to collect some of the particles, and microscopic examination showed that they consisted of long chains or ropes of particles containing apparently thousands of units.

The phenomenon may probably be explained as follows. Suppose we consider an aerosol which has been positively charged by a positive brush discharge. The outside of the glass walls of the chamber immediately after dispersal is found to be highly positively charged. This implies that the inside is negatively charged by induction, though we have not been able to verify this experimentally. If then complexes carrying a high negative charge are present in the chamber, they will certainly be repelled towards the centre. On reaching the centre, their mutual repulsion will prevent very close approach, so that a loose sphere should be formed.

The complexes themselves may be formed in the following way. Whilst, for example, the positive brush discharge is in action, heavy negative charges must be induced on any objects near the brush. Now experimentally we find that if there are two point electrodes with a field of a few hundred volts per cm. between them in an aerosol, long chains of particles will gradually form and project out from the points. These chains may easily be detached by an air current, and will presumably remain as long chains, providing that the cohesive force between the particles is greater than the repulsive force due to their charge. A similar state of affairs will probably obtain whilst the brush discharge is in action. When the fanning ceases, the negatively charged chains will obviously be repelled to the centre of the chamber, whilst those positively charged will be attracted to the walls.

It may be noted that if the sphere is once completely removed in any way, it will not reform, and that in any case it tends to disperse with lapse of time. This latter may be attributed partly to gradual neutralisation of the charges on the complexes by coagulation with particles of opposite sign and partly to loss by leak of the charge induced on the glass walls.

The existence of such a spherical, highly charged assemblage of particles suggests that globular lightning may owe its origin to an analogous effect, in which particulate matter, either liquid or solid, is charged to a very much higher potential.

W. CAWOOD.
H. S. PATTERSON.

The University, Leeds,
June 12.

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[1] *Proc. Roy. Soc.*, A, vol. 124, p. 523; 1929.

Temperature Stability and Denaturation of Serum Albumin.

IT has been shown by Svedberg and Sjogren[1] that at ordinary temperature serum albumin is stable (that is, homogeneous with regard to molecular weight) in a region of pH varying between 4 and 9. These authors have also shown that outside of the stability region, but not too far from it, the serum albumin molecule is dissociated into smaller molecules. This first stage of breaking up of the molecule probably means the formation of particles of half the weight of the original molecule. The complete breaking up of the molecule follows immediately after this stage. The first stage has been shown to be reversible with regard to the molecular weight.

Now the influence of different heat treatment on serum albumin in different buffered solutions has been studied by means of the ultracentrifugal technique worked out by Svedberg and the electrophoretic technique worked out by Tiselius,[2] and it was found that there is a distinct difference in the behaviour of the serum albumin inside and outside the stability region. Inside the stability region, different proportions of the total quantity of the serum albumin will undergo change and give aggregation products, the number and size of these aggregation products varying according to the pH and to the salts of the solution, to the temperature and the time during which the heat treatment has taken place. That part of the serum albumin which has undergone aggregation may, if not already coagulated, be removed by centrifuging, and it is then found that the serum albumin in the remaining solution is quite unchanged. It was found to have exactly the same sedimentation constant, the same molecular weight, the same electrophoretic movement, and the same light absorption as the original solution. This may be a property peculiar to serum albumin.

Some preliminary experiments with amandin have shown that this protein undergoes quite a different change by heat treatment. In this case the protein is partially split up into very small particles, so small that they do not show any sedimentation in the ultracentrifuge. But, as in the case of serum albumin, the main part of the amandin is found to be unchanged in the solution, if the treatment has not been too strong.

The aggregation products can be centrifuged off and washed, and they can be suspended in a buffer solution. Such suspensions have been examined by electrophoresis, and they were found to be homogeneous with regard to electrophoretic movement, in spite of being quite polydisperse in the ultracentrifuge. The *p*H mobility curve of this denatured serum albumin was found to be nearly parallel to that of the native serum albumin, but the isoelectric point was found to lie between *p*H 5·1 and *p*H 5·3 instead of at *p*H 4·88 for the native serum albumin in the same buffer solutions. This seems to indicate that the native serum albumin has undergone a definite chemical change when transformed into the denatured serum albumin.

The acid limit of the stability region was found at about *p*H 3·8. At this point the solution was treated for six minutes in boiling water, and yet the sedimentation constant was unchanged and there were no aggregation products, but the diffusion constant showed a drift indicating that the particles were not quite monodisperse.

Outside the stability region, at *p*H less than 3·8, it was found that the serum albumin particles were split up into smaller particles giving a sedimentation constant of about $s_{20} = 3{\cdot}5 \times 10^{-13}$ instead of $s_{20} = 4{\cdot}3 \times 10^{-13}$ for native isoelectric serum albumin, and this was the case even if the solution had been treated in boiling water for five to ten minutes. Inside the stability region in buffers containing the same ions this treatment would always cause coagulation or the solution would at least be opalescent, indicating the formation of aggregation products.

By electrophoretic experiments it was found that the heat-treated solutions (at *p*H less than 3·8) gave such mobilities as would be expected for denatured serum albumin at these hydrogen ion concentrations. After standing one day at room temperature, an untreated solution of serum albumin (at *p*H less than 3·8) showed the same mobility as the one treated by heat.

When the hydrogen ion concentration of a heat-treated solution (at *p*H less than 3·8) was changed to about the isoelectric point, it was in some cases found that such a solution in the ultracentrifuge was not distinguishable from a solution of native serum albumin, but in some other cases there was found a sedimentation constant of about $s_{20} = 3{\cdot}6 \times 10^{-13}$; but in these cases the electrophoretic mobilities were not those of native serum albumin but those of denatured serum albumin.

Some preliminary experiments have shown that serum albumin solutions at *p*H 3·5 exposed to ultraviolet light are strongly changed, and it is found that the light absorption increases very much, the odour becomes very peculiar and strong, the solution remains clear, but the sedimentation constant is about twice that of native serum albumin, and the diffusion constant shows a strong drift.

Experiments to reverse the coagulation either with potassium thiocyanate or acetic acid were negative; the results were inhomogeneous polydisperse solutions. An experiment with heat treatment at *p*H about 10 showed that the serum albumin was split up and gave a sedimentation constant of $s_{20} = 3\ 5 \times 10^{-13}$, but the diffusion constant showed a strong drift, and the light absorption was about five times as large as usual, which indicates that a deeper chemical change had taken place.

KAI O. PEDERSEN.

Laboratory of Physical Chemistry,
University of Uppsala,
Uppsala, Sweden,
June 28.

[1] *J. Am. Chem. Soc.*, **52**, p. 2855, 1930.

[2] *Nova Acta Regiæ Soc. Scient.*, Uppsala, **4**, 7, No. 4; 1930

A New Relation between Electrical Resistance and Energy of Magnetisation.

IN two recent papers[1] I have shown that there are two effects of a magnetic field on the electrical resistance of ferromagnetic wires. At temperatures appreciably below the Curie-point (*C-P.*) there is an increase $+\Delta R$ of the resistance by magnetisation which attains a saturation value exactly at the saturation of the magnetisation. The relation between the magnetisation I and the change of the resistance is $+\Delta R = c(I^2 - I^2_0)$, where I_0 is a critical value of the magnetisation process; for example, in crystals the component of the spontaneous magnetisation in the direction of the field. So far as the limit I_0 of the magnetisation, there is practically no change of resistance. The greater part of the resistance increase takes place in the region approaching saturation.

At temperatures in the neighbourhood of the *C-P.* the magnetic field decreases the resistance. Just below the *C-P.* there is at first a small increase and then a decrease of the resistance; above the *C-P.* we find only a diminution of the resistance. We have put forward the hypothesis that in a ferromagnetic material the spontaneous magnetisation produces a diminution of the resistance, and have shown that in the absence of an external field this effect is exactly proportional to the inner magnetic energy: that is, to the square of the spontaneous magnetisation. Since in the neighbourhood of the *C-P.* an external magnetic field gives an augmentation of the magnetic energy (proportional to the square of the 'true' magnetisation), the resistance should be diminished by a field, as is observed. There, however, a difficulty appeared; for we found that between 0 and 500 gauss $-\Delta R$ is approximately proportional to the first power of the field. In a letter to NATURE,[2] H. H. Potter has confirmed our results, and has also shown that, in fields high enough and at temperatures above the *C-P.*, the decrease of resistance is proportional to the square of the field, as would be expected from our theory.

In continuation of our experiments, we have measured again as exactly as possible the diminution of the resistance and also the magnetisation at temperatures above the *C-P.* at low field-strength. We have found that the decrease of resistance is always proportional to the square of the true magnetisation $-\Delta R = c.\sigma^2$ and is independent of the relation between R and H. Just above the *C-P.* the external field has a double influence on the magnetisation: it produces a true magnetisation and also a certain form of ferromagnetic magnetisation. The fact that there the two effects will be superposed, explains our observation that the negative change of resistance can be approximately proportional to the first power of the field.

We would suggest that these experiments, in connexion with the results of Potter, *show definitely that true magnetisation diminishes the electrical resistance proportionately to the true magnetic energy.*

Walther Gerlach.
Erno Englert.

University, Munich,
June 26.

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[1] W. Gerlach u. K. Schneiderhan, *Ann d. Phys*, 6 (V), 772; 1930. W. Gerlach, *Ann. d. Phys*, 8 (V), 649; 1931.

[2] H. H. Potter, Nature, April 11, 1931, p. 555.

Wires drawn through Rotating Dies.

A chance observation by one of us (H. G.) that if the die through which a wire was being drawn was simultaneously rotated the tension required was appreciably reduced, has led to results of considerable interest. The following series of values refer to an 80:20 cupro-nickel wire reduced from 0·073 in. to 0·0635 in. in diameter, that is, 24 per cent. A sintered tungsten carbide die of 6° taper was used, with 'Oil-dag', a suspension of colloidal graphite in oil, as a lubricant.

Speed of Rotation. r.p.m.	Tension required lb.	Decrease. Per cent.	Power to rotate Die. ft.lb./min.
0	82	0	..
50	61	26	200
80	58	29	450
160	51	38	700
1920	26	68	1000
2660	23	72	1300
3300	21	75	1400

Since the speed at which the wire was drawn in these tests was only 3 in. per min., it will be appreciated from the values given in the last column that the observations are at the moment of theoretical interest only, and have no industrial significance. Whether this still holds at higher rates of drawing we have not yet determined, but work in this direction will be undertaken.

Up to the present we have been unable to detect with certainty any change in the structure of the wire drawn through fixed and rotating dies, nor have we found any alteration in the recrystallisation on annealing. The very few mechanical tests so far carried out reveal no modification in the tensile properties of the wire, though the number of twists withstood—on a length of 100 times the diameter of the wire—appears to be less with the rotating die than for wire drawn through a stationary one. Typical results, which refer to a 70 : 30 brass wire again reduced 24 per cent from an initial diameter of 0·073 in., are given below.

Die.	Maximum Stress, Tons/sq. in.	Elongation Per cent on 2 in.	Reduction of Area. Per cent	Torsions.			
				1	2	3	Mean.
Fixed	34·5	25	55	115	106	111	111
Rotating	34·3	25	55	87	65	72	75

The Brinell hardnesses of the wires were again almost identical. Using a 1 mm. ball and a load of 30 kgm. the Brinell number was 125 for the fixed die and 123 for the rotating one.

H. Greenwood.
F. C. Thompson.

Metallurgical Department,
University of Manchester,
June 23.

Diamagnetism of Liquid Mixtures.

Mr. S. P. Ranganadham states, in Nature of June 27, that he has obtained values for the specific susceptibility of mixtures of organic liquids which differ markedly from those obtained by us.[1] It is impossible to answer Mr. Ranganadham's assertion without a full knowledge of his data, consequently we must await the publication of his results before we can reach an opinion as to the comparative value and accuracy of the two sets of values. In the meantime, however, we must justify our continued belief in the accuracy of our work. In the first place, as pointed out in our paper, the specific susceptibilities of the pure liquids used in our experiments were found, with a single exception, to be closer to Pascal's calculated values than any values hitherto published. We attribute this fact to the carefully checked purity of the material used. The susceptibility values used in plotting our curves were, in every case, obtained several times with fresh portions of the mixtures; the symmetry of the curves and the fact that they exhibit maxima in the same positions as other property-composition curves is confirmatory of the accuracy of our results.

It is well known that acetone-chloroform mixtures show greater deviations from the mixture law than almost any other pair of organic liquids; it would, therefore, not appear to be extraordinary that the specific susceptibility should also show a very marked deviation such as we find. Furthermore, as pointed out in our paper, we found it possible to calculate a mass action constant for the reaction between the constituent liquids and an equimolecular compound from the specific-susceptibility-composition curve for acetone and chloroform.

Mr. Ranganadham sees with astonishment that this curve passes from the diamagnetic to the paramagnetic region. Whilst this fact is remarkable, it is of experimental origin and, in our opinion, not open to doubt. In our view, the astonishing fact is that although we have no evidence that acetone and chloroform combine under our conditions to give dimethyltrichloromethyl carbinol, this substance, originally made by Willgerodt, is considerably more paramagnetic ($\chi = +2{\cdot}564 \times 10^{-6}$) than any of our mixtures of acetone and chloroform. Further work on the physical properties of acetone-trichloroethylene and bromoform-acetone mixtures is about to be published, and this fully supports our published curves for the specific susceptibility of mixtures of these substances.

V. C. G. Trew.
James F. Spencer.

Physical Chemistry Laboratory,
Bedford College,
Regent's Park, N.W.1.

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[1] Trew and Spencer, *Proc. Roy. Soc.*, 131, A, 209; 1931.

Excretion of Uric Acid.

Dr. Wigglesworth's communication in Nature of July 18 raises some very interesting points regarding the physiology of animals which possess uricotelic metabolism. Evidence in favour of his suggestion that a circulation of base takes place, as well as of water, in the excretion of uric acid, can, it seems to me, be found in the facts already known about the development of the chick embryo.

The use of the term 'urates' for the solid masses present in the allantoic liquid during the last week of incubation rests on nothing more than an assumption. For (1) the inorganic cations of the allantoic liquid are completely accounted for by the inorganic anions, as is shown by the recent work of Iseki.[1] Moreover, (2) the concentration of ash on the fourteenth day of development in the allantoic liquid is almost exactly the same as it was on the ninth, although a 550 per cent increase in the concentration of uric acid has taken place. (3) The uric acid cannot be combined as ammonium urate, for there is not enough ammonia present in the allantoic liquid. About ten times as much as what is found there[2] would be required to form ammonium urate. (4) The slimy masses of uric acid in the allantoic liquid towards the end of development, when washed in distilled water and ashed, give an ash content of only 3·9 per cent. Sodium urate would require 12 per cent and potassium urate 18 per cent. (5) The *p*H of the allantoic liquid, which is about 6·3 during the last week of incubation[3] also strongly suggests that the uric acid is not present as urate.

It seems justifiable, then, to conclude that the uric acid which accumulates in the developing chick's allantoic cavity is free. It may enter the allantois in the form of the sodium or potassium salt, and the cation may then be reabsorbed as carbonate or in some other way, but such an absorption of base might presumably take place just as well in the developing kidneys or cloaca. However, it is known that the allantoic blood-vessels absorb water from the allantoic liquid after the tenth day, and, as they certainly take part in a circulation of water, they may take part in a circulation of base as well.

JOSEPH NEEDHAM.

Sir William Dunn Institute of
Biochemistry, Cambridge.

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[1] *Zeit f. physiol. chem.*, **171**, 101 ; 1928.
[2] Needham, *Jour. Exp. Biol.*, **4**, 114 and 145 ; 1926.
[3] Aggazzotti, *Archives Ital. de. Biol.*, **59**, 305 ; 1913.

The Slow Combustion of Acetylene.

IN a recent paper, Bodenstein[1] has propounded a theory of the slow oxidation of acetylene, which accounts extremely well for the observed[2] kinetic phenomena. However, he considers the chain length to be of the order of one link, contrary to the generally accepted mechanism of hydrocarbon oxidation. That acetylene and oxygen form a reaction chain of considerable length is evident from the following experiments, carried out at 320° C. in a circulating apparatus of the same design as that described by Spence and Kistiakowsky.[2] Using an unpacked pyrex glass furnace of 75 c.c. volume, with an internal diameter of 20 mm., and circulating a mixture of 276·6 mm. of acetylene and 147·2 mm. of oxygen, 51·4 mm. of acetylene reacted in one hour. When, however, a furnace packed with pyrex glass tubing of 2 mm. internal diameter and having a total free gas volume of 75 c.c. was substituted for the unpacked vessel, using the same initial amounts of acetylene and oxygen, less than 1 mm. of acetylene had reacted after one hour. Also, a much slower reaction was observed when the surface of the unpacked vessel was coated with potassium chloride.

There can be no doubt, then, that under the conditions stated the amount of reaction taking place upon the glass surface itself is insignificantly small, while it seems most probable that reaction chains originate upon the surface, undergo considerable branching in the gas phase, where some deactivation by oxygen occurs, and finally are broken at the walls of the vessel. Chain reactions of this type have been discussed by Semenoff[3] (see also Bursian and Sorokin[4]), who shows that they are accompanied by an induction period the duration of which depends upon the concentration of active centres, that is, upon the nature of the surface, upon the total probability of forming another link, and upon the time necessary for the propagation of each link in the chain. A more detailed account of other experiments bearing on this point will be published shortly.

R. SPENCE.

Frick Chemical Laboratory,
Princeton, N.J.

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[1] Bodenstein, *Z. ph. Chem.*, B, **12**, 151 ; 1931.
[2] Spence and Kistiakowsky, *J. Am. C. S.*, **52**, 4837 ; 1930.
[3] Semenoff, *Z. ph. Chem.*, B, **11**, 464 ; 1931.
[4] Bursian and Sorokin, *Z. ph. Chem.*, B, **12**, 247 ; 1931.

Diamagnetism and the Colloidal State.

SOME preliminary experiments by Vaidyanathan[1] show that the diamagnetic susceptibility (χ) decreases as the size of the particle is reduced in the cases of the colloids of bismuth, antimony, and graphite. Detailed and careful experiments by me with much stronger fields have in general confirmed this result. The quantitative variation of χ with the diameter d of the particle has also been studied. The results for bismuth and antimony are affected by oxidation, but in the case of graphite there is no such trouble. A graph drawn between χ and $1/d$ for this element gives a straight line. The inverse of the diameter is a measure of the surface or boundary area of a number of spherical particles in unit mass of the substance. It is thus found that χ decreases proportionately as the boundary area of a given mass is increased.

The results for bismuth and antimony are equally interesting. The curves between χ and $1/d$ are such as could be explained on the basis that the decrease of χ is due to two causes, namely, oxidation and the genuine fall on account of the reduced particle size.

It is interesting to note that as the boundary area is increased the orbits of a large number of *structure electrons* postulated by Prof. O. W. Richardson[2] will decrease in size. This, on the orbital theory, may account for the decrease in the diamagnetic susceptibility value as d is reduced. The fact that χ decreases proportionately as the boundary area is increased seems to lend considerable weight to this view.

S. RAMACHANDRA RAO.

Annamalai University,
Annamalainagar,
South India.

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[1] *Ind. Jour. Phy.*, **5**, 559 ; 1930.
[2] *Proc. Roy. Soc.*, A, **128**, 41 ; 1930.

The late Mr. Herbert Tomlinson, F.R.S.

THE obituary notice of Mr. Herbert Tomlinson in NATURE of July 11, p. 58, reminds me that, about a year ago, I came across what appears to be a complete collection of his published work for sale in a second-hand bookseller's shop in Worthing.

This collection consists of three thick octavo volumes which were evidently bound for his private use, as the pamphlets and articles are interlined with letters to and from the secretary of the Royal Society, the Editor of NATURE, etc., and there is an index in his own handwriting.

It contains, in addition to his formal scientific papers, many cuttings of letters to the *Times*, and articles which were printed in chemical journals and in North London papers. There are also quite a considerable number of literary articles, mainly on the subject of Italian poetry ; and several metrical versions of Dante and Tasso which indicate that the author was no mean poet.

The volumes are now in the library of King's College, Strand, W.C.2, where they are available for reference by anyone interested.

J. JOHNSTON ABRAHAM.

38 Harley Street, W.1.

Research Items.

Pit-Dwellings at Kiatuthlanna, Eastern Arizona.—Ruins on the Long H ranch, Twin Salt Lakes, in Apache County, were excavated by Mr. Frank H., H. Roberts, jr., on behalf of the Bureau of American Ethnology in 1929, the results being described in *Bulletin* 100 of the Bureau. By the end of the field season, eighteen pit-houses, the remains of jacal structures, and a pueblo ruin with forty-nine rooms and four kivas had been recovered. The chronological sequence was in the order named. There were two forms of pit-house, of which the larger was a later development of the smaller. In each case there was a rectangular superstructure of poles with flat ceiling and sloping sides. The framework was covered with brush, leaves, etc., and a rectangular hole in the centre of the ceiling served as an entrance and smoke escape. Characteristic furnishings were a ventilator, fire-pit, a *sipapu* or symbolic representation of the mythical place of emergence, and a hole for the storage of small objects. This group of features survived in the later ceremonial chamber of the communal dwelling, a survival for ceremonial purposes of the old original type of house. The pit-houses occur in groups of four to six, perhaps representing a single family group or clan. Several might constitute a village. In some groups the central house was larger, suggesting that a definite ceremonial significance was becoming attached to a particular building, possibly representing the prototype of the kiva of later periods. The smaller houses were found to be reminiscent of structures belonging to the end of Basket Maker III. period, the larger of Pueblo I. of the Chaco Canyon of New Mexico and south-west Colorado. In general the pit-houses show a greater resemblance to dwelling forms excavated in the north than they do to those of the south and south-west. The jacal dwellings, which have upright walls of poles covered with mud and ranging from a single to several rooms, were contemporary with the large pit-dwellings.

The 'Vital' Factor in Diet.—In connexion with the letter on "Photographic Effects of Vitamins A and B", by Sophie Botcharsky and Anna Foehringer, published in our columns recently (NATURE, vol. 127, p. 856; June 6, 1931), and the note on p. 864, Dr. Chalmers Watson has sent us a paper by him on "The 'Vital' Factor in Diet: A Theory of the Nature of Vitamins", published in the *Edinburgh Medical Journal*, June 1931. He was impressed by the early experiments on rats in which it was shown that immediate and dramatic recovery was brought about when animals previously fed on abnormal diets were given a diet of bread and milk; by the capacity of irradiated milk to bring about a rapid healing of rickets in children; and by the valuable therapeutic effects of the 'Gerson' diet, which includes vegetable and fruit juices freshly prepared, wholemeal bread and milk, vegetables cooked in oil and potatoes cooked in their jackets, but with restricted amounts of meats and salt. Dr. Watson points out that the effectiveness of irradiated milk in the cure of rickets appears to be much greater than can be accounted for by its vitamin D potency as determined by tests on rats. Solar energy acts on the cells of plants and initiates the chemical energy which promotes healthy growth; this energy is passed on to the animal kingdom when the vegetable food is consumed. Artificial irradiation has the same effect as exposure to the sun's rays. The best source of vitamins is living food; much of that in common use is more or less dead or devitalised; in fact, the amount of vitamins present varies inversely with the nearness of the food to the original source of its energy. Dr. Watson considers that the plant tissues hold some of the original vital (or solar) energy which initiated the chemical changes; in other words, they are activated. When the tissues are consumed by animals or man, that energy is in turn transmitted to them as a so-called vitamin.

Ringed Plover and its Eggs.—A series of simple and instructive experiments relating to the eggs of the ringed plover (*Charadrius h. hiaticula*) has been carried out by George Marples in an area where he had more than forty nests under observation (*British Birds*, vol. 25, July 1931). When eggs were removed a short distance from the nest, the birds found them and dragged them back; but they also dragged and sat upon egg-shaped pebbles which had been painted to resemble their own eggs, although the disguising of the shape of their own eggs by the addition of lumps of plasticine did not deceive them, nor did the painting of the eggs with bright yellow, blue, and red colours. A curious observation of Mr. Hughes, that the ringed plover keeps its eggs in the positions of the cardinal points of the compass, was tested, with the result that after the deliberate derangement of the clutches in 121 cases, it was found that 80 were rearranged exactly north and south, 11 were nearly but not quite restored to the cardinal point position, and 30 clutches remained in disarrangement, north-east and north-west. Tests with various scents placed upon the eggs indicated that the birds were deficient in sense of smell (though it may be merely that the parental instinct overcame any sense objection), and the numbering of the eggs and frequent examination of their relative positions in the nest failed to prove that there was systematic rotation of the clutch, though it was clear that movement, as distinct from rotation, usually takes place.

South American Sea Stars.—Mr. W. K. Fisher, of the Hopkins Marine Station, Pacific Grove, California, describes a number of star fishes, based on material collected by Dr. Waldo L. Schmitt, of the United States National Museum, in 1926 and 1927 during an investigation chiefly of the higher Crustacea of South America in various parts (*Proceedings of the United States National Museum*, vol. 78, No. 2859, art. 15). There are some very interesting finds, especially three forms of *Anasteria* from the Falkland Islands, which, although here recorded as three species, may very likely all belong to *A. minuta*. The handsome species *Ophidiaster agassizii* Perrier is figured for the first time, two specimens having been collected in Juan Fernandez, and there are, further, very good photographs of several other species.

Japanese Dinoflagellates.—In continuation of the series of papers dealing with the fauna and flora of Mutsu Bay, Prof. Charles A. Kofoid describes the unarmoured dinoflagellates (*Report* of the Biological Survey of Mutsu Bay; Number 18, "Protozoan Fauna of Mutsu Bay. Subclass Dinoflagellata: Tribe Gymnodinioidæ". Science Reports of the Tohoku Imperial University, Fourth Series (Biology): Sendai, Japan; vol. 6, No. 1, 1930). This is one of the contributions from the Marine Biological Station, Asamushi, Amori-Ken; No. 61. These lovely organisms must be studied alive, as the usual methods of preservation destroy their characters: 33 species are recorded, including 14 which are new to science, and these are figured in three striking coloured plates, the colours ranging from pale yellow and green to pink, purple, and bright blue. A new *Nematodinium* bears large nematocysts, and there are two new species of *Pouchetia* having conspicuous eyes with complicated lenses. Prof. Kofoid's notes on *Pronoctiluca* are very interesting. The period of the prevalence of *Pronoctiluca pelagica* in Mutsu Bay coincides with that of sporulation of *Noctiluca*, and the theory that it is possibly a stage in the life cycle of *Noctiluca scintillans*, "representing the earliest stage in the life of that species before inflation by hydrostatic vacuoles", is very suggestive. *Noctiluca* itself has periods of great abundance in Mutsu Bay, especially in May and June, forming local shoals by wind action so dense that the water is much discoloured. In the same report and also from the Marine Biological Station of Asamushi (No. 19, "Notes on Recent Foraminifera from Mutsu Bay"), Dr. Yoshine Hada records 94 species and 6 varieties, 11 of the species being new to science. The paper is beautifully illustrated with text figures.

Additions to the British Coleopterous Fauna.—For a number of months past, a special feature of the *Entomologists' Monthly Magazine* has been the contributions of Mr. H. St. J. Donisthorpe on additions to the British coleopterous fauna. These articles are in the form of an annotated list of all additions made to this division of the fauna since the publication of the supplementary volume (6) of Fowler's standard work on the order. The excellent coloured plates that have appeared from time to time greatly enhance the value of these articles, and it is hoped that when the series is completed it will be available as a separate publication. The 'list' serves as an admirable example of how much work there still remains to be done, even in so well explored an order of insects as the Coleoptera, before our fauna can be regarded as having been fully studied. Many of the species, now rightly claimed as British, are only known from a single locality, or perhaps from but one or two places, and there is consequently plenty of work for the assiduous collector still to do in determining their actual ranges of distribution.

The Rift Valleys of South Australia.—The problem of the structural origin of the gulfs of South Australia and the Lake Torrens basin is discussed at some length in a paper by Dr. C. Fenner on the major structural features of South Australia in the *Transactions and Proceedings* of the Royal Society of South Australia, vol. 54. Dr. Fenner argues against the use of the term rift valley and prefers to call the features Spencer-Vincent and Torrens Sunklands, but maintains that there is insufficient evidence to support either the tension or compression theory of origin. Nevertheless, he believes that in the Mount Lofty and Flinders Ranges there is much to suggest that thrust movement and not tension has been the dominating factor. The fault block movements are generally considered to have occurred in late Miocene and Pliocene times, but there is much evidence of an intense phase in early Pleistocene and of differential movements along fault lines in late Pleistocene to recent times.

A New Uranium Mineral.—The uranium minerals of Spruce Pine, North Carolina, include a central core of black uraninite surrounded by a dark reddish brown zone, which is followed successively by brilliant orange-red gummite and an outer shell of bright yellow uranophane. The reddish brown zone has now been investigated in detail by Ross, Henderson, and Posnjak (*Amer. Min.*, May, 1931, pp. 213-220) and found to be a new mineral with distinctive chemical and optical properties and X-ray spectrum. They propose to call it *clarkeite*, after the veteran geochemist F. W. Clarke. Henderson's analyses show a composition of the type $RO . 3UO_3 . 3H_2O$. The mineral is a direct hydrothermal alteration product of uraninite, and as it is rich in soda it was probably formed during the stage of pegmatitic alteration characterised by the replacement of microcline by albite. At a later stage the solutions became poorer in alkalis and richer in silica, and clarkeite, being unstable in their presence, altered to gummite, which in turn was changed to uranophane with still higher silica and more lime and water. A reinvestigation of gummite is foreshadowed, the authors having discovered that the optical properties of the Spruce Pine gummite differ from those given in the literature.

Nitrate Deposits of California.—The nitrate deposits of southern California are generally associated with the soils resting on tilted beds of Tertiary clays and shales. A typical section shows a few inches of *caliche* underlying a layer of soil that is efflorescent below and compact above. The caliche contains most of the nitrate, though the percentage is small compared with that of the associated chlorides and sulphates. The various occurrences and the problem of origin are dealt with by L. F. Noble in *Bull.* 820 of the United States Geological Survey. Three hypotheses are considered: (*a*) upward movement of soluble salts by sub-surface moisture through capillary action; (*b*) downward movement from the soil and other surface sources; and (*c*) enrichment at the contact zone between soil and bedrock by general erosion. The last of these is regarded as the dominant process, subject to there being a sufficient quantity of saline material available, ample time for concentration, and a favourable arid climate. Although the deposits investigated do not appear to justify commercial exploitation, workable deposits of other useful commodities have been found in the course of the investigation. These include bentonite and various clays, boron minerals, strontium minerals, rock salt, gypsum, and magnesite.

Luminous Phenomena accompanying Earthquakes.—There can be little doubt that the destructive Idu (Japan) earthquake of Nov. 26, 1930, was closely associated with the lights seen shortly before, and for at least an hour after, the earthquake. They were observed by Mr. K. Musya, who collected records from about 1500 observers on both sides of the Idu peninsula, in the valley of the Sagami river, and on the shores of Tokyo Bay and the Boso peninsula (*Earthq. Res. Inst. Bull.*, vol. 9, pp. 177-215; 1931). The lights were very strong—in one place brighter than moonlight. They were usually described as bluish in colour, but sometimes as reddish yellow, yellow, or reddish blue. In shape, they resembled the rays of the rising sun, search-lights, and fireballs. The duration of each light was longer than that of lightning, and some careful observers report that the same light continued more than a minute. The directions in which they were seen pointed usually, but not always, to the epicentral region of the earthquake.

The Raman Effect.—The issue of the *Physikalische Zeitschrift* for May 15 contains an account, which extends to 20 pages, by Prof. K. W. F. Kohlrausch, of the University of Gratz, of the present position of our knowledge of the Raman effect. The author points out that Lommel in 1878 predicted the production of oscillations of frequency $n \pm w$ when light of frequency n impinged on a substance having a free frequency of w; and that the theory of the production of such oscillations was further developed by Smekell, Herzfeld, Kramers, and Heisenberg from the quantum point of view in the years 1923–25, although Raman and Krishnan were only able to establish their existence experimentally in 1928 (NATURE, 121, p. 501). After a short account of experimental methods, the author reviews the theories and deals with the structure of the undisplaced lines, the entry of rotational frequencies, the intensities of the displaced lines, and the relation between the displacement of the lines and the structure of the molecule of the substance. References to 103 papers on the subject are given.

Absolute X-Ray Wave-lengths.—Since it has been found possible to measure the wave-lengths of X-rays by diffraction from an ordinary ruled grating, there has been some doubt as to the value of the charge on an electron, which can be calculated from the X-ray data, and has appeared higher than Millikan's value. Some new absolute measurements of X-ray wave-lengths are described and discussed critically by J. A. Bearden in the second May number of the *Physical Review*. The lines measured were the K lines of copper and chromium, which are as long as can be used conveniently without an exhausted spectrometer. Gratings were used which had been ruled by Prof. R. W. Wood and under the direction of the late Prof. Michelson, and in some cases as many as eighty orders of diffracted lines were obtained. The results are of high accuracy, the wave-length of the K_β line of copper, for example, being given as 1·39225 A., with a limiting error of ± 0·00014 A., which is definitely about 0·2 per cent greater than the wave-length from crystal measurements. The corresponding charge upon the electron is $4{\cdot}806 \times 10^{-10}$ e.s.u. This could be taken to indicate that the standard value of $4{\cdot}77 \times 10^{-10}$ e.s.u. is wrong, and has at times been so interpreted. Dr. Bearden, however, now takes the contrary view, that the charge as found from the X-ray measurements is too high, and that there is a flaw in one step in the deduction of the electronic charge, in neglecting the imperfections in crystal structure the existence of which has been pointed out by Zwicky. If the difference found is entirely due to this cause, it gives in fact a precise method for determining quantitatively the magnitude of the effect in crystals, and further, if a good independent estimate of the flawing existed, the present data could be applied to the determination of the electronic charge with higher precision than has been attained by other methods.

The Jet-Wave Rectifier.—The extending use of direct current for electric traction has caused a great demand for devices which will rectify alternating current into direct current. High power rectifiers based on the valve patented by Cooper Hewitt in 1903 are widely used. The Hartmann jet-wave rectifier, which is a purely mechanical device based on interrupting a jet of mercury carrying a current by means of a tungsten knife, is also being used in practice, but they each have special fields where they do not compete with each other. In a treatise entitled "The Jet-Wave Rectifier: an Account of its Constructional Development during the Years 1919–1929" (*Danmarks Naturvidenskabelige Samfund*: *Ingeniørvidenskabelige Skrifter*. A, Nr. 24. Pp. 300. København: G. E. C. Gad. 30·00 kr.), Jul. Hartmann gives a fairly complete account of the research work carried out by the Hartmann Rectifier Co. in Copenhagen on this rectifier. The author gives an interesting account of the development of the invention. When preparing for his master's degree at Copenhagen, in 1906, he was given by Prof. Christiansen the problem of determining the velocity and the charge-mass ratio of the particles of a cathode ray using the method of deflection in a magnetic field. A few months later, when using induction coils with mechanical interrupters, he found them very unsatisfactory. Thinking over his previous work, it suddenly struck him that a mercury jet might be deflected by a magnetic field in the same way as a cathode ray, and this led him to devise the jet-wave rectifier.

Astronomical Topics.

Encke's Comet.—A letter from Mr. H. E. Wood, Director of the Union Observatory, Johannesburg, announces that he detected this famous comet a week earlier than Mr. Bobone at Cordoba; but as he did not send a telegram, the announcement of the latter arrived first. The comet was so low in the evening twilight when first photographed that part of the field of the object-glass was cut off by the wall of the dome. In spite of this, the comet gave such a strong image with eight minutes' exposure that Mr. Wood estimates its magnitude as fully 7, which is 2 magnitudes brighter than Mr. Bobone's estimate. The plates have not yet been accurately measured, but the following rough positions are sent:

1931	R.A (1931.0)	N. Decl.
June 14·7 U.T.,	$7^h\ 1{\cdot}6^m$,	15° 23′
June 16·7	7 10·8	13 38

These positions fully confirm those of Mr. Bobone in indicating that perihelion passage was about 18 hours earlier than Matkiewicz's prediction, which was June 3·84757 U.T.

This is the thirty-eighth observed apparition of the comet; it was seen in 1786, 1795, 1805, 1819 (when its periodicity was recognised by Encke), and at every return since then. The reason for the unbroken records held by this comet and by that of Halley is that their perihelion distances are small, so that they are easy objects when near their perihelion.

As a proof that Encke's comet is gradually fading, it may be mentioned that in 1865 the perihelion passage was 5·7 days earlier than in 1931, so that the conditions of observation were similar; in 1865 the comet was observed in February with instruments of moderate size; but in 1931, Prof. G. van Biesbroeck, using the powerful instruments at Yerkes Observatory, failed to obtain the faintest image of it on his photographic plates in February and March.

Impact of Stars with Nebulæ.—Mr. K. Hirayama, of Tokyo Observatory, investigates in *Proc. Imperial Acad. Japan* (7, No. 5; 1931) the effects of the impact of a star with a spherical nebula. The relative velocity is probably hyperbolic before impact, but it may be reduced by the impact below the parabolic value, in which case there will be repeated impacts, which will result in the capture by the star of part of the matter of the nebula, while the star's orbit relatively to the nebula will be reduced in size. The author suggests that the nebula might in time be so reduced and broken up as to form a system of planets revolving round the star; this is an alternative to the theory that explains the formation of the planets by the tidal action of a star passing near the sun. The paper goes on to show that a binary system passing through a nebula would have the size and eccentricity of the orbit diminished and the masses of the components increased. It also suggests that a large spherical nebula might, by capturing a great number of stars, form a globular cluster, while the repeated impacts of the stars with nebulous matter would end in the absorption of most of the latter.

Jubilee Celebrations of the Society of Chemical Industry.

THE celebration of its jubilee by the Society of Chemical Industry will long remain as a landmark in the history of both pure and applied science, and as a very convincing demonstration of the progressive narrowing of the gap between industry and pure research. The members of the Society were welcomed at the inaugural ceremony at Guildhall by the Lord Mayor of London and the Vice-Chancellor of the University of London. The close association which has always existed between the Corporation and the livery companies of the City and chemical education and research was manifested by the presentation of plaques and addresses to a number of the companies. The importance of chemical technology in this industrial age will render the meeting a not unimportant event even in the long history of Guildhall.

The first day of the celebration was marked also by the opening of the British Chemical Plant and Research Instruments Exhibition by the president of the Society, Sir Harry McGowan. A similar exhibition has not been held since 1926, and the progress made during the past five years in the application of pure metals such as aluminium, nickel, and silver, of stainless iron and steel, and of special alloys, is very striking; although it cannot yet be said that an alloy may be selected to meet any given set of requirements relating to corrosion resistance, ease of working, and mechanical strength, nevertheless such an ideal state is approaching rapidly. Methods of fabricating plant have also made strides, largely as a result of the work carried out by the British Non-Ferrous Metals Research Association on the welding of, especially, copper and special alloys; of particular interest was what is believed to be the first public exhibit of welded copper plant. Despite these developments, fused silica is still making progress and widening its scope and the size of unit available; recent productions include a valveless plunger pump, a water-driven gas injector, and a new type of lamp in which the shorter wave-length rays of the quartz mercury arc are utilised to produce ozone but are removed from the light by a filter in order to obviate danger to the eyes. New aids for the laboratory were represented by the Meta-filter, a continuously operating still for the production of conductivity water, stainless steel and iron apparatus, and a flow meter for gases at high pressure; a notable demonstration was that of the cinematographic method of studying crystal growth, which should be of considerable value to the research worker and to the industrial chemist.

A special section of the exhibition was arranged by the Chemical Engineering Group to illustrate some of the work carried on by the Department of Scientific and Industrial Research and the various industrial research associations. One of the most important advances made in physico-chemical science during the past decade or so, namely, the investigation of structure by means of X-rays, was illustrated in its technical applications by a variable anticathode X-ray tube and some forms of X-ray spectrograph designed for studying the change of structure of alloys on heat treatment and cold working, and for examining such materials as rubber and wool. Other exhibits in this section included a quartz spectrograph for the routine quantitative analysis of metals and alloys, apparatus for testing the surface conductivity of materials such as ebonite, for measuring plasticity and plastic yield, and for bringing about artificial weathering and ageing. The development of the chemical autoclave from Papin's digester of 1681 to the modern vessel, which, thanks to special forged alloy steels, is capable of being used at several hundred atmospheres pressure and at temperatures up to 450° C., formed the subject of a series of drawings and exhibits by the National Physical Laboratory. The products of high pressure synthesis shown included hydrogenation products of low temperature tar, reduction products of fluorine compounds, and a variety of condensation products.

Other activities of the Chemical Research Laboratory at Teddington, demonstrated when the laboratories were opened for inspection by the members of the Society, related to the investigation of tars, the production of synthetic resins, and to studies on the corrosion and protection of metals, and notably the protection of aluminium by anodic oxidation and of magnesium alloys by films of selenium. An attractive collection of co-ordination compounds, chemotherapeutic substances, and chemicals of historic interest, such as organic antimonials and arsenicals, were also on view.

One of the most valuable of the week's activities, and one which merits wider attention than that of those directly engaged in the relevant industries, was the discussion of a series of papers on fuel, selected by the Fuel Committee. The paper by Dr. C. H. Lander summarised the present position of Great Britain with regard to fuel supplies, and discussed the economic practicability of the hydrogenation of coal and of the production of our oil fuel requirements by this process and, to a limited extent, by pre-carbonisation of some of the coal which is now burned in its raw state. The application of hydrogenation to the treatment of petroleum residues is regarded by Dr. A. E. Dunstan, of the Anglo-Persian Oil Co., as a definite technical success, although its objective is no longer the production of petrol, but of, for example, lubricating oils from low grade stocks; the relative values of the refinery products are bound to alter in the not very distant future, when petrol is ousted from its present premier position by the development of the high-speed Diesel engine. It appears likely that a by-product industry, based on petroleum and comparable in magnitude with that based on coal tar, will become established during the next few years as a result of the increasing utilisation of refinery gases and gases obtained by cracking for the production of solvents such as glycols, esters and alcohols, and of 'anti-knock' substances; the growing demand for asphalte for road use and of carbon black for rubber manufacture is also of importance in this connexion. The future of fuel is a controversial subject, but it seems clear that the production of oil from coal in quantities sufficient to meet the demands of Great Britain is, at the moment, economically impossible; but the striking and constantly increasing yields of oil which are now obtained suggest that the processes available may compete seriously if and when oil prices rise from their present abnormally low values.

Another aspect of the same problem was presented by Mr. Taylor in his paper on the production of liquid fuels from water gas. The most promising of the many processes which have been investigated is that of F. Fischer, which yields 75–80 per cent of the calorific value of the water gas as hydrocarbons; this yield corresponds with about twenty-five per cent of the heat value of the coke required for the production of the gas. Although processes of this type resemble hydrogenation in being economically impracticable at the moment, it is probable that when the price of petrol rises, more direct and therefore cheaper methods will have been perfected. Other important papers in the fuel section included that by Prof. R. V. Wheeler on gaseous combustion, which dealt with the industrial applications of recent research work on the combustion of gases, and especially on flame propagation and the influence of diluents; and papers on low temperature carbonisation, the utilisation of low temperature tar, and fuel developments in iron and steel practice. A closely related subject, at least from the theoretical aspect, was dealt with in Prof. Wheeler's lecture on a subject of both academic interest and increasing technical importance, namely, dust explosions—delivered, very appropriately, at the Home Office Industrial Museum.

Sir Harry McGowan's presidential address dealt mainly with the reaction of scientific progress on the finance and economy of the modern State, and constituted an opportune appeal for economic unity between the nations of the Empire, for still greater unification of the various industries of each country, and for a deeper appreciation of the economic background of all industrial activity. The address by Dr. H. Levinstein, on the occasion of the presentation to him of the Society's medal, urged that the lessons to be learned from the history of the dyestuffs industry should be taken to heart by other national industries, and that the 'buy in the cheapest market' maxim should be reconsidered.

Dr. G. Engi, conveying the congratulations of the Society of Chemical Industry in Basle in an address delivered at the Salters' Hall, gave an account, in considerable detail, of recent developments in both the scientific and technical aspects of the chemical industry in Switzerland. The development of the dyestuffs industry in that country has resulted largely from fertile inventive activity and a reasonable degree of rationalisation; recent developments include the production of thioindigo dyes of the naphthalene series, of vat dyes obtained by introduction of the cyanuric ring into the anthraquinone molecule and by the synthesis of indigoid and thioindigoid derivatives of the anthracene and anthraquinone series, and of complex chromium and copper azo-dyes. Important advances have been made also in connexion with pharmaceutical products, synthetic resins, textile chemistry, and electrochemical processes. Addresses were given also by two of the new honorary foreign members of the Society, that by Dr. Sørensen dealing with hydrogen ion concentration, and that by General G. Patart with the technique of gaseous syntheses at high pressure; the development of, for example, synthetic methanol demands considerable reduction of costs, which, since the raw materials are available at almost zero cost, must be concerned mainly with the plant and equipment used. The large part played by catalysis in this type of reaction, however, necessitates improved methods of purification of the raw materials in order to remove 'poisons', and further work on the preparation of highly active catalysts. The importance of the outlets for these synthetic products justifies continued research and the expenditure of relatively large sums of money.

The very full programme for the jubilee week was completed by a series of visits to factories engaged in the chemical and related industries and to various research laboratories, and by a number of purely social functions.

H. F. GILLBE.

Congress of Universities of the Empire, 1931.

THE congress of the seventy universities of the British Empire began its official programme in London on July 1 and continued its work in Edinburgh on July 6-11. On July 3 in Guildhall—"the centre of the Empire in London, which has been for centuries a financial, and is this day an educational clearing-house of the world"—H.R.H. the Prince of Wales in his address of welcome as president of the Congress observed that "one of the things the world requires most to-day is organised knowledge and the means of distributing it". This truth crystallised in a sentence world necessities in a time of crisis. Pope said a little learning, not a little knowledge, was a dangerous thing; and assuredly in these days it is not learning which the peoples of the world require. They have enough of that from the popular press and the politician.

That millions are anxiously seeking "the two noblest things, sweetness and light" in the matter of post-War reconstruction, presented to the Empire universities an opportunity of discussion and decision on the question of the best method of disseminating organised knowledge and of promoting a closer co-ordination of their activities so as to ensure that they play their part in bringing order out of chaos. It was realised by all who participated in the work of Congress that it is in the universities, and possibly in the universities only, that the problems of to-day and the policy of to-morrow can be examined with that detachment of view, that width of judgment and that patience of understanding which alone will ensure their solution, and that these centres of knowledge must become more and more the training grounds of the young men and women who will have to do the work of the Commonwealth in the future. Lord Meston presented this point of view in another form when he said that there were certain things, essential to the well-being of their peoples, which he believed their universities were doing, which ought to be done by their universities and which could not be done systematically except by their universities. It was further realised that universities, any more than individuals, cannot live to themselves alone. The social functions—a natural and necessary part of the work of a congress of this kind—contributed to the formation of friendships, the creation of mutual understanding and trust and to that action and interaction of minds which, in Burke's words, "draw out the harmony of the universe". From every part of the Empire an instinctive desire for closer association was revealed.

Universities, however, are naturally jealous of their autonomy. Sometimes, perhaps, they are disposed to convert their conceptions of autonomy into a fetish. It is, none the less, a condition of their very existence that they should be responsible neither to individuals nor to the State for the direction of their affairs. They must develop along the lines set by tradition, by geographical accident, and by their charters. It will be a tragedy if that independence which the universities have rightly and sacredly cherished is sacrificed to expediency or to financial necessity. Not even the benefactions of the wealthy must detract from the purposes for which they have been established and which they must subserve.

The calm of the cloisters has, in these post-War years, however, been disturbed by repercussions from world politics, and in his observation that Imperial necessities demanded from the universities support of the Universities Bureau of the British Empire, the Vice-Chancellor of Manchester lifted a discussion on financial commitments out of the sphere of self-commiseration into that of bounden duty. By this one observation, the Congress was called upon to decide whether one of "the strongest and soundest links of Empire", in the Prince's words, should be the universities of that Empire.

The question of the financial support of the Bureau arose out of the proposals formulated by the executive committee of that Bureau for its reconstitution. The amended articles of association circulated for consideration by Congress were directed to the creation of a central institution which should be a genuine university organisation. Three main principles were enunciated in these draft articles: that the Empire universities should be the members of the reconstituted Bureau; that these members should pay a fixed annual subscription, the amount of which is to be determined by the members themselves acting through their representatives at the first annual general meeting held after the adoption of the articles; and that the policy and the administration of the Bureau should be controlled by a council composed of twenty-one of these representatives selected by regional groups of university representatives. In considering the proposals of the executive committee, the question that excited the greatest interest at the Congress business meeting was whether the fourteen individuals representing, but not directly responsible to, the Empire universities, who at present constitute the association known as the Universities Bureau, should continue to control and direct its administration; or whether the time has come to express a resolute faith in the solidarity of the universities of the Empire, to create an organisation which shall be truly representative of these universities, and to provide funds which will enable these members to give effect to the late Lord Balfour's policy of "promoting greater co-ordination and power of mutual consultation". A third possibility, which was indirectly raised but was rejected, was whether the Universities Bureau, which has been the creation of the universities themselves, should or should not be dissolved.

Doubt was cast by a few, dwelling in a past of fond imaginings, upon the new form of constitution, and it was even suggested that the scheme promulgated by the committee should be referred back for further consideration by the universities. It is significant, however, that Congress refused to accept this suggestion of flinging the work of two years again into the melting-pot, and satisfied the apprehensions of the ultra-orthodox with the assertion of the principle that the powers of the Universities Bureau of the British Empire should not be exercised in any such way as to restrict the powers and duties exercised by the constituent members under the several charters, statutes, regulations, and other instruments of their self-government.

This discussion finally asserted the view—a view which was unquestionably a distinctive feature of this Congress—that the Bureau has a definite place in the hegemony of Empire universities. The recognition by the Prince of Wales of the invaluable work done by the Bureau in publishing the "Universities Yearbook", a compendium which, since Sir H. Frank Heath assumed the office of editor, has become of ever-increasing value—by its administration of trusts, by its organisation of congresses and conferences, and by its centralised machinery, was affirmed by Congress itself. Indeed, during the subsequent sessions of Congress, it was frequently suggested that the Bureau might be of greater utility to overseas universities in many more directions than has hitherto been contemplated as feasible.

The addresses delivered by the Lord Provost of the City of Edinburgh, in which he hinted at the citizens' pride in their university; by the Marquess of Linlithgow, which in its insistence on the value of the trained mind was tinged with the sage reflections of an administrator; by Lord Meston, who as a layman prescribed not panaceas but useful and suggestive 'dietary' regulations and denounced illusions, claptrap and clichés, and by Sir Donald MacAlister, who from a wealth of experience warned universities of the dangers arising from overcrowding, directed attention in different ways to some of the more important questions with which universities are faced severally and collectively.

The discussions on the university graduate in commerce and industry, the Ph.D. degree, the conditions of admission to universities, general honours courses, post-graduate study in medicine and surgery, and facilities for overseas students, were all followed with interest by delegates from the universities both at home and overseas. The members of Congress had facilities provided for them to visit the Universities of Oxford, London, Reading, Glasgow, and Edinburgh, their colleges and their departments, and also visited a number of London County Council and other educational institutions, and two of the largest new schools in Edinburgh. The hospitality which was extended to all throughout their stay in London and Edinburgh has left an indelible impression of friendliness and goodwill.

This Congress will have more than served its purpose if it has helped to eradicate that feeling of isolation in which many of the overseas universities have to discharge the trust imposed upon them as repositories of organised knowledge, and to create in them a sense that the kinship of universities is not a localised relationship but is world-wide. It has also served to suggest, and perhaps this is its most remarkable achievement, that it is through a centralised agency that information of value to all parts of the Empire may best be distributed and that a community of interest may be created and maintained at full strength.

Annual Conference of the Museums Association.

THE forty-second annual conference of the Museums Association was held at Plymouth on July 6–11, by invitation of the Mayor and Corporation, who kindly placed at the disposal of the delegates the ancient Prysten House of St. Andrew's Church, now being restored under the name of the Abbey Hall. Here some two hundred delegates assembled under the presidency of Sir Henry A. Miers, whose address dealt with the recent and the impending work of the Association.

The chief event of the year has been the legal incorporation of the Association as a "company limited by guarantee", and this has led to the recognition of the Association by the Government. A directory of all museums in the British Isles, to which the public has access, has been issued. With the co-operation of the Carnegie United Kingdom Trustees, a short school for curators was held in London last October, and schools for this autumn are being organised in both London and Edinburgh; to interest educational authorities in the work done by museums in connexion with schools, an exhibition of circulating cases and collections was arranged at the London County Hall; grants to a total of £1220 have been made to six museums to aid them in reorganising their exhibited collections, and other applications are being considered; to accomplish all this work a permanent office with a paid secretary and staff has been provided."

Other matters on which Sir Henry Miers commented were "the growing magnitude and importance of the *Museums Journal*"; the discussion with the Library Association of needed new legislation for public libraries and museums; the federations of museums in Lancashire and Cheshire and in Yorkshire; the reorganisation of various museums in the direction of local education, as at Portsmouth, Salisbury, Port Sunlight, Wisbech, Norwich, and Aylesbury; and the recent visit of the secretary, Mr. S. F. Markham, M.P., to the United States. More in the future were the suggestions made by the Association to the Standing Commission on Museums; the preparation of a survey of museums throughout the British Empire, and the completion of the directory by a volume including them (this is with the help of the Carnegie Corporation of New York); the growing realisation by the educational departments of the British Government and by the World Institute of Adult Education of the educational possibilities of museums, long since realised by the Association.

The meeting was noteworthy for the increased time devoted to papers and for the animated discussions. Following the president's address, Dr. W. T. Calman, while approving modern attempts to illustrate the problems of biology, urged that on one hand they should be kept distinct from the systematic series, and on the other that there should be an exhibit definitely explaining the principles and main outlines of taxonomy. Mr. J. Bailey, formerly head of the Circulation Department at the Victoria and Albert Museum, complained that the 1924 and 1931 Loans Acts had not been put into operation, at least so far as the Bloomsbury departments of the British Museum were concerned; his view that the national treasures should be more widely lent out did not find much support from subsequent speakers. An instructive talk on "Plymouth Porcelain", illustrated by the epidiascope, was given by Mr. A. J. Caddie, curator of the Plymouth Museum. "Why do we use Plate-glass in Museums?" was the provocative title of Mr. Leney's account of his proposals for an unenclosed reconstruction of the county's natural scene in the Norwich Museum; while sympathising with their colleague's bold and beautiful dream, the practical curators present supplied satisfactory replies to his question.

On Wednesday morning an account of the Courtauld Institute of Art by its director-elect, Mr. W. G. Constable, set at rest doubts that had been raised by the letters of Lord Lee of Fareham and other notices in the daily press. A fluent and witty speech by Mr. S. C. Kaines Smith, director of the Birmingham Museum, on "Art Museum Problems", provoked much applause and some criticism. After this, "A Suggested System of Museum Registration", by Mr. K. de B. Codrington, of the Indian Section of the Victoria and Albert Museum, fell a little flat, though it was clearly the fruit of experience and careful thought; there would doubtless have been more discussion had the author not been prevented by illness from attending. The important but somewhat dry subject of paper for museum labels was made interesting by Dr. L. J. Spencer, Keeper of Minerals in the British Museum.

On Thursday, Lieut.-Col. J. M. Mitchell, secretary of the Carnegie United Kingdom Trust, expounded the principles of the Trust's action as laid down by its founder, and thus showed what kind of help museums might expect to receive; this was a revelation to many of those present. Mr. H. J. M. Maltby, of the Salford Museum, showed, perhaps unintentionally, that the "Present-Day Problems of Provincial Museums" are much the same as the problems that have vexed curators ever since the Association was founded; among them the local town council looms large.

Friday produced three very diverse papers. Mr. J. H. Iliffe, recently professor at the University of Toronto, in charge of classical archæology at the Royal Ontario Museum, spoke on "The Museum Situation in Canada", and urged the importance of personal contact between Canadian curators and their colleagues in the home country, so that the latter might realise the great diversity of outlook and the distinctness of the several regions in the Dominion. Dr. C. Hay Murray, of the Liverpool Museum, recounted his attempts at estimating the value of the Museum to the public by the length of time spent in the building by visitors; he had found that the average duration of a visit had notably increased of recent years. The final paper, an account by Mr. C. A. Ralegh Radford of the Roman remains discovered at Exeter by excavation, was a valuable contribution to archæology, with no obvious bearing on museum questions.

The only exception that could be taken to the number of papers was that they left little time for visits to museums. Members would gladly have given up the walk round Devonport Dockyard for more opportunity of studying the Plymouth Museum and the recently restored Elizabethan house. They were, however, hospitably and instructively entertained at the Marine Biological Laboratory, and were courteously received at the Athenæum, where is a museum said to be one of the oldest in the country and an excellent example of a learned society's museum in the day of our grandfathers. Too short a stay was made among the delights of Cotehele, visited by kind permission of Lady Mount-Edgcumbe. Other grateful entertainments were a luncheon offered by the Mayor, a Mayoral reception and dance at the Guildhall, and tea at the Abbey Hall on the invitation of Lady Astor, who at the annual dinner proposed health and prosperity to the Museums Association.

Imperial Sugar Cane Research Conference, 1931.

THE first Imperial Sugar Cane Research Conference, which was opened on July 20 by Dr. Drummond Shiels, M.P., is the second of these conferences of overseas research and administrative men convened by the Empire Marketing Board on a crop rather than on a science basis. The first was the Wool Research Conference held last year. The object is to get a clear picture of research in widely scattered countries, so that the gaps can be clearly seen and a general programme of research for the Empire worked out.

The Board has already made grants for research in Mauritius, where a Cane Research Station was started last year, and in Barbados, and it supports the Imperial College of Tropical Agriculture in Trinidad, where a beginning has been made in fundamental research on cane genetics. Other applications have been received, and the Board decided to consider the broad questions of research policy and of where the work could best be carried out. Besides delegates from home organisations, such as the Imperial Bureau of Plant Genetics at Cambridge (the director of which, Sir Rowland Biffen, attended the Conference), there were representatives from India, South Africa, Trinidad, Barbados, British Guiana, Fiji, Mauritius, and the Leeward and Windward Islands.

The economic position in each sugar-producing country was outlined, and this was followed by a sketch of the scope and aims of the research stations. Genetics and cane-breeding have hitherto overshadowed the other branches of research, although more attention has lately been given to the control of insect and fungus pests. Interesting details were given of the breeding work at Coimbatore, in South India, where improved varieties of the north Indian hardy cane have been evolved which are estimated to give an increased yield of 50 per cent over the ordinary varieties. Attention is now being given to intergeneric crosses with cereals which aim at reducing the ripening period. One of the Java canes, *POJ* 2725, has been crossed with *Andropogon sorghum* and the hybrid has matured in five months, instead of the normal 10-12 months, and yielded a sucrose content of 16 per cent in the juice. Equally remarkable results have been obtained with tropical or 'noble' canes (*Saccharum officinarum*) in Barbados, where the whole system of cane-breeding first originated. The Department of Science and Agriculture pots out about 16,000 seedlings a year, largely for distribution throughout the West Indies, and one variety in particular, *BH* 10 (12), is now known all over the world.

Each country, however, has its own peculiar requirements, often depending as much on economic as on climatic or edaphic factors, and has to work out its own salvation as regards varieties. But the fundamental aspect has barely been attacked in the Empire, and there is clearly a case for some central station to undertake long-range research admitted to be outside the scope of the ordinary department of agriculture.

University and Educational Intelligence.

CAMBRIDGE.—The managers of the Frederick James Quick Fund have elected Mr. David Keilin, Magdalene College, to the Quick professorship of biology for a period of three years from Nov. 1, in succession to Dr. G. H. F. Nuttall, Magdalene College, who has held the professorship since 1906, when it was founded.

W. J. Heasman, of Trinity Hall, has been appointed senior curator, and G. J. Kerrich, of Christ's College, junior curator of the Museum of Zoology.

E. E. Pochin, St. John's College, has been elected to the Michael Foster research studentship in physiology.

LONDON.—Prof. C. Burt, part-time professor of education at the London Day Training College, has been appointed professor of psychology in University College, as from Aug. 1, 1932.

The Sir George Jessel studentship in mathematics awarded to Mr. T. E. Garstang, of University College, for 1930–31, has been renewed for the session 1931–32, and a similar studentship awarded to Mr. H. Kestelman, of University College, for the session 1931–32.

IN a note in NATURE of July 18, p. 124, in referring to the reception at the new premises of Messrs. H. K. Lewis and Co., Ltd., it was stated that Prof. Thane discussed text-books; we are informed that the speaker was Prof. H. R. Kenwood, emeritus professor of hygiene in the University of London.

THE following scholarships have been awarded by the Council of the Institution of Naval Architects: Royal Commissioners for the 1851 Exhibition post-graduate research scholarship in naval architecture (1931), £250 per annum for two years, to Mr. William John Roberts, University of Liverpool; Sir William White post-graduate scholarship in naval architecture (1931), £150 per annum for two years, to Dr. J. A. J. Bennett, University of Glasgow.

SIR CAMPBELL STUART has been appointed chairman of the Beit Fellowships for Scientific Research Trust, and Sir Alfred Beit, a trustee, both in succession to the founder of the fellowships, the late Sir Otto Beit. New fellowships of the value of £250 a year tenable for two years, beginning September 1931, have been awarded to Mr. W. H. Wheeler (University of Cambridge and the Imperial College) for research on the effects of electric and magnetic fields upon gaseous explosions and detonations and to Mr. J. I. Armstrong (Queen's University, Belfast, and the Imperial College) for research on the respiration of Fungi with special regard to inorganic nutrition.

UNDER the patronage of the New Education Fellowship, a prize of 10,000 francs is being offered for the best treatise on "Total Education (Physically, Intellectually, and Morally)". Realising that the total education of an individual is conditioned chiefly by heredity and environment, the object of the competition is to emphasise the necessity of making inherited qualities the best possible, and of a careful development of such characteristics. Each individual can train himself and others in the world-wide propagation of this education, and it is essential that there should be an understanding between educationists, especially from the universal point of view. Further particulars concerning this prize competition can be obtained from either Groupe Français d'Éducation Nouvelle, 41, Rue Gay-Lussac, Paris V^e^, or the Institut de l'Entente Universelle, Terres Rouges, Toulon, Var., the latter of which remains open during vacations.

AT the British Commonwealth Education Conference which is being held at Bedford College, London, on July 24–30, under the presidency of Sir Percy Nunn, the general theme will be "Education in a Changing Empire". Native education in Africa and India occupies a considerable part of the programme of the proceedings of the Conference. The education of the non-European in Africa will be considered by the Rev. R. C. Blumer, Dr. G. G. Gillie, Miss Sara Burstall, Dr. S. Rivers-Smith, Mrs. Macgregor Ross, Mr. J. H. Driberg, and Mr. F. S. Livie-Noble. Education in India will be dealt with, under the chairmanship of Sir Phillip Hartog, by A. Yusif Ali, Fakhruddin Ahmad, and others, and the problem of bilingualism in Indian schools will be considered by Dr. Michael West. The Right Hon. W. Ormsby Gore, M.P., will give an address on "Some Education Problems of the Tropical Dependencies". Considerable attention, too, will be directed to interracial understanding, which is all to the good, showing how alive educationists are to this serious problem. Mr. H. Chaning Pearce and Miss A. Purvis will give addresses on the problem, and a discussion will be introduced by Mr. Arnold Lloyd. This subject will be closed by an address by Prof. H. J. Fleure. Among other subjects to be considered are vocational guidance, university problems in Africa south of Zambezi (Sir Carruthers Beattie), rural science and schools (Sir John Russell and others), the physical needs of children from 2 to 7 (Dr. James Kerr), growth (Prof. A. H. Harris), an Imperial Film Institute (Dr. T. Drummond Shiels, M.P., Mr. G. T. Hankin, Mr. J. R. Orr, and Prof. J. L. Myres) and modern psychology. Demonstrations of new aids to education include one by the British Broadcasting Corporation. Sir Percy Nunn will consider the question of an Imperial Institute for Education.

Birthdays and Research Centres.

July 26, 1872.—Prof. J. BARCROFT, C.B.E., F.R.S., professor of physiology in the University of Cambridge.

Until recently it was scarcely realised that an appreciable proportion of the blood in the body is not being used, except as occasion requires. Either it is side-tracked in such places as the spleen, the skin when congested, and possibly the large uterine veins of some pregnant animals, or it is 'held up' as in the liver (Maunter and Pick, Rein, Dale). Where are these depots? How long does blood remain in them? By what mechanisms is it held? For what purpose is it released?

July 28, 1864.—Prof. C. H. LEES, F.R.S., emeritus professor of physics in the University of London (East London College).

My objects of chief investigation now in progress are: The laws of plastic flow in overstressed materials; improvements in the methods of determining heat conductivities, with special reference to geothermal problems; the solubilities of gases in liquids at very high pressures, and the equilibrium of such solutions in gravitational fields; tests of theories of magnetisation with special reference to the effect of temperature on dia- and paramagnetic materials; and the solution of physical problems which arise in the study of flame propagation.

July 30, 1889.—Prof. J. KENDALL, F.R.S., professor of chemistry in the University of Edinburgh.

I am at present much concerned to find time for research in the short intervals between performance of administrative duties and attendance on committee meetings. An examination of the atomic weight of calcium contained in very old potassium-rich minerals from Portsoy and Rhiconich is, however, now being initiated. If a significant fraction of the small percentage of calcium present has resulted from the slow radioactive disintegration of the potassium, results of considerable interest in several directions may be anticipated.

Societies and Academies.

DUBLIN.

Royal Dublin Society, June 16.—**M. J. Gorman** and **H. A. Lafferty**: On a method of distinguishing the seedlings of Swedish turnip (*Brassica napus* L. var. *napobrassica* (L.) Reichb.) from those of broad-leaved rape (*Brassica napus* L. var. *biennis* (Schubl et Mart) Reichb.). Characteristic differences in the shape of the first foliage ('rough') leaf and the relative length of first internode are recognisable in the seedlings of these two plants in fourteen to twenty days from the time of sowing the seeds.—**T. Dillon** and **Annie McGuinness**: On alginic acid: its mode of occurrence and its constitution. Alginic acid cannot occur in the free state in seaweeds, since no carbon dioxide is evolved during the solution of the fronds of *Laminaria* in sodium carbonate. Dialysis of alginic acid prepared from fresh fronds gives rise to an increase in the ash-content. This suggests that in the plant the acid is combined with non-polar colloidal compounds of calcium and iron. Dry alginic acid has the formula ($C_6H_8O_6$); but this is a lactone. The polymerising unit is not an anhydride as in the case of starch and cellulose but the complete acid $C_6H_{10}O_7$. The units are therefore not pyranose or furanose rays; but open chains.—**M. Grimes** and **A. J. Hennerty**: A study of bacteria belonging to the sub-genus *Aerobacter*. The paper describes two species of bacteria previously unknown. These have been named *Aerobacter hibernicum* and *Aerobacter liquefaciens* respectively.

Royal Irish Academy, June 22.—**J. Reilly, B. Daly**, and **P. J. Drumm**: Studies in the pyrazole series—Diazotisation of aminophenylpyrazoles. The condensation of *p*-nitro phenylhydrazine and benzoyl acetone gives *p*-nitro phenyl 3 methyl 5 phenyl pyrazole, and the corresponding amino compound on reduction. This compound on diazotisation gives comparatively stable diazonium salts, and these as well as related-azo compounds have been prepared and compared.—**J. Reilly, M. Hayes, P. J. Drumm**: Lichenin. Purified lichenin has been nitrated and a compound of the type $C_{12}H_{15}O_5(NO_3)_5$ prepared. It is closely related to the corresponding cellulose nitrate.—**P. J. Drumm**: The constitution of Fischer and Bülow's pyrazole. The pyrazole obtained by Fischer and Bulow by the condensation of benzoyl acetone with phenyl hydrazine has been re-examined and found to be 1 : 5 diphenyl 3 methyl pyrazole. Evidence of the formation of the isometric 1 : 3 diphenyl 5 methyl pyrazole has not been obtained.

EDINBURGH.

Royal Society, July 6.—Clerk Maxwell Centenary: **Prof. E. T. Whittaker** delivered an address on James Clerk Maxwell and mechanical descriptions of the universe.—**J. Phillip, J. D. Scott**, and **J. Y. Moggridge**: Photochemical measurements of light intensity in two common vegetation types in tropical Africa, by means of the improved Eder-Hecht photometer. The paper records the high photochemical values registered under the light canopy of that very widely distributed woodland type, the *Berlinia Brachystegia*—other spp. community or 'Miombo'—and shows how the Bunsen-Roscoe values are correlated with duration of sunshine and with the readings of the Livingston radio-atmometer, and directs the attention of biologists to the usefulness of the Eder-Hecht photometer in the study of habitats in Nature.

PARIS.

Academy of Sciences, June 1.—The president announced the death of Eugène Cosserat, non-resident member.—**A. Lacroix**: The ægyrine nepheline syenite minerals of the north of the island of Kassa. The various pneumatolytic phases of the nepheline syenites of the Los Archipelago.—**Jules Drach**: Partial mean values and their application to the problems of mathematical physics.—**P. Villard**: The titration of phosphoric acid. Discussion of the results of Sanfourche, Cavalier, and Joly.—**M. d'Ocagne**: Remarks on interpolation with reference to a recent note by Wolkowitsch.—**Jean Baptiste Senderens**: The catalytic dehydrogenation, in the gas phase, of the fatty alcohols in the presence of pumice carrying sulphuric and phosphoric acids. Phosphoric acid has a less active dehydrating action upon alcohols in the gas phase than in a liquid system. Sulphuric acid, on the contrary, acts more readily in the gas phase.—**Georges Giraud**: The determination of tensors by partial differential equations connected with conditions at the boundary.—**G. Pólya** and **G. Szegö**: Some qualitative properties of the propagation of heat.—**S. Stoilow**: The inversion of the continued transformations of two variables.—**Gr. C. Moisil**: A system of functional equations.—**N. Aronszajn**: A remark on the singularities of Dirichlet's series.—**R. Gosse**: The integration of an equation of the first class.—**Florent Bureau**: Some properties of uniform functions in the neighbourhood of an isolated essential singular point.

—**F. E. Myard**: A closed chain with five rotoid couples, deformable at the first degree of freedom.—**E. Crausse** and **J. Baubiac**: The application of a recording method to the study of the vortices produced in liquids.—**H. Mineur, Varchon, Barbier,** and **Mlles. Canavaggia, Chevallier,** and **Roumens**: The movements of the stars as a whole.—**J. Renaux**: A new contribution to the study of the reduction of photographic negatives.—**G. Fayet**: The proximities of cometary orbits and the orbit of Pluto. From a study of 241 orbits of comets it was found that one parabolic comet and seven elliptical comets might come within the range of action of Pluto.—**Paolo Straneo**: The unitary theory of gravitation and of electricity.—**E. Estanave**: The projection in relief in space of the composite image recorded by the autostereoscopic plate.—**V. Dolejšek** and **J. Kubiček**: The complexity of the L series of barium.—**E. Huguenard** and **A. Magnan**: An ultra-rapid cinematograph giving from 2000 to 3000 images per second. The method employed consists in separating the film into a certain number of bands, each acted upon by a special objective, the various objectives working in turn at equal intervals of time. The apparatus has been applied to the study of the flight of a large fly, the wings of which were found to beat 100 times per second.—**S. Takvorian**: The search for element 61 by means of optical spectrography. These results confirm those given in a recent communication; neither the X-ray spectrum nor the optical spectrum shows any trace of element 61.—**La. Goldstein**: Atoms of recoil in the rare gases.—**Mlle. L. S. Levy**: Adsorption equilibria on previously precipitated manganese dioxide.—**E. Rinck**: Diagram of solidification of the calcium-sodium alloys. An account of a general method for determining, with satisfactory accuracy, the temperature-solubility curve of two partially miscible metals.—**M. Lemarchands** and **H. L. Roman**: The action of anhydrides upon metals. A study of the reaction between carbon dioxide and the metals sodium and potassium, and of the conditions giving the highest yield of oxalate. With potassium, at temperatures between 230° C. and 240° C., the maximum yield was 17 per cent of oxalic acid.—**Charles Baron, Charles Boulanger,** and **René Le Grain**: Contribution to the study of petrol-alcohol-benzene mixtures. A mixture of 70 per cent aviation petrol, 20 per cent benzene, and 10 per cent alcohol avoids the formation of hoar frost, possesses great stability at low temperatures, and retains the valuable properties of the alcohol-benzol mixture.—**André Chrétien**: The dielectric constant and chemical constitution. Method of measurement. As a source of current, the induction coil is replaced by a triode valve, and a galvanometer with a rectifying valve replaces the telephone as a detector. Data are given for benzene, chloroform, hexane, and acetal.—**Deluchat**: Ortho- and meta-divinylbenzenes. Ortho- and meta-diacetenylbenzenes.—**Charles Dufraisse** and **Raymond Buret**: Researches on the dissociable organic oxides: a dimethoxyrubrene. The introduction of two methoxy groups into the molecule of rubrene does not modify the essential properties of this hydrocarbon, except that the proportion of oxygen set free by the dissociation of the oxide (52 per cent of theoretical) is less.—**R. Quelet**: The monomethyl and monoethyl ether oxides of para-xylylene glycol.—**P. Carré** and **P. Mauclère**: The preparation of hydrobenzoin. The benzoin-hydrobenzoin system.—**Lespieau** and **Reginald L. Wakeman**: 1-methyl-2-ethyl-cyclopropane.—**Georges Lévy**: β-ethylnaphthaline and its hydrogenation products. Starting with carefully purified β-ethylnaphthaline, reduction with sodium and amyl alcohol gives only a dihydride: catalytic reduction with nickel gives a tetrahydride and finally a decahydride.—**St. Pavlovitch**: The transformations of braunite under the action of heat.—**F. Diénert**: Contribution to the study of the origin of subterranean waters.—**Montagne**: The yields of springs under uninfluenced régime.—**Mlle. Germaine Py**: The evolution of the cytoplasmic constituents of the pollen cells of *Vincetoxicum officinale*.—**Labergerie**: The action of oscillating circuits on the degeneration of the potato.—**F. Maignon** and **J. Guilhon**: The influence of the seasons on respiratory metabolism in the dog.—**A. Machebœuf**: Researches on the function of lipoids and proteins of the blood in the exchanges of water in the organism.—**Léon Binet** and **J. Magrou**: Glutathione, growth and cancer of plants.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 24, 1930).—**A. Archangelskii** and **D. Perkin**: A note on the origin of the ferrous deposits in the Lipetsk area. The deposits found in the Moscow region contain remains of *Lepidodendron* and should have been formed during the Carboniferous period as sedimentary rocks.—**N. Demjanov**: The isomerisation of the cyclic amines with the lateral chain CH_2NH_2. A brief outline of the history of the problem.—**D. Prianischnikov** and **V. V. Butkevitch**: A contribution to the physiological characteristics of potassium salts. The physiological acidity of potassium chloride is not the same for different plants; while Gramineæ, like oats and barley, absorb both potassium and chlorine at the same rate, in the case of sugar beet there is a marked excess in the absorption of potassium as compared with chlorine. Similar results were obtained for potassium sulphate.—**L. Mysovskii** and **R. Eichelberg**: The radioactivity of rubidium by observations in Wilson's camera. No definite proofs of the radioactivity of rubidium have been obtained by the method used.—**A. A. Birula**: A note on the metacarpalia and metatarsalia of *Ursus spelæus* Rosenm. In the cave bear these bones always have a shallow pit at the verticillum of the apical end. This character is absent in all recent bears, except *Melursus ursinus* Shaw.—**E. Cheisin**: Some new marine infusoria, symbiotic in molluscs of Lake Baikal. Three new genera of infusoria, *Tiarella, Ancistrina,* and *Ancistrella* found in the mantle cavity of various molluscs are described. The infusoria belong to the families Ancistridæ and Boveridæ, both known only from marine molluscs.

Comptes rendus, No. 25.—**G. Gause**: Logistic curves of the growth of the population of Leningrad and of the U.S.S.R.—**K. Nikolskii**: The geometry of the Dirac matrices.—**J. Medvedev**: The kinetics of the alcoholic fermentation. An equation is discussed which expresses the relation of the rate of fermentation to the initial concentration of the sugar and to the time.—**D. Eropkin**: The problem of studies of the solar spectrum at different altitudes above the horizon.—**N. Putochin**: α-Pyrrolidine-methylamine and the action of nitric acid on it and on α-pyrrolmethylamine. Experiments on the isomerisation of a pyrrole ring under the action of nitric acid into a pyridine ring.—**P. I. Tolmatchev**: The equilibrium in solutions of barium nitrate in nitric acid at the temperatures of 0° and 25°. The investigations proved that the solubility of barium nitrate becomes less with the increase in the concentration of the nitric acid.

WASHINGTON.

National Academy of Sciences (*Proc.*, Vol. 17, No. 3, Mar. 15).—**Elsie H. Field**: Reactions of dermal melanophores in *Necturus* to heat and to cold. As in other amphibians, the melanophores expand at very low temperatures and contract at moderately high ones; unlike those of other amphibians, they expand at relatively high temperatures.—**Stanley G. Warner**: Histological polarisation of lateral giant-fibres in the crayfish. Demonstrated by treating sections with Vom Rath fluid containing some 5 per cent acetic acid instead of the usual 1 per cent solution and afterwards with a 5 per cent solution of pyrogallic acid.—**Tsai-Han Kiang**: On the groups of orientable two-manifolds.—**G. A. Miller**: Inverse commutator subgroups.—**Arthur E. Kennelly**: The convention of equidimensional electric and magnetic units. A set of electromagnetic unit dimensions is derived, based on the hypothesis that the dimensions of permittivity κ_0 and permeability μ_0 for free space are the same. The dimensions obtained are in every case arithmetical means of the Maxwellian electrostatic and electromagnetic dimensions.—**Richard C. Tolman**: On thermodynamic equilibrium in a static Einstein universe. A discussion of the thermodynamic equilibrium between matter and radiation. It is concluded that the equilibrium concentration of matter would be exceedingly small even for masses as small as the electron and temperatures as high as 40,000,000°.—**Paul S. Epstein**: Answer to Prof. Størmer's remark. Comment on the fact that whereas Prof. Størmer's method of dealing with the motion of electrons in the magnetic field of the earth is based on classical mechanics, the author's method takes relativity into account.

Official Publications Received.

BRITISH.

Journal of the Royal Microscopical Society. Series 3, Vol. 51, Part 2, June. Pp. xvi+109-220. (London.) 10*s.* net.

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 3, No. 1, March. Compiled by Agnes Elisabeth Glennie. Pp. iv+167. (London: H.M. Stationery Office.) 2*s.* net.

India: Meteorological Department. Meteorology of the Persian Gulf and Mekran. By Dr. B. N. Banerji. Pp. iii+65+9 plates. 3 rupees; 5*s.* 3*d.* Scientific Notes, Vol 3, No. 24: On the Utility of Observations of Barometric Characteristics and Tendencies for Local Forecasting in North-West India. By Flight-Lieut. R. P. Batty. Pp. 61-76. 8 annas; 10*d.* (Calcutta: Government of India Central Publication Branch.)

Committee on Bird Sanctuaries in Royal Parks (England). Report for 1930. Pp 22. (London: H.M. Stationery Office.) 6*d.* net.

Royal Dublin Society. Bi-Centenary Celebrations, 1931: Official Handbook and Catalogue of Museum. Pp. xxxii+116. (Dublin.)

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge for the Academical Year 1929–1930. Published by Authority. Pp. 128. (Cambridge: Printed at the University Press.)

The Welsh Journal of Agriculture: the Journal of the Welsh Agricultural Education Conference. Vol. 7. Pp. 431. (Cardiff: University of Wales Press Board.) 2*s.* 6*d.*; cloth, 4*s.*

Proceedings of the Royal Society. Series A, Vol. 132, No. A819, July 2. Pp. 352. (London: Harrison and Sons, Ltd.) 18*s.*

South Australia: Department of Mines: Geological Survey of South Australia. Bulletin No. 15: Report on the Geology of the Region to the North and North-West of Tarcoola. By Dr. R. Lockhart Jack. Pp. 31+map. (Adelaide: Harrison Weir.)

Quarterly Journal of the Royal Meteorological Society. Vol. 57, No. 240, July. Pp. 243-344. (London: Edward Stanford, Ltd.) 7*s.* 6*d.*

Report on the Phenological Observations in the British Isles from December 1929 to November 1930. No. 40. (From the *Quarterly Journal of the Royal Meteorological Society*, Vol. 57, No. 241.) By J. Edmund Clark, Ivan D. Margary, Richard Marshall, C. J. P. Cave and L. C. W. Bonacina. Pp. 345-404. (London: Edward Stanford, Ltd.) 3*s.*

The Royal Society for the Protection of Birds. Fortieth Annual Report, January 1st to December 31st, 1930; with Proceedings of Annual Meeting 1931. Pp. 54. (London.)

Chemistry and Industry. Special Jubilee Number, July 1931. Pp. 52+272+53-110. (London: Society of Chemical Industry.) 10*s.*

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 14, Part 2, July 3. Pp. 49-220. (Pretoria.)

Journal of the Indian Institute of Science. Vol. 14A, Part 1: Studies on the Chemical Composition and Physical Properties of Plant Tissue Fluids. Part 1: Effects of Age and Environment on the Tissue Fluids of French Beans (*Phaseolus vulgaris*). By C. Narasimha Acharya and B. N. Sastri. Pp. 9. (Bangalore.) 12 annas.

Medical Research Council. Eleventh Annual Report of the Industrial Health Research Board (formerly the Industrial Fatigue Research Board) to 30th June 1931, including an Analysis of Work published during the Years 1926–30. Pp. ii+85. (London: H.M. Stationery Office) 1*s.* 6*d.* net.

Southern Rhodesia Geological Survey. Short Report No. 25: The Geology of the Country around the Norah, Molly and Umboe Copper Claims, Lomagundi District. By A. M. Macgregor. Pp. 10+1 map. Short Report No. 26: A Geological Traverse down the Lower Inyantue Valley, Wankie District. By H. B. Maufe. Pp. 10+1 map. (Salisbury.)

Department of Health for Scotland. Second Report of the Scottish Advisory Committee on Rivers Pollution Prevention. River Esk (Midlothian). Pp. 44. (Edinburgh and London: H.M. Stationery Office.) 9*d.* net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 6, No. 3, July. Pp 221-344. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

Empire Marketing Board, May 1930 to May 1931. (E.M.B. 41.) Pp. 75. (London: H.M. Stationery Office.) 1*s.* net.

FOREIGN.

Publikationer og mindre Meddelelser fra Københavns Observatorium. Nr. 76: The Possible Solutions of the "Equations of Fit" on the Standard Model. By Bengt Stromgren. Pp. 8. Nr. 77: The Point-Source Model with Coefficient of Opacity $k=k_1\rho T^{-3\cdot 5}$. By Bengt Stromgren. Pp. 28. (København)

Publications de l'Observatoire Astronomique de l'Université de Poznan. Tome I. Pp xi+75+5 planches. (Poznan.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 100: The Ruins at Kiatuthlanna, Eastern Arizona. By Frank H. H. Roberts, Jr. Pp. viii+195+47 plates. (Washington, D.C.: Government Printing Office.) 65 cents.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 10, 1928. iv. Meteorologiska iakttagelser i Sverige, Band 70. Pp. x+179. 7.00 kr. Årsbok, 12, 1930. i. Månadsoversikt over vaderlek och vattentillgång jamte anstaltens årsberattelse. Pp. 98. 2.50 kr. Årsbok, 12, 1930. ii. Nederborden i Sverige. Pp. 160. 5.00 kr. (Stockholm.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 3, Part 3. Pp. 131-183+10 plates (Tokyo: Maruzen Co., Ltd.) 1.20 yen.

Collection des travaux chimiques de Tchécoslovaquie. Redigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 6, Juin. Pp. 285-332. (Prague: Regia Societas Scientiarum Bohemica.)

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1929. By R. S. Wimpenny. Pp. iii+92. (Cairo: Government Press.) 5 P.T.

Report of the National Research Council for the Year July 1, 1929–June 30, 1930. Pp. iv+119. (Washington, D.C.: Government Printing Office.) 15 cents

U.S. Department of Agriculture. Farmers' Bulletin No. 1642: Chalcid Control in Alfalfa-Seed Production. By V. L. Wildermuth. Pp. ii+14. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 79, Art. 9: A new Species of Troodont Dinosaur from the Lance Formation of Wyoming. By Charles W. Gilmore. (No. 2875.) Pp. 6+5 plates. Vol. 79, Art. 12: A new Pearl Oyster from the Hawaiian Islands. By Paul Bartsch. (No. 2878.) Pp 2+2 plates. (Washington, D.C.: Government Printing Office.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 20, No. 2, May. Pp. 197-322. (Tokyo and Sendai: Maruzen Co., Ltd.)

Report on the Cloud Observations made at the Mera Meteorological Observatory, Mera, near Tokyo, April 1927 to March 1929. By M. Watanabe, Y. Isimaru and K. Yosinari. Pp. iii+50+72+137 plates. (Tokyo: Central Meteorological Observatory.)

Kungl. Sjokarteverket, Stockholm. Ergebnisse der Beobachtungen des magnetischen Observatoriums zu Lovo (Stockholm) im Jahre 1929 Bearbeitet von Sven Aslund. Pp 29. (Stockholm)

CATALOGUES.

Bulletin No. 3: Spectrum Analysis. Pp. 19. (London: Adam Hilger, Ltd.)

Verlag: Publications: Livres de Fonds. Pp. 141. (Berlin: W. Junk.)

Diary of Societies.

SATURDAY, JULY 25

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District) (at Hastings Town Hall), at 11.30 A.M.

TUESDAY, JULY 28.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.

CONGRESSES.

JULY 17 TO 25.

BRITISH MEDICAL ASSOCIATION (at Eastbourne).

JULY 24 TO 30.

BRITISH COMMONWEALTH EDUCATION CONFERENCE (at Bedford College).—Subject: EDUCATION IN A CHANGING EMPIRE:—
- Education in India.
- Individual Education.
- Modern Psychology in Education.
- Examinations and Tests.

JULY 26 TO 31.

INTERNATIONAL CONGRESS ON RADIOLOGY (at Paris).

CALCUTTA UNIVE
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SATURDAY, AUGUST 1, 1931.

CONTENTS.

PAGE
Reform of the British Patent System . . . 165
Hamilton's 'Characteristic Function'. By A. S. Ramsey 167
Soviet Science. By Prof. F. S. Marvin . . . 170
Aeroplane Survey of Peru 172
Short Reviews 172
Stresses in Wheels. By Prof. E. G. Coker, F.R.S. . 174
Oxidation by Living Cells. By Prof. J. B. S. Haldane 175
Obituary:
  Lieut.-Col. Sir Charles Bedford. By R. R. . 178
  Dr. R. C. Macfie 179
News and Views 179
Letters to the Editor:
  A Method of Recording Coincidences between Geiger Counters.—Dr. J. C. Jacobsen . . 185
  An Investigation of Infra-Red Radiation from an Engine.—Sydney Steele 185
  Temperature and Humidity Relations of the Cockroach.—D. L. Gunn 186
  The Pyranoid Structure of Glucuronic Acid and of Theophylline Arabinoside.—John Pryde and R. Tecwyn Williams 187
  A New Virus Disease of the Tobacco Plant.—Dr. H. H. Storey 187
  Intensity Anomalies in Rare Gas Spectra.—Ebbe Rasmussen and Hugo Swenson . . 188
  Effect of Pressure on Raman Spectra.—S. Bhagavantam 188
  The Slow Combustion of Methane and Ethane.—Prof. William A. Bone, F.R.S. . . . 188
  Unusual Lightning.—H. E. Beckett and A. F. Dufton 189
  Valency and Diamagnetism of Titanium in the Tetrachloride.—Dr. V. I. Vaidhianathan . 189
  Synthesis of Ethyl Thio-aceto-acetate.—Sir P. C. Rây 189
Research Items 190
Astronomical Topics 192
Textile Research 193
The Carnegie United Kingdom Trust 194
Atomic Synthesis and Stellar Energy. By Dr. d'E. Atkinson 194
Empire Travel for British Students 196
University and Educational Intelligence . . . 197
Birthdays and Research Centres 198
Societies and Academies 198
Official Publications Received 200

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Reform of the British Patent System.*

THE need for various improvements in the British patent system has been constantly before the public in recent years, and it is generally agreed that the time is ripe for a general overhauling and lubrication of the machinery. The matter is important, for invention is closely, if subtly, connected with unemployment, and, moreover, it is chiefly through patent protection that workers in applied science can hope to win a share of the economic benefits which they confer on the community.

It is therefore satisfactory to learn, from a recent statement by the President of the Board of Trade, in reply to a question asked by Major A. G. Church in the House of Commons, that the Government proposes to take steps to prepare a Bill on this subject.

The history of the movement for reform is familiar to readers of NATURE. In October 1928 the British Science Guild published a report comprising a systematic survey of the needs of the situation, with some fifty or sixty recommendations, large and small. This was widely circulated among persons interested in the subject, and was canvassed, criticised, and mainly endorsed, in reports afterwards issued by various authoritative bodies, notably the General Council of the Bar, a joint committee representing several chemical associations, and the Chartered Institute of Patent Agents. Eventually, in May 1929, the Government set up, under the chairmanship of Sir Charles Sargant, a departmental committee, which issued its report in May last. Since the latter will presumably form the foundation of any legislation that may be introduced, a brief notice of its contents may be of interest.

The Sargant Committee appears to have used the British Science Guild's report largely as the basis of its agenda, and its conclusions, though marked in a certain degree by timidity and conservatism, are in general consistent with the policy put forward by the Guild. There can be little doubt that general support will be forthcoming for legislation on the lines proposed, if the Sargant Committee's recommendations be taken as the minimum rather than the maximum that is expected of the legislature.

The Guild's proposals were somewhat numerous. Among the more important may be mentioned the extension of the scope of the official investigation as to the novelty of inventions; extension of the judicial functions of the Comptroller of the Patent Office; a change in the tribunal for appeals from the Comptroller's decisions; strengthening of the law relating to unwarranted threats of patent litigation; and the institution of a system of cheap short-term patents of narrow scope, analogous to the German *Gebrauchsmuster*. The Sargant Committee rejected the last of these proposals outright, for reasons which are stated fairly and at some length in its report. The evidence tendered before the Committee was rather evenly divided for and against the proposal, and the decision is probably right. Short-term patents would bring advantage to some sections of the community and disadvantage to others, and legislation on such a complicated and uncertain subject would not be justified unless an overwhelming demand for it had followed the British Science Guild's report. Such a demand has not arisen. In view, however, of the German practice, it is well that this proposal should have been thoroughly thrashed out.

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* Board of Trade. Report of the Departmental Committee on the Patents and Designs Acts and Practice of the Patent Office. (Cmd. 3829.) Pp. 104. (London: H.M. Stationery Office, 1931.) 1s. 6d. net.

As regards the proposed extension of the Comptroller's jurisdiction, the members of the Sargant Committee were divided among themselves. The object of the British Science Guild's suggestion on this head was to provide a way out of the impasse which arises from the high cost of patent litigation and the difficulty of obtaining a suitable arbitrator in many patent disputes. In effect, only the wealthiest corporations can afford to enforce their patent rights or to defend themselves against an action for infringement; for such actions have to be tried in the High Court with the assistance of expensive expert witnesses and of counsel who are capable of dealing with scientific technicalities: thus, for the great majority of those who are entitled to justice in connexion with patents, justice is inaccessible on account of its high cost.

The British Science Guild proposed, as a partial solution of this difficulty, that the Comptroller of the Patent Office should be authorised to deal with infringement actions by consent of the parties. This proposal, together with modifications of it, was rejected by the majority of the Sargant Committee; but although a minority report was not formally appended, the fact is mentioned that "a substantial minority has been so impressed with the desire and the need for providing some less costly method of settling disputes relating to patents that it would like a trial to be made of an extension of the jurisdiction of the Comptroller for this purpose". The reasons underlying the opinion of the progressive minority are convincingly stated, while the reasons given for the majority opinion amount in large part to a mere description of prejudices of the kind which are known to be directed against innovations in legal practice. The general question of the high cost of patent litigation is waived, as lying outside the Committee's terms of reference; but for our part, we fail to see why there should be at present no prospect of "the immediate constitution of a special Court to deal with disputes relating to patents and other forms of industrial property, with a view to working out a cheaper and speedier method of trying such disputes". A change in the High Court of that character is undoubtedly desirable and practicable. The majority are content, therefore, to leave without attempted remedy what is probably the most serious of all the defects of the existing patent system in Great Britain.

Appeals from the Comptroller's judicial decisions are at present heard by one of the Law Officers of the Crown, and the British Science Guild recommended that these officers should be replaced by a special judge sitting in chambers. This recommendation was adopted by the Sargant Committee in a slightly modified form. The procedure would be as at present, but a judge selected by the Lord Chancellor would be substituted for the Law Officer.

With regard to the protection of manufacturers against unwarranted threats based on alleged patent rights, the Sargant Committee goes somewhat further than the Guild thought it politic to suggest, and there is clearly a strong case for drastic legislation in the sense of the recommendation made. The effect of this would be that when a person, claiming to possess patent rights without really being entitled to do so, threatens to take legal proceedings for infringement against a manufacturer or his customers, either the manufacturer or his customers would be able to carry through an action against the threatener, so as to get an injunction to restrain him and to recover damages. At present this obviously just proceeding is obstructed by certain legal provisions of a somewhat technical character, the result of which is, in particular, that makers of seasonal goods sometimes lose their market for a year, without remedy, in consequence of threats for which there was no legitimate foundation.

At present the Patent Office examiners make a search among British patents not more than fifty years old, to see how far the inventions that come before them are really new. This restricted search was instituted as an experiment more than a quarter of a century ago, and it is very generally felt that, since the experiment has yielded satisfactory results, the time is ripe for the system to be carried to its logical completion: that is to say, that the Patent Office search should no longer be restricted to British patent specifications, but should comprise other relevant technical documents. The only obstacle is a financial one, for such an extension of the search would cost a good deal of money. The British Science Guild pointed out that the necessary funds are already available in the excess of fees taken every year from the pockets of inventors and used as revenue by the Exchequer, which adopts this singular method of encouraging the inventions on which the progress of industry depends.

The annual surplus of the Patent Office budget is steadily increasing, and for the year 1930 amounted to no less than £154,545. There are indications in the report that the Sargant Committee was sensitive to Treasury opinion in dealing with this subject; for while the members declare in paragraph 404 that "the subject matter referred to them is an essentially technical one, and questions of finance lie outside its proper limits", the Committee does not dare in paragraph 47 to recommend any extension of the search that would cost more than £60,000 per annum, and even of this sum two-thirds is to be raised by an increase in the fees paid by inventors. Reading between the lines, one can guess that if the matter had been decided on technical considerations alone, without reference to financial restrictions, the Committee's recommendations would have gone considerably further. But in these hard times we must be thankful that the Committee had even that much courage, and the somewhat parsimonious improvement recommended by it will at least be a step in the right direction.

The report contains a number of minor recommendations, which are generally in harmony with the recommendations of the British Science Guild and will, if adopted, enable the patent system to work more smoothly. It discusses also two important questions which were brought before it not by the Guild but by the Joint Chemical Committee and the Patent Office. The first of these was the 'dedicated patent' scheme. This was intended to take account of a tradition held by the medical profession to the effect that, while it is legitimate to accept fees for administering new drugs, it is illegitimate to accept patent royalties for inventing them. In an attempt to reconcile this tradition with the interests of chemical research and invention, the Joint Chemical Committee suggested that medical patents should be compulsorily dedicated to the public and administered by a State department, which should allocate a fair profit to the patentees. The medical profession, after some wavering, showed itself hostile to this scheme, and the Sargant Committee, while reporting adversely upon it, evinced a feeling that medical inventions may quite legitimately be patented in the ordinary way.

The other important new point was somewhat technical, and related to Section 32A of the Patents Acts. Briefly, it may be said that prior to 1919 the invalidity of a single one of the claims which define the scope of a patent was enough to damn the whole patent; but the Act of 1919, in remedying this hardship, made way for an abuse by removing the danger which a patentee had incurred if, in defining the scope of his monopoly, he had tried to cast his net unreasonably wide and to claim more than he had really invented. As a result, there has grown up a bad practice of using unconscionably wide verbal formulæ in patent claims, and the Sargant Committee proposes that this abuse should be checked.

The findings of the Sargant Committee represent the irreducible minimum of reform that will content those who desire to bring the British patent system up to date. The chief danger is that the technical character of the whole subject may blind the public and the legislature to its importance, particularly when parliamentary time is subject to such keen competition on behalf of controversial and party legislation.

Hamilton's 'Characteristic Function'.

The Mathematical Papers of Sir William Rowan Hamilton. Vol. 1: *Geometrical Optics.* Edited for the Royal Irish Academy by Prof. A. W. Conway and Prof. J. L. Synge. (Cunningham Memoir No. 13.) Pp. xxvii + 534. (Cambridge: At the University Press, 1931.) 50*s.* net.

THE publication of the mathematical papers of Sir William Rowan Hamilton, to whom no one will deny the title of greatest of Irish mathematicians, is a notable event. This is the first of the four volumes which are expected to be published, and the only regret that its appearance can arouse is that it did not appear until sixty-five years after Hamilton's death and more than a hundred years after some of its contents were written.

Hamilton's name is known to most students in connexion with the general equations of dynamics and more particularly to students of quantum and wave mechanics, and there are probably comparatively few but the specialists who realise what a remarkable man he was, or that his dynamical theorems were a development of his work in geometrical optics.

The volume before us opens with an *éloge* delivered by the president of the Royal Irish Academy, the Very Reverend Charles Graves, in 1865, shortly after Hamilton's death. This gives an interesting review of the life and work of a man of very great distinction. To quote one passage only, it is said that " he was to the last degree solicitous about the metaphysics of every subject on which he undertook to write . . . this was in accordance with his views regarding the ascending scale of the subjects of human thought. To religion he gave the highest place, and this not as a formality; for his was a deeply reverential spirit. He assigned the next to metaphysics. To them he subordinated mathematics and poetry, and assigned the lowest place to physics and general literature." His literary attainments were of a high order and he was on terms of friendship with Wordsworth, Southey, Coleridge, and many other distinguished writers of his time.

The present volume is a monument to Hamilton's powers as a mathematician and the vast amount of his original work. We learn from it that the number of his note-books in the library of Trinity College exceeds two hundred, in addition to unbound manuscripts; that they " contain memoirs on a variety of subjects, complete in themselves, and carefully elaborated . . . ", and the author of the *éloge* expressed the hope that they will yet see the light. Of Hamilton's youth, he records that he was born in 1805 and entrusted at the age of three to the care of his uncle, the Rev. James Hamilton, of Trim, under whom he studied until he entered Trinity College in 1823; that he communicated his first paper, " On Caustics ", to the Royal Irish Academy in 1824; and that while still an undergraduate of twenty-one he was elected to be professor of astronomy in the University of Dublin and Royal Astronomer of Ireland.

With our curiosity further aroused by the fact that by the time he was twenty, this young man had added the " Characteristic Function " to the sum of human knowledge, we turned to his biography (by the Rev. R. P. Graves, 3 vols., 1882 . . .), there to learn something of the early education which had made such developments possible. His uncle was a schoolmaster, and a very capable one. By the time he was four and a half years old, the child was reading Latin, Greek, and Hebrew; at eight he had added French and Italian, and before he was ten he was working at Persian, Arabic, and Sanskrit and reciting Dryden, Collins, Milton, and Homer. At eleven he compiled a Syriac grammar; and withal he was a very human boy, swimming with his uncle, 'riding the ass', and 'making small pits for the workmen to fall into'. It was no doubt an advantage that he acquired a zest for languages before beginning the study of mathematics, for though he carried on his classical studies as an undergraduate and won prizes for English verse and the highest distinction in Greek, yet if mathematics had caught him earlier he might have missed some of that love of literature which was to be a permanent enjoyment throughout his life.

Hamilton appears to have begun Euclid and algebra at about ten; at fourteen he was studying optics and astronomy, and making observations of eclipses and occultations on his own account. A little later he was at work on Newton's " Principia ", Garnier's " Differential Calculus ", and the " Mécanique céleste " of Laplace; and at seventeen he asserted that he would " rather have the fame of Archimedes than of his conqueror Marcellus or than any of those learned commentators on the classics, whose highest ambition was to be familiar with the thoughts of other men ", and began forthwith to write a paper on " Systems of right lines in a plane "; a paper which, as he said many years later, contained the germ of his investigation respecting systems of rays.

At eighteen, Hamilton entered the University, and within a year he had a paper ready for publication. Its title was " On Caustics ", and it is printed for the first time in the volume before us. It is a remarkable production for a boy in his teens. It deals with the properties of a general rectilinear congruence without special reference to optics and with no reference to the characteristic function. The editors note an error—a cusp-locus mistaken for a singular solution, an error which Lagrange also appears to have made—and they elucidate it at length in an appendix. The paper was presented to the R.I.A., but was not published. The referees, though impressed by its novelty and by the analytical skill displayed in it, were cautious, and in a friendly report asked for the analytical processes to be more fully developed before publication.

Hamilton continued his investigations on a more definitely optical basis and in the next two years produced a new paper, greatly enlarged in scope, which was presented to the Academy under the title "Theory of Systems of Rays" and published in 1827. This paper with its three supplements fills more than half of the present volume and is of itself sufficient to establish Hamilton's fame as a mathematician. The 'characteristic function' is introduced at an early stage and at once becomes the basis of the theory. The first part of the paper deals with ordinary systems of reflected rays, and the second part in a similar way with refractions. The geometry of the general normal congruence is extensively developed and there are lengthy discussions of aberrations and of the density of reflected light. The second part concludes with the application of the calculus of variations to the characteristic function to deduce the path of a ray in a medium of continually varying density. This second part of the paper is now printed for the first time.

The "First Supplement" (1830) introduces us somewhat abruptly to Hamilton's function W applied to straight rays in a homogeneous medium. It is a function of the direction cosines of the final ray, whose form is determined by that of the characteristic function V considered as a function of the co-ordinates of a point on the ray. In a useful appendix the editors direct attention to further aspects of the function W, in particular in relation to tangential co-ordinates.

The "Second Supplement" (1830) shows that W (an arbitrary function of the direction cosines of the final ray) furnishes a general integral of the differential equation

$$\left(\frac{\partial V}{\partial x}\right)^2+\left(\frac{\partial V}{\partial y}\right)^2+\left(\frac{\partial V}{\partial z}\right)^2=\mu^2$$

satisfied by V in an assigned medium; and introduces a further function U, a modified characteristic function which was used by Lord Rayleigh in his paper on "Hamilton's Principle and the Five Aberrations of Von Seidel" (1908).

The "Third Supplement" (1832) represents a great advance. It is a generalisation and extension of the previous work to include the case of heterogeneous and anisotropic media. It includes variations of the initial as well as of the final elements of the ray, and adds a term to the characteristic function to provide for variations in colour. It introduces the second auxiliary function T, applies the methods to the wave theory as well as to the emission theory, and contains the remarkable theoretical discovery of *conical refraction*.

Part II. of the volume contains, in some fifty pages, reprints of ten minor papers dating from 1832 to 1841, all of which are of interest, particularly so a British Association Report "On the Characteristic Function in Optics". Part III., "Manuscripts", consists of papers not hitherto published, including the original paper "On Caustics" and a lengthy paper "On the Improvement of the Double Achromatic Object Glass".

In addition to Hamilton's papers, the book also contains an excellent introduction, which traces the development of the characteristic function as it gains in generality and power through the various papers that follow, and sums up Hamilton's achievement in the general theory of geometrical optics. The editors also direct attention to the value of Hamilton's work from the purely geometrical point of view, and indicate that Kummer, who is often regarded as the founder of the theory of the general rectilinear congruence, was careful to give full credit to the work of Hamilton; they also remark that Hamilton not only developed the theory of the congruence in his paper "On Caustics" but even attacked its singularities. The introduction to the book also contains a brief summary of the contents of all the papers that follow.

The volume closes with some fifty pages of "Editors' Appendix", containing historical notes and references and notes explanatory of difficulties in the text, where the argument is unnecessarily prolix or where it needs amplification. Indications of the relation of Hamilton's work to modern mathematics are also given. This is a very valuable part of the volume. It affords evidence of the thoroughness and the great amount of care that the editors have expended on the work, and is deserving of the gratitude of all students of the subject and, indeed, of all who desire to see Hamilton's papers published in a form befitting their merit and the greatness of their author. There is no gainsaying the fact that though Hamilton's style is lucid and attractive, his ideas are not always easy to follow to their conclusions, and, to quote the editors, "the application of his methods to the optical instrument of revolution was for long the despair of mathematicians". There is little enough of application of the theory to be found in the papers, and it is a matter for regret that Hamilton did not complete the book to which he refers in a letter of 1841 (quoted in his biography): "I am seriously thinking of publishing after some months a treatise on Optical Systems of Rays, for University men and others of that class, and have several times recomposed the first mathematical chapter. . . . My object will be to make better known my method, and especially to show that it *is* a *method*, an *instrument* of demonstration and research." The book was never published, and it would be of interest to know whether the manuscript is among the many in the library at Trinity College, Dublin.

It is curious that while Hamilton's work on optics was well known in Great Britain and the use of the characteristic function in optics was the subject of a number of papers by Maxwell and others, it remained almost unknown in Germany for the best part of a century. In 1895 a paper, "Das Eikonal", was published by H. Bruns announcing his discovery of the characteristic functions for homogeneous isotropic media, naming them the Eikonal, and making what was in the circumstances a singular claim, that the Eikonal which he had discovered plays, in the narrower region of geometrical optics, a similar rôle to that of Hamilton's theorem in mechanics. The theory of the Eikonal was more fully developed by Schwarzschild in 1905 and has been used by several modern writers. But the editors direct attention to the valuable appreciation and review of Hamilton's published papers on geometrical optics in two papers by G. Prange in 1923, and to the 1924 edition of Czapski-Eppenstein, "Grundzüge der Theorie der optischen Instrumente", in which, for the first time, the work of Hamilton has received adequate notice in a compendious textbook.

In conclusion, the editors are to be congratulated on the publication of so much of Hamilton's work in so attractive a form, and on the production of a volume which reflects so well the care they have bestowed upon it.

In the printing of the book, the standard of excellence associated with the Cambridge University Press is well maintained.

A. S. RAMSEY.

Soviet Science.

Science at the Cross Roads.[1] Papers presented to the International Congress of the History of Science and Technology held in London from June 20 to July 3, 1931, by the Delegates of the U.S.S.R. Pp. iv + 23 + 4 + 24 + 12 + 12 + 10 + 4 + 31 + 62 + 15 + 3. (London: Kniga (England), Ltd., 1931.) 10*s.* 6*d.*

THE file of black-bearded men who marched across the room at South Kensington at the opening meeting of the recent International Congress of the History of Science was one of its most striking features. They were delegates from Russia and had arrived from Moscow by aeroplane. It was the largest deputation which appeared together at that reception from any country except the United States. Finding later that no one speaker could be allowed more than ten minutes to develop his subject, they decided to have their speeches printed and published in London, and this was done in what is probably the record time for a volume bound in cloth and lettered in gold. It appeared on the seventh day after they had handed their manuscripts to the printers, and it was reviewed in at least one weekly journal two days after. The story is typical of the feverish speed with which the work of reconstruction is going on in present-day Russia, and one can only hope that what is being done in such haste will not be repented at leisure by the masses who are undergoing the process.

The book before us will be read with mingled feelings, sometimes of admiration for the grandiose ideas and the energy with which they are being applied in virgin soil, often with puzzlement as to the meaning of certain abstract phrases which are constantly used in connexion with well-known facts in the evolution of science, often again with irritation at the ceaseless repetition of catchwords which no fair-minded student can think have any real bearing on the subject under discussion. The last class of instances will probably be most obvious to the average English reader and can be dealt with most easily. The essays refer constantly to "bourgeoise" science and "science in capitalist societies" and the revolution to be effected in science by "dialectical materialism". Throughout there is the implication that science before the Russian Revolution, even if not entirely due to capitalist contrivance, had certainly been used for capitalist ends.

On this point a clear and simple distinction may be made. So far and so long as industry is in the hands of private producers, the discoveries of science will be used by those persons for the improvement of their processes. The first effect, if the science is sound and the applications practicable, will be to increase their profits, though the advantage will be gradually distributed throughout society according to the economic and moral relations existent in it. Hence, no doubt, the primary result of the applications of science in the nineteenth century was the creation of a large comfortable middle-class, based on scientifically organised industry. But this development is immediately followed by a diffusion of the gains—through social reform, cheaper prices, trades unionism, etc.—among society as a whole. We therefore have at the present time, in all the most fully industrialised countries of the West, a population largely and demonstrably better off than they were before the Industrial Revolution. Whether the Russian method will in the end secure the same, or even superior, results remains to be seen; up to the present it certainly has not.

When we come to speak of science in itself, that is, the systematised and tested knowledge of the world we live in, the attempted distinction between a 'bourgeoise' and a 'socialist' science is irrelevant and absurd. The laws of Nature are the same for all of us, and they have been built up by the co-operating efforts of men of all nations, classes, and opinions. No one, in all the millennia which have seen this process going on, has ever before suggested that there was one type of truth about Nature produced by, and useful to, those in a privileged position in society, and quite another type to be revealed to those who approach it under the orders of a socialist government. Such a government might indeed make better use of the gifts bestowed by science than have certain governments in the past, but it could not discover different laws. It might by generous encouragement lead its subjects to build up the fabric of science more quickly. If Russia does this, all the world will be her debtor, just as she is in debt to all the past and all the nations—'capitalist' or otherwise—who have given her, and are still giving, the fruits of science which she enjoys.

The slogan which is thus dinned into our ears is, of course, of political origin and derives from the fundamental statute of the Russian universities under the Soviet Government. This lays down that "The Academy has to contribute to work out a unique scientific method on the basis of a materialistic world view, directing the whole system of scientific knowledge toward answering the needs of social reconstruction". Here again we must distinguish the element of truth from the large and dangerous fallacy. It is well to make more prominent than the past has done the need of reconstructing society on a scientific basis; it is fatal to attempt to limit the free use of their powers by those who have to lay the theoretical foundations.

Of the papers submitted to the Congress, the most interesting and learned is that by Bukharin, director of the Industrial Research Department of the Supreme Economic Council. His reading is immense and varied, and he uses it to illustrate his two main theses. The first is that all knowledge is a social product and is inseparably connected with practice, "for every man experience, representing the result of the influence of the external world on the knowing subject in the process of his practice, stands on the shoulders of the experience of other people. In his 'I' there is always contained 'we'." This is all excellent and clear. The latter part of his paper is less so, for it involves that identification of the movement of scientific opinion with social revolution which is continually repeated as 'dialectical materialism'. This is the crude legacy which Marx inherited, or claimed to inherit, from Hegel, and it lies heavy on the shoulders of these men who are striving, many of them with genuine and disinterested enthusiasm, to make a success of their experiment and raise the lot of the millions of Russia.

Of the remaining papers, two will attract most attention and add something notable for our information or inquiry. One is the paper by Vavilov, president of the Lenin Academy of Agricultural Sciences. It gives, in summary form, the results of inquiries carried out in different parts of the world as to the origins of agriculture. Expeditions have been sent out and results tabulated as to seven or eight primary agricultural centres, both in the Old World and the New. Great stress is laid on Abyssinia, and some curious and valuable facts appear to have been discovered there as to the early cultivation of wheat, flax, barley, and coffee. Vavilov concludes that Egypt borrowed its crop plants largely from Abyssinia, and that the primary agricultural centres generally are in tropical and sub-tropical mountain regions.

The other paper which will lead to further inquiry is that of Prof. M. Rubinstein on the recent development of institutions for scientific research. Of these there has been a large increase, especially in the last few years. In 1930 there were 72 scientific research institutes, with 83 branches, as against 24 with 8 branches in 1928, with thousands of factory laboratories, and a personnel of 'workers' given as 40,000 and students (in 1931) as 157,000.

It is evidence of amazing zeal and energy, whatever may be the quality or permanence of the work. Our visitors, and those who sent them, should rest assured that we have in Great Britain nothing but goodwill for all genuine efforts to advance knowledge and spread its beneficent results over the widest area. We plead only for that tolerance and goodwill which are ready to recognise similar merits, wherever they may be found and under whatever government. For science, being the common offspring, should be the common link of all mankind.

F. S. MARVIN.

Aeroplane Survey of Peru.

Peru from the Air. By Lieut. George R. Johnson. With Text and Notes by Raye R. Platt. (Special Publication No. 12). Pp. xii + 159. (New York: American Geographical Society, 1930.) 5 dollars.

THE value of aeroplane photography and surveying has been well demonstrated in archæology and forestry, and its special service to the geography of rugged and waterless countries is illustrated by the volume of photographs of Peru, taken by Lieut. G. R. Johnson, when chief photographer to the Peruvian Naval Air Service, and issued by the American Geographical Society. The volume includes 150 well-selected photographs, each 8½ in. by 6½ in., and six sketch maps. It has an excellent introduction by R. R. Platt, head of the Department of Hispanic-American Research of that Society.

The geographical structure of Peru is still inadequately known, owing to the difficulties imposed by the waterless nature of most of the coastal plain and the almost chronic rains and the labyrinth of deep and densely forest-clad valleys in the Eastern Andes. It consists of three geographical units: the coastal belt, the Andes, and the upper valleys of the Amazon. The essential structure of each of them is still imperfectly known or has been, until recently, misunderstood. The Andes form the backbone of the country and they were regarded as composed of two fold-mountain chains separated by the great basin which contains Lake Titicaca. The Western Cordillera have been found to be a high plateau, of which the surface is a peneplane cut across the folded strata; the western front is dissected by profound canyons, the irrigated floors of which include the most productive areas in Peru. Some of these valleys are continued across the coastal belt and their crops of cotton and sugar are exported from the thirty ports that occur isolated in the coastal desert. The southern coast is bordered by an ancient mountain chain which has been called by Steinmann the Chimu-Andes.

As the photographic survey was conducted by the Peruvian Naval Department, the coastal belt is naturally the best illustrated, with numerous views of the deeply indented northern coast, the guano-capped islets and peninsulas, the ports and the valleys they serve, and the dunes and deserts that sever overland communication along the coast. The peneplane of the Western Andes is graphically portrayed and there are striking photographs of the lofty extinct volcanoes that rest upon it.

The eastern valleys are relatively neglected. The illustrations are of the riverside hamlets an the hydroplane stations on the upper tributaries o the Amazon. They show that the development o eastern Peru has made less progress than might b inferred from the ordinary maps. The volume doe not illustrate the structure of the Eastern Andes, a it does that of the coastal belt. The nature of th front of the Andes above the Amazon is uncertain it has been often regarded as a dissected fault scarp but that view is denied by Dr. Bowman. A serie of aeroplane photographs of the area might affor the easiest solution of this problem, but the fe views of the Eastern Andes were selected to illustrat the settlements in the valleys and not the geneti structure of the country. The volume will be most useful companion with current literature o Peruvian geography.

Short Reviews.

Contributions to Marine Biology: Lectures an Symposia given at the Hopkins Marine Station December 20–21, 1929, at the Midwinter Meetin of the Western Society of Naturalists. Pp. viii + 277. (Stanford University, Calif.: Stanford University Press; London: Oxford Universit Press, 1930.) 35*s.* net.

THE growth of marine stations on the Pacific coas of the United States has induced much experimental research on the biology of organisms an the nature of their environment. The Wester Society of Naturalists has instituted mid-winte meetings where this is discussed, and the presen volume contains 23 papers presented in 1929. The commence with a most thoughtful lecture by C. A Kofoid on the "Evolution of the Tintinnoinea" a group of pelagic ciliates, which he has monographed. They possess an external chitinoid shell formed perhaps by both daughter cells after fission The species in a genus are characterised by increas in size, duplication of structural features, elongation, and differentiation of surface pattern. Undigested fæcal residues may be built into the shells and there is a beautiful picture of the utilisatio of coccoliths for this purpose. The known specie in polar waters is 101 and in the tropics 515, whic approximates to the requirements of Van 't Hoff' law. It is suggested that solar radiation is the on outstanding factor capable of inciting genetic chang in these animals. Another lecture was given b T. Wayland Vaughan on "The Oceanographi Point of View". Then follow 21 papers divided into oceanography, permeability, photosynthesis early development, marine Algæ and growth.

We admire the quality and keenness of th writers, while in some cases desiring that the research had been further extended before publication. We are pleased to see researches on the livin green and brown Algæ from Stanford and Seattl Universities, and a thoughtful article by A. R. Moore, in which it is claimed that cell-bridges ar necessary to account for the arrangement of the cells in the formation of blastula and gastrula. As general propositions, not necessarily applied to the papers in this volume, we suggest that no research be published without an adequate summary, and that an author is not entitled to cite any literature which he has not personally consulted without stating this fact.

Outlines of Palæontology. By Prof. H. H. Swinnerton. Second edition. Pp. xii + 420. (London: Edward Arnold and Co., 1930.) 21*s.* net.

It is a good sign that a second edition of this excellent book should be called for after seven years, a period which for text-books of this rather special character must be regarded as short. For this is far removed from the ordinary manual. It is no mere summary of either facts or theories. While it does not ignore facts, it bases on them a succession of thoughts that breed thought in the reader. Prof. Swinnerton has not compiled facts, he has assimilated them, and every page bears the mark of an original thinker.

While welcoming a second edition, we feel it our duty to say that the revision has not been so extensive as to provoke any student to exchange old lamps for new. Several obvious misprints have been corrected, but others only partially or not at all. *Saccemina*, for example, has had the *e* changed to *a*, but does not yet attain the perfection of *Saccammina*. Some erroneous or inexact statements of the first edition have been modified, but not always quite successfully, and this clearly has arisen from a desire not to alter the standing type or stereo-plates more than was necessary. Thus, on p. 141, there is an ingeniously contrived improvement in the account of the crinoid centrodorsal, but the distinction between that structure and the proximale is still incorrectly given. Several statements or expressions that we should like to have seen altered, remain as they were. Prof. Swinnerton is entitled to his own opinion; but some of them are more of fact than interpretation. Among these, the diagram showing the relative abundance of the echinoderm classes in time certainly should have been re-drawn to-day, whatever may have been thought of it in 1923. Let us hope for a third edition in 1937. F. A. B.

Chemistry for Matriculation. By Dr. G. H. Bailey and H. W. Bausor. Third edition. Pp. viii + 448. (London: University Tutorial Press, Ltd., 1931.) 7*s.* 6*d.*

The aim of this class-book is to present a clear account of the essential principles and phenomena of elementary chemistry. The subject is divided into three sections. Section 1 is of an introductory nature. The earlier chapters are concerned with the study of such common substances as air, water, chalk, and the acids, bases, and salts. In the later chapters of this part, the fundamental principles and theories are deduced and outlined. This section concludes with a description of the phenomena of electrolysis and with chemical calculations. Section 2 consists of a lengthy systematic treatment of the non-metals and their more important compounds, whilst Section 3 deals similarly (but more briefly) with some of the metals.

The authors have endeavoured to keep the treatment of the subject as practical as possible, and have introduced many simple experiments to illustrate the facts and support the general theories of the science. Sufficient details are generally given to enable the student to carry out the experiments unaided. Compared with previous editions, the subject matter of the book has undergone considerable revision and rearrangement, whilst additional information has been given, especially in connexion with industrial practice. Opinions differ concerning the most suitable methods of treating elementary chemistry; but as a text-book for candidates reading for university matriculation examinations, Bailey and Bausor's volume attains its object.

Aus der Medizin des Rinascimento. An der Hand des "Leben von Benvenuto Cellini" nach der übersetzung Goethes. Von Prof. Dr. Paul Strassmann. Pp. 56. (Leipzig: Georg Thieme, 1930.) 13 gold marks.

This fine volume contains a commentary on the passages in Goethe's translation of Cellini's autobiography which throw light on the medicine of the Renaissance. The close relationship between the artists and anatomists of the period, of which Leonardo da Vinci offers the best-known example, is well illustrated by Cellini, who counted among his friends Guido Guidi, otherwise known as Vidus Vidius, of Florence, and Berengario da Carpi, of Bologna, who, in addition to being highly skilled surgeons, made valuable contributions to anatomy.

Several pages are devoted to a consideration of Cellini's illnesses, which included malaria, from which he suffered on several occasions; brass founders' ague, contracted while he was engaged on the statue of Perseus at Florence; a protracted fever, accompanied by delirium, which may have been typhoid; and a disease regarded by some authorities as syphilis, though this view is discredited by Strassmann; as well as an almost fatal attack of arsenical poisoning. The other points of medical interest discussed in this book are the prevalence during the Renaissance of syphilis, prostitution, and homosexual practices; the high incidence of illegitimacy, the position of contemporary obstetrics, and the high maternal and infantile mortality.

The text is interspersed with numerous excellent illustrations relating to Cellini and the medical life of his age.

The Human Body. By Dr. Logan Clendening. Second revised edition. Pp. xiv + 399. (London and New York: Alfred A. Knopf, 1931.) 10*s.* 6*d.*

It is refreshing to meet a book like this, which is at one and the same time enlightening and entertaining. It contains a fund of common sense, and the passages on dyspepsia and constipation ought not to be missed by present-day food faddists. It represents a pleasant means of obtaining much information about the inner workings of the body.

Stresses in Wheels.

By Prof. E. G. COKER, F.R.S.

THE stresses imposed on wheels during construction are usually not inconsiderable, and the loads, borne by them later, add greatly to the stress intensities. Although wheels are in universal use, comparatively little appears to be known of the stress distributions in them, although long practical experience has enabled constructors to satisfy exacting modern conditions.

In the vast majority of cases a wheel is built up with a central hub connected by spokes to a circular rim, a combination usually known as a wheel centre, on which is secured an outer tyre. Until the bicycle era, spokes were almost always in compression, and the invention of the wired wheel with all spokes under considerable tension was a notable advance in construction for light vehicles. Modern conditions, however, appear to favour the use of the older form for all heavy traffic, with a well-marked difference between wheels for road and rail vehicles, in that for the former the wheel almost invariably revolves on a fixed axle, while for the latter the axle is secured to the wheel and revolves with it.

The determination of the stress distribution in any form of built-up spoked wheel is difficult, either by analysis or experimental means. It has, however, become a matter of some urgency to know accurately what are the maximum stresses in wheels for very heavy duties such, for example, as occur in present-day railway practice.

With the object of showing the general nature of the stresses produced in construction, a simple illustration is chosen of a railway wagon wheel, consisting of a wheel centre of the form shown in the photograph (Fig. 1, *a*), having eight spokes connecting the central hub with the rim, into which an axle is forced and an outer tyre is shrunk on. Into the hub of this model wheel centre, which is constructed of transparent material to a scale of one-twelfth full size, an axle has been forced, but this latter is not seen owing to the vertical stand used for photography, although the stress distribution it causes in the wheel centre is made visible by a beam of circularly polarised light. The photograph shows great stress intensity in the hub and very little in the spokes, except where they join the hub, while at the outer rim the stress, although of small intensity, is of such a nature that the rim experiences a maximum stress at its outer edge opposite to a spoke, and another maximum stress at its inner edge at places midway between adjacent spokes. The chief feature of interest, however, is at the contact surface between the axle and the hub, where the isochromatics show, and the measurements confirm, that the radial pressure P (Fig. 2, *a*) is variable round the axle with maximum values at the spokes, so that this pressure waxes and wanes in the manner shown. In the hub, however, the circumferential tension Q at the axle reaches a minimum value opposite a spoke with only slightly greater values between.

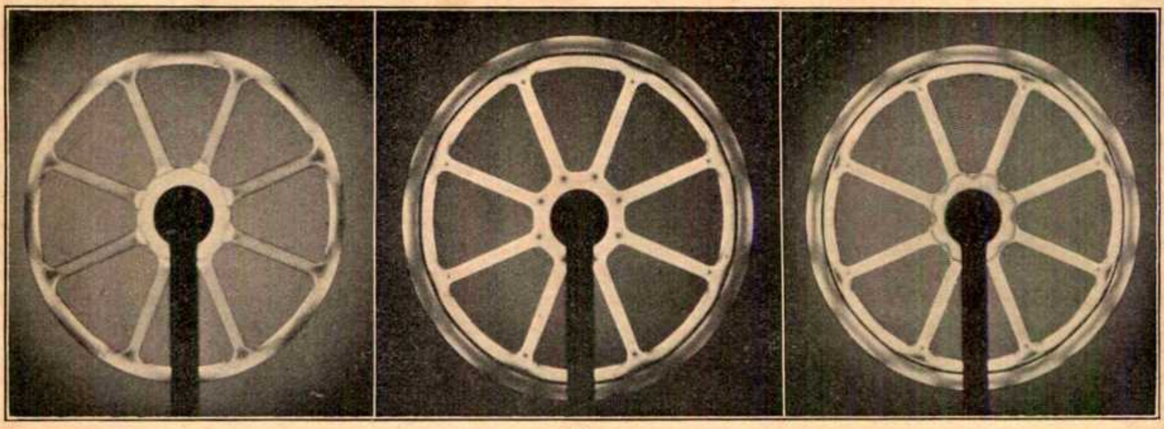

FIG. 1.—*a*: Wheel centre stressed by an axle forced into the hub. *b*: Stress distribution in a tyre and wheel centre before the axle is forced in. *c*: Stress distribution in a completed wheel.

If, instead of forcing an axle into a wheel centre, a tyre is shrunk on first, some interesting features are observed in the wheel centre, due to two separate groups of principal stress differences of zero value, and shown in the photograph (Fig. 1, *b*) by symmetrically placed black dots, one set in the hub and the other in the spokes near their junctions with the rim.

These stress effects, due to the identity in magnitude and sign of the principal stresses, are traced along a spoke in Fig. 2, *b*, where the measured values of the radial stress distribution P, and the corresponding circumferential stress distribution Q, not only confirm the existence of these two groups of stress difference zeros at points A and B, but also show that a third group of low stress intensity exists at points C. The occurrence of this last group is a matter of practical importance, as will appear later.

The principal feature, however, is the high stress intensity in the tyre, which, over a spoke, has a maximum intensity at its outer edge, and a minimum at the inner edge, as shown in Fig. 2, *b*, while midway between the spokes this state of stress is reversed, as we then find a maximum stress at the inner edge with a corresponding minimum at the outer circumference.

In railway work it is the usual practice to force the axle into the wheel centre first, and then shrink on the tyre. When this is accomplished, a stress distribution is found of the kind shown in the photograph (Fig. 1, *c*), in which both the hub and the tyre are highly stressed, while the spokes are still only moderately loaded. As will be noticed here, the two outer groups of stress difference zeros are still present, although in slightly different positions radially. This is seen more clearly in Fig. 2, *c*, where the measured principal stresses *P* and *Q* are shown with reference to a radial plane through the centre of a spoke.

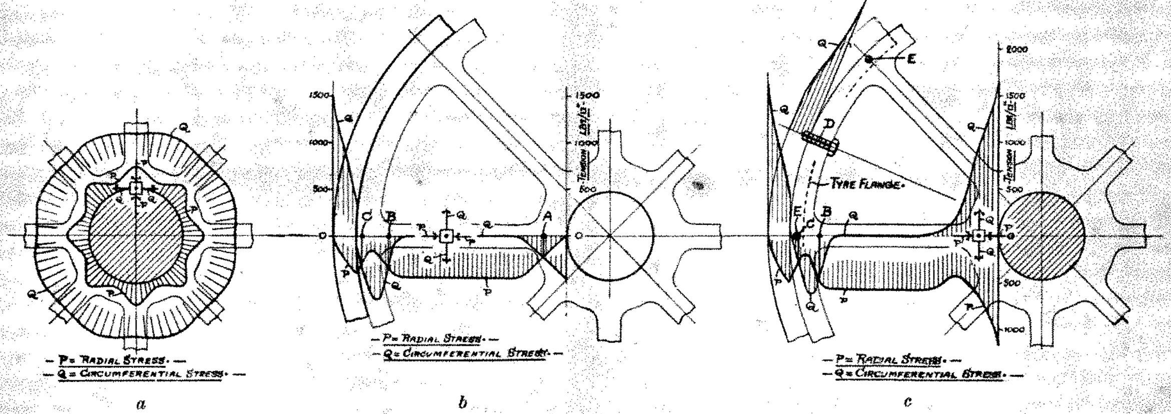

Fig. 2.—*a*: Stress distribution in the hub of a wheel at the axle, when the latter is forced on. *b*: Stress distribution in a wheel, along the line of a spoke, when a tyre is forced on to a wheel centre. *c*: Stress distribution in a wheel when the axle has been forced into the wheel centre and the tyre shrunk on.

These distribution curves also show that the combined effect of both axle and tyre is to increase the radial stress on the axle greatly. In the tyre, increased stress is also apparent, although it remains of the type already described with reference to Figs. 1, *b*, and 2, *b*. This latter distribution is more particularly interesting in its application to much larger wheels, such as the driving wheels of locomotives, where, on account of their size and the necessity of supporting the tyre at short intervals, the number of spokes is much increased, and since, unlike wagon wheels, they are required to exert great tractive force at the rails, it is found necessary to fasten the tyres more securely to the rim of the wheel centre by additional devices, in order to prevent circumferential slipping.

Formerly it was the practice to screw radial studs *D* (Fig. 2, *c*) through the rim of the wheel centre and into the tyre at places midway between the spokes, as indicated here, thereby making holes in the tyre at places where the stress is already intense, and therefore adding to it very greatly, owing partly to the lessened cross-section of the tyre, and also to the effect of the discontinuity, necessitating changes of direction of the tensional stress in passing round the hole so formed. This practice has now been given up in favour of transverse rivets *E* inserted in holes made in the wheel centre rim, very close to the stress difference zeros *C*, and passing through a flange formed on the tyre, which is now constructed to lap over the rim, as indicated by a dotted line in Fig. 2, *c*.

The photoelastic effect shows clearly the advantage of this method of fastening, for the discontinuity now produced by boring a hole at a place near the position of the stress difference zero *C*, where the principal stresses *P* and *Q* are both small, only causes a very moderate increase in both stresses, while no inroad is made into the main cross-section of the tyre. Practical experience has shown that tyres fastened in this way are much stronger and safer than those secured to the wheel centre by the older method, and the advantages of this new form of fastening have secured its very general adoption.

Oxidation by Living Cells.*

By Prof. J. B. S. Haldane.

Until recently our knowledge of the chemistry of respiration stopped abruptly at the boundary of the cell. We knew how the oxygen was carried to it in vertebrate blood, and the carbon dioxide carried away. We also knew that the rate of oxygen consumption by the body as a whole, and by certain organs, was a function of numerous variables, such as temperature, hydrogen ion concentration, nervous stimulation, and so on. A certain number of partially oxidised metabolites, such as β-hydroxybutyric acid, had been isolated. But such quantitative knowledge as existed with regard to the details of oxidation was mainly confined to reactions in which coloured molecules were involved: for example, the reduction of methylene blue to a colourless substance, or the oxidation of *p*-phenylene-diamine to a coloured one.

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* Substance of lectures delivered at the Royal Institution on Feb. 5, 12, and 19.

The modern period began with the work of Batelli and Stern, and of Bach and Chodat, in Geneva, and since the War the most important centres of research have been the laboratories of Thunberg in Sweden, of Warburg and Wieland in Germany, and of Hopkins in England. This work has led to the recognition of a number of distinct catalysts, each responsible for a different part in the process of respiration. Inorganic catalysts of oxidation may activate the oxidant, the reducer, or both. Thus, Langmuir concluded that when a hot platinum surface catalyses the union of hydrogen and oxygen, a layer of adsorbed O_2 molecules is so activated as to unite with H_2 striking them; but adsorbed H_2 does not unite with bombarding O_2. On the other hand, when the same reaction is catalysed by porcelain, both molecular species must be adsorbed side by side before they react.

We need not, therefore, be surprised to find in the cell catalysts which activate O_2, alongside of activators of reducers such as the lactate ion, and shall be prepared to steer a course between the unitary theories of Warburg [1] and Wieland,[2] who respectively regard the activation of oxygen and of reducers as the fundamental feature of respiration.

When an enzyme catalyses the reaction between two molecular types, one very restricted, the other very general, we describe it as specific for the former. Thus Dixon [3] and Coombs [4] found that xanthine dehydrogenase catalyses the reaction $AH_2 + B = A + BH_2$, where A must be one of a small number of purine bases (it is possible that the same enzyme also activates aldehydes; if so, they are oxidised at about one per cent of the rate of the purines). But B may be oxygen, iodine, nitrate, permanganate, or any of a large number of dyes, such as methylene blue. These latter are perhaps all held on the enzyme surface near the former, but it is difficult to imagine that there is a single molecular grouping responsible for activating all of them. For reaction it is not sufficient that a molecule should be united with the enzyme; it must be activated as well. Thus, uric acid unites with xanthine dehydrogenase at the same spot as xanthine, thus inhibiting its oxidation, but is not oxidised, though another enzyme can accomplish this process.

A large number of dehydrogenases are known which act in a similar manner, each causing the activation of one or more organic substrates. Thus, lactic dehydrogenase, which can be obtained in solution from a number of sources, activates several α-hydroxyacids; succinic dehydrogenase, another enzyme easily obtained in solution, activates succinic and methyl-succinic acids; and so on. The activity of these enzymes is generally measured by the rate at which they catalyse the reduction of methylene blue by their substrates. They usually have a wide range of optimal pH from about 7 to 10, instead of a small range like hydrolytic enzymes, and a fairly constant Q_{10} in the neighbourhood of 2, that is, a critical increment of about 12,000 calories. They are not inhibited by small concentrations of cyanide or sulphide, but are so by the usual enzyme poisons, such as heavy metals and nitrites, and oxidising agents. The formic dehydrogenase of *Bacillus coli* appears to be a copper compound, but there is no evidence that most dehydrogenases contain metals. Quastel [5] and his colleagues have made a very thorough study of the dehydrogenases on the surface of *Bacillus coli*. There are probably at least seven different ones, and possibly many more. In this case they can readily be shown to be concerned in oxygen uptakes. In certain conditions malonic acid inhibits methylene blue reduction by succinic acid, both uniting with the enzyme at the same point; and in high concentrations of both, the rate of reduction of methylene blue depends on the ratio of the two. Cook [6] found that oxygen is reduced at nearly the same rate as methylene blue, and malonic acid inhibits its reduction to about the same extent.

When a dehydrogenase and its specific substrate act directly on O_2 it is reduced to H_2O_2. Some anaerobic bacteria act in this way. Bertho and Glück [7] found that at least 90 per cent of the O_2 consumed by *Bacillus acidophilus* is converted into H_2O_2, which damages the bacteria. But some dehydrogenases when separated will not reduce O_2, and a separate activator is required. We know rather less about the activation of O_2 than of H_2O_2. This latter can be activated by two different enzymes, catalase and peroxidase, and by heat-stable peroxidase-like substances such as cytochrome and hæmatins.

Catalase catalyses the reaction $2H_2O_2 = 2H_2O + O_2$. Zeile and Hellström [8] have shown that it is a derivative of hæmatin with a definite spectrum, and convertible into a hæmochromogen, or into protophyrin. It unites with HCN to give an inactive compound. Under suitable conditions a catalase molecule can destroy more than 10^5 H_2O_2 molecules per second. Peroxidase catalyses the reactions $H_2O_2 + X = H_2O + XO$, or $nH_2O_2 + nX = nH_2O + nXO$, where X may be a large variety of molecules, generally aromatic, but including nitrite and HI. It can be very highly concentrated, and appears to be a coloured iron compound. Its extreme sensitivity to cyanide suggests that it is of a similar nature to catalase.

The oxygen activators (oxygenases or *Atmungsferment*) have been specially studied by Warburg.[1] They unite not only with O_2 but also with CO, for which they have a rather smaller affinity. Like CO-hæmoglobins, the CO-oxygenases are generally sensitive to light. Thus the oxygen uptake of yeast in presence of glucose or alcohol is reduced to about 50 per cent, in a mixture containing ten parts of CO to one of O_2, in the dark. In strong light it returns to almost normal values. By studying the relative efficiencies of different monochromatic lights, Warburg and Negelein [9] found that its spectrum is very similar to that of alkaline hæmatin, and still closer to that of iron-phæophorbide-*b*.

Cook, Haldane, and Mapson [10] worked with *B.*

coli in toluene-saturated buffer solutions. Under these conditions, succinic, lactic, and formic acids each lose two hydrogen atoms and no more. It is thus possible to study reactions much simpler than the complete oxidation of a substance such as glucose. They found that CO and HCN, which in moderate amounts do not prevent oxidations by methylene blue, inhibit oxygen reduction. In both cases the oxidation of lactate is more sensitive than that of formate, while that of succinate is intermediate. Hence there appear to be three oxygenases with specific relative affinities for CO and O_2, like those of the hæmoglobins, and also with different affinities for HCN. Each dehydrogenase is associated with a particular set of oxygenase molecules, for oxygen uptakes in presence of formate and lactate are strictly additive, even when oxygenase activity has been reduced by HCN. If the various dehydrogenases could draw on the same common stock of oxygenase molecules for activated oxygen, this would not be so. This rather rigid organisation is probably exceptional, for oxidations by *B. coli* are largely carried out on its surface, instead of internally, and it does not contain all the three cytochromes. In the absence of toluene, similar but not quite so clear-cut results are obtained.

Cytochrome is the name for a group of metal-porphyrin compounds, the metal being probably iron, which are found in almost all cells, and have been studied by Keilin.[11] When the cell runs short of oxygen, through asphyxia, intense metabolism, or cyanide poisoning, a strong spectrum of cytochrome, resembling that of a mixture of hæmochromogens, appears. If the supply of oxygen becomes adequate, the characteristic bands disappear, being replaced by a fainter spectrum of the alkaline hæmatin type. Cytochrome is not oxygenase, as it does not combine readily with CO or HCN. One of the three components of cytochrome, cytochrome *c*, has been obtained in fairly strong solution. It is a red substance, only slowly oxidised by molecular oxygen, readily by mild oxidising agents. It can be reduced by reducing agents or living tissues, and is an iron-porphyrin compound. Keilin found that the oxygen uptake of a system composed of oxygenase from heart muscle, cytochrome, and cysteine behaves like that of a tissue to cyanide and CO. With this system he was able to show that oxygenase is heat-labile like an enzyme, which cytochrome is not. In plants, a particular type of oxygenase, which Keilin calls catechol oxidase, and the CO compound of which, where investigated, has been found to be insensitive to light, yields H_2O_2 when oxidising catechol and its derivatives, as shown by Onslow.[12]

We can thus give a scheme (Fig. 1) which probably covers most of the oxidation process in the average cell. In anaerobes one or more of the catalysts is absent. Oxygen is activated by oxygenase, which is reduced by cytochrome, and the latter is reduced in turn by dehydrogenases of the common or anaerobic type, that is, those which cannot reduce O_2 directly. This process is occasionally simplified, as in *B. coli*, where cytochrome does not seem to intervene in certain oxidations. Oxygen can also be reduced to H_2O_2, either by catechol oxidase or by an aerobic dehydrogenase. This H_2O_2 is used for further oxidation with peroxidase, or is destroyed by catalase. The latter can act as a safety-valve owing to its low affinity. Whereas peroxidase acts most rapidly in a concentration of H_2O_2 which may be as low as 10^{-6} *M*., catalase has an optimum H_2O_2 concentration of about 0·2 *M*., and at 10^{-6} *M*. is working at only about 0·0004 of its maximum rate. Other substances may act as intermediates. Glutathione appears to remove hydrogen from certain groupings in proteins, the reduced glutathione being later re-oxidised. St. György's[13] hexuronic acid is apparently reduced by dehydrogenases and oxidised by peroxidase. Doubtless many more similar substances will be discovered in future.

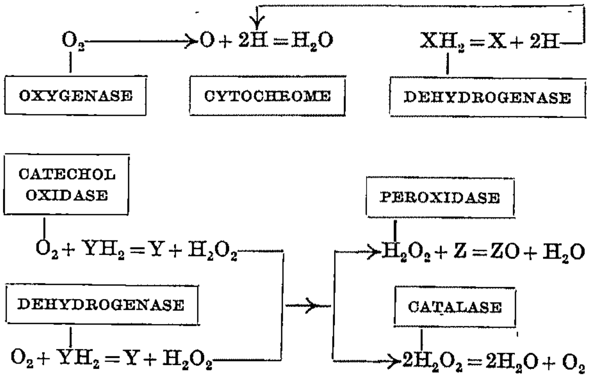

FIG. 1.—The names of the catalysts are given in rectangles, the molecular species activated by each being indicated. The molecule YH_2 is catechol or a derivative in the case of catechol oxidase (Onslow's oxygenase) and is a purine base in the case of xanthine oxidase acting as a reducer of O_2. X and Z may be very varied.

We note the great importance of metal-porphyrin compounds (Table I.). It is fairly clear that their catalytic function is primitive. They have afterwards been modified to act as stores or carriers of oxygen in higher animals. Except in chlorophyll, a magnesium compound, the metal united with the porphyrin is usually, if not always, iron. As oxygenase, catalase, and cytochrome are almost universally distributed, we need not be surprised that hæmoglobin and related pigments such as chlorocruorin have often been independently evolved, a suitable protein being combined with iron-porphyrin residue.

TABLE I.—METAL-PORPHYRIN IN COMPOUNDS FOUND IN CELLS.

1. Catalysts. Chlorophyll *a* and *b*. Oxygenases. Catalases. Probably peroxidases. Cytochrome *a*, *b*, and *c*.
2. Mainly concerned in oxygen storage. *Arenicola* hæmoglobin.
3. Mainly concerned in oxygen carriage. Vertebrate hæmoglobins.
4. Uncertain whether in group 2 or 3. Many invertebrate hæmoglobins. Chlorocruorin. Helicorubin, etc.

We know little as to the immediate source of CO_2. Two obvious processes are available, the dehydrogenation of formic acid, and the decarboxylation of pyruvic acid and related compounds by the enzyme carboxylase according to the equation: $R-CO-COOH=R-COH+CO_2$. The enzymes concerned in both processes have a wide distribution.

Still less is known of how in detail the energy made available in oxidation is passed on, or of how the rate of oxidation is controlled, though both processes are evident enough in the whole organism. The control is largely exercised on the fuel supply. Thus a rise of blood sugar in man causes an increased oxygen consumption. Hormones such as thyroxin are also concerned, but their mode of action is not understood. The energy is not generally liberated directly, but is largely employed in building up compounds of high chemical potential. These may either form new tissue or be available for rapid energy production. Thus the oxidation of sugar or lactic acid in muscle provides energy for the resynthesis of glycogen from lactic acid, and of phosphagen from creatine and phosphate.

If these processes are to be efficient, two conditions must be fulfilled. The energy of oxidation must be made available in quanta somewhat, but not greatly, larger than those required for synthesis; and the molecules undergoing oxidation and synthesis must be united with the same catalyst, which must thus have a double specificity. The significance of the complicated oxidising systems here described will remain obscure until we know what syntheses are correlated with each of them. A beginning of such an analysis has been made by Wurmser.[14] But an indispensable preliminary is a study of the total and free energy changes in the various reactions which are linked. This is still in its very early stages.

But even when we know the stages in the oxidation of different substances, and the use to which the energy thus made available is put, we shall be faced with the problem of regulation. In the living cell the activity of peroxidase or lactic dehydrogenase is doubtless governed by laws as definite as those which govern that of the heart in the living organism, laws which can be stated both in terms of chemistry and of biological function. The question of whether these two types of explanation can be reconciled, or whether one of them is superfluous, will then have to be fought out. However, that day is far distant; meanwhile the biochemist can continue to accumulate knowledge without committing himself on philosophical questions.

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[1] Warburg, "Über die katalytische Wirkungen der lebendigen Substanz", 1926.
[2] Wieland, *Ergeb. Physiol.*, **20**, p. 477; 1922.
[3] Dixon, *Biochem. Jour.*, 20, p. 703; 1926.
[4] Coombs, *Biochem. Jour.*, **21**, p. 1259; 1927.
[5] Quastel and colleagues, *Biochem. Jour.*, 1924–1928 (Bibliography in *Jour. Hyg.*, **28**, p. 139; 1928).
[6] Cook, *Biochem. Jour.*, **24**, p. 1538; 1930.
[7] Bertho and Gluck, *Naturwiss.*, **19**, p. 88; 1931.
[8] Zeile and Hellstrom, *Zeit. physiol. Chem.*, **192**, p. 171; 1930.
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[10] Cook, Haldane, and Mapson, *Biochem. Jour.*, **25**, p. 534; 1931.
[11] Keilin, *Proc Roy Soc.*, B, **98**, p 312; 1925: **104**, p. 236; 1929.
[12] Onslow and Robinson, *Biochem. Jour.*, **20**, p. 1138; 1926.
[13] St. Gyorgy, *Biochem. Jour.*, **22**, p. 1387; 1928.
[14] Wurmser, "Oxidations et réductions", 1930.

Obituary.

Lieut.-Col. Sir Charles Bedford.

THE death of Lieut.-Col. Sir Charles Bedford, which occurred on July 8, terminates a career of scientific activity. Born in 1866, the youngest son of Dr. F. W. Bedford, headmaster of George Heriot's Hospital, Edinburgh, Bedford graduated in science and medicine at the Universty of Edinburgh and entered the Indian Medical Service in 1889. His special aptitude for work of an investigatory character was soon recognised in his appointment by the Punjab Government to be chemical examiner and professor of chemistry at Lahore Medical College. In 1897 he transferred to similar posts in Bengal. Whilst holding these appointments, Bedford rendered valuable assistance to the Indian Excise authorities, particularly in connexion with alcoholic liquors. He became scientific and technical adviser to a committee of investigation into excise questions, and later was appointed director of the Central Excise Laboratory, which was formed on the recommendation of that committee.

It was whilst holding these positions that Bedford performed his most valuable work. Under his direction an extensive investigation was made of all alcoholic liquors produced in or imported into India, their composition and physiological effects, with those of the by-products of manufacture. In 1907 he made a report upon the determination of alcoholic strengths. He submitted new tables intended for use with a glass Sikes's hydrometer in place of those which for upwards of a century had formed the basis of revenue charge. The old tables which were legalised in England in 1816 were compiled for use with a brass hydrometer and covered a range of temperature from 30° to 80° F. For use in warmer climates the tables were extrapolated to 100° F. Strengths determined under these conditions could be regarded as little better than approximations, and Bedford demonstrated that the inevitable errors operated for the most part against the revenue. The new tables were officially adopted in 1908, and remained in use until replaced in 1922 by others calculated from data which formed the basis of the British tables legalised in 1915.

Bedford was also responsible for the methods officially adopted in India for rendering unpotable alcohol intended for commercial and industrial purposes.

After his retirement from the Indian Service, when he was rewarded with a knighthood, Bedford continued to render valuable service in various directions, being a member of numerous committees and occupying advisory positions at home and in connexion with the Dominions. Bedford also found time in the course of a busy life to indulge in considerable literary activity. One of his first publications was a memoir of his father, followed by a history of George Heriot's Hospital. His later works included books on poisoning, enteric fever, and elementary hygiene in India. He received the honorary degree of LL.D. from St. Andrews and Edinburgh, and that of D.C.L. from the University of Oxford.

R. R.

DR. R. C. MACFIE.

ON June 9, in a nursing home in London, Dr. Ronald Campbell Macfie passed quietly from amongst us with whom he had so quietly lived. He was not fond of the limelight, and was intimately known by few, by all of whom, however, he was greatly beloved.

An Aberdonian by birth, he was not in temperament true to type, for he was pre-eminently a man of feeling; yet it was also characteristic of him that he was never without some big problem to ponder over. He graduated in arts and in medicine in the University of Aberdeen, and continued his training in other schools at home and abroad. As locum-tenens at many places and consulting physician in health resorts, he saw a good deal of the world, and he had ever a keen appetite for beauty. With a very high ideal of health of body and health of mind, he lived an ascetic, highly strung life, often with a too strenuous struggle for existence, but, on the whole, rich in high joys and the delights of laborious days.

It was a great encouragement to Dr. Macfie when his poems brought him laureation from his Alma Mater, and he was almost pathetically pleased—two years ago—when he was asked to give the Thomson Lectures in the United Free Church College. These were published under the title "Science Re-discovers God", and they give noble expression to the main trend of his mind. He was spiritually minded, and was convinced that it is the business of science not merely to make the world intelligible, so that a religious interpretation may be more convincing, but to declare a theodicy. His scientific books dealt with heredity and evolution, with vitalism, with health, with the vital value of light, and most successfully of all, we think, with the romance of the body. They were characterised by sparkling lucidity, picturesque phrasing, poetic flashes, and an idealistic setting. His poems, which were his strongest self-expressions, are marked by their combination of music and high thinking. Many of them are little essays in philosophy, and yet at the same time they are melodies.

Of Ronald Campbell Macfie the world did not show itself quite worthy, but he did his day's work cheerfully.

MR. HENRY JAMES WADDINGTON, who died at Bournemouth on June 28 at ninety-one years of age, was well known to microscopic workers both at home and abroad. Many of his preparations, especially those of prawns and crabs, as well as various protozoa, are exhibited in the Natural History Museum, South Kensington. His wonderful manipulative skill at mounting the most delicate protozoa and insects in their natural condition was the admiration of all who came in contact with him. His knowledge of chemistry was an enormous help to him, and his successful preparation of realgar as a mounting medium of high refractive value, as well as his mounts of various diatoms in realgar, are known to many. Mr. Waddington was one of the founders of the Natural Science Society of Bournemouth, and was later presented with the gold medal of the society and elected honorary vice-president.

WE regret to announce the following deaths:

Dr. Francis R. Cross, who was reader in ophthalmology in the University of Bristol and formerly president of the Ophthalmological Society, on July 12, aged eighty-three years.

Prof. Harald Höffding, formerly professor of philosophy in the University of Copenhagen, known for his publications on philosophy and psychology, on July 2, aged eighty-eight years.

Sir Harry R. Reichel, emeritus rector of the University College of North Wales, Bangor, who was principal of the College for forty-three years and known for his work in education, on June 22, aged seventy-four years.

News and Views.

MR. HERBERT MORRISON, Minister of Transport, stated in the House of Commons, on July 24, that the Weir report on the electrification of the railways of Great Britain raises important issues of industrial policy and that the Government will consider its recommendations most carefully. In the opinion of some, an objection to the scheme is that, as the report indicates, the coal consumption will be reduced by 3·8 per cent, or nearly ten million tons a year. It is also true that part of the economy which will be gained will be secured by the reorganisation of the railway men. But it would be foolish to let these two facts prevent us from carrying out a great scheme of industrial improvement. In the making of our country industrially efficient it cannot be wrong to face the new problems and solve them in the same spirit that we solved similar problems in the past. It would be foolish to be frightened because the report deals with big figures. It is significant that the manager of the L.N.E.R. signed the report. The Government is at present discussing the report with the railway companies. The Weir Committee estimated that a return of about 7 per cent could be secured upon the new capital (£261,000,000) involved in electrification. In the present condition of affairs this remuneration would doubtless be welcomed by the companies, but it is doubtful whether they could at present attract the necessary capital without State assistance. At the recent N.U.R. Conference, Mr. C. T. Cramp, the General Secretary of the Union, welcomed electrification on behalf of the employees. He takes it for granted that if the State assists to raise the capital it will assume some kind of control of the scheme. It is probable that a semi-public body of a central board type will have to be made. There is no reason why it should not prove to be as successful as the Central Electricity Board set up by the Electricity Act of 1926.

CONSIDERABLE advances have recently been made in controlling street traffic by means of visual signals. One of the largest of the synchronised systems has now been in operation for a few weeks in Oxford Street, London. It is the first system of this kind in Great Britain and its working will be watched with interest, as before it was started the traffic was very congested. A careful census of the main streets and the cross streets at all times of the day was first taken. From the data thus obtained the whole scheme was worked out. The signal lamps, green, amber, and red, are electrically connected with a ' controller ' fixed on one of the lighting poles and the length of the times the lights are on is easily controlled from it. The speed at which maximum street capacity and efficiency are obtained was roughly determined by the data obtained. It depends on road width, length of blocks, and the nature of the traffic. If the signals are set for a speed higher than the ideal speed, the traffic gets out of step with the system and there is a consequent slowing down. The Oxford Street system was originally set for a speed of thirteen miles per hour, but this has now been increased to a speed of fifteen miles per hour, and it is probable that still higher speeds will be used in the future. The relative density of the cross traffic is an important factor in the calculations. At important crossings such as the one at Oxford Circus, where the volume of the Regent Street traffic is practically the same as the Oxford Street traffic, equal periods of green are given in both directions. At less important crossings the main road has a longer green interval than the cross road. The master controller kiosk is situated on the north side of Oxford Circus and the whole system is controlled from it. There is a private telephone exchange in the kiosk which enables constables on duty to report instantly any defective signal. In the 1½ miles of Oxford Street there are twenty-one groups of traffic signals.

SINCE the War, a very peculiar form of degeneracy has been observable in London sparrows—the breakage of the tail-feathers some time after the moult; this generally occurs close up to their roots, so that at first sight the bird looks as if it had had the quills pulled out, but on close inspection stumps are to be seen, and in some cases the breakage is in the middle of the tail. In any case, it is the outermost feathers that break off nearest the roots, the point of breakage becoming more distant until the central pair are reached, so that the broken tail presents a rounded outline, whereas the undamaged tail is slightly forked. Birds thus affected may be seen in widely separated London districts, and it is curious that they are not otherwise degenerate; their general plumage and condition are average and may even be exceptionally good, while they are often to be seen in company with an intact mate or collecting food for young. Moreover, whatever causes the breakage of the tail-feathers operates quickly on all, as it is rare to see a bird with the tail containing both intact and broken feathers. Before the War, birds showing white feathers here and there were common; then these disappeared for some years, and have only been noticeable again for the last year or two, when, like the broken-tailed birds, they appeared at widely separated points in London: so that whatever cause produces these defects—which are common to both sexes—it operates independently on many isolated individuals.

ALL the four forms of jungle-fowl (*Gallus*) are now to be seen at the London Zoological Gardens—a most instructive exhibit, as the genus is so natural that all recognise the birds immediately as fowls; and yet the species are so distinct that even the hens are as different in plumage as are our four common spotted thrushes—missel, song, redwing, and fieldfare. The cocks are strikingly unlike, as much in voice as in plumage and in details of feathering and head appendages. The most aberrant is the Javan *G. varius*, which has no neck-hackle or wattles, and has indeed been separated as *Creagrus*; yet it agrees with the common *G. gallus* in having the underparts black in the male and brown in the female, and with the Ceylonese *G. lafayetti* in the bold black barring of the wings in the latter sex, in the possession of a dewlap by the male—though this in *lafayetti* is very small—and in the eyes being yellow in both sexes. Between it and the south Indian *G. sonnerati* no special resemblance can be traced; but this agrees with *G. gallus* in having orange-red eyes and in the males assuming ' undress ' neck-feathering after breeding, and with *G. lafayetti* in having the underparts hackled and striated in the male and variegated with black and white in the female, while in these two alone the legs are red in the former and yellow in the latter sex. Yet the male of *G. lafayetti* agrees with that of *G. gallus* in showing much red in the plumage, and in flapping the wings before crowing, unlike the two others; while it may be noted finally that in none of the species except the last-mentioned is the crow at all like that of any tame fowls.

A STATISTICAL report on the third year's operations of the Bureau for Contraceptive Advice, Baltimore, by Prof. Raymond Pearl, is contained in the third report of the Bureau (Baltimore, Maryland, 1931). It is considered that the Bureau has been in operation too short a time to warrant any report on either the relative or the absolute effectiveness of the advice given as to the technique of contraception. In a group of 183 women who came for advice, the average number of pregnancies was 5·5 and the average number of children was 4·7. But their average age was only thirty-one years, and the average duration of marriage was eleven years. These are high reproductive rates which cannot be regarded as helpful to either private or public health. All the women who came to the Bureau were married, and the experience of the Bureau so far demonstrates that there is no validity in the argument sometimes advanced against the giving of contraceptive advice, to the effect that it is chiefly sought by the young as a means of escaping the moral responsibilities of marriage. In this connexion, it may be mentioned that the Ministry of Health has issued a *Memorandum* (153/M.C.W.) stating that local authorities in Great Britain have no general power to establish birth control clinics as such, but that they have under the Public Health Acts power to provide clinics at which medical advice and treatment would be available for women suffering from gynæcological conditions, and that in these advice may be given on contraceptive methods, restricted to married women who attend and in whose cases pregnancy would be detrimental to health.

NEW seismological stations have recently started work in China, Denmark, and Scoresby Sound, Greenland. When the disastrous Kansu earthquake occurred on Dec. 16, 1920, the only seismological station in the whole of China was that of Zikawei, near Shanghai, under the charge of Father Gherzi. Soon after the earthquake, Mr. Wong Wen-hao, the Director of the Geological Survey of China, suggested to the Government that a station should be established in North China, but it was not until September 1929 that permission was given. The place chosen is Chiufeng, about twenty-two miles north-west of Peking (lat. 40° 3′ 55″ N., long. 116° 5′ 46″ E.). The building in which the first instruments (Wiechert horizontal and vertical seismographs) are installed is situated on a granitic hill, 508 feet above the sea. It has been placed under the charge of Mr. S. P. Lee, who has recently issued the first two numbers of the *Seismological Bulletin*, containing the records for about the last three months of 1930. Though they have been somewhat longer at work, a description of the two stations belonging to the Danish Geodetic Institute has recently been published. The station near Copenhagen (opened in November 1926) consists of two caponnieres of the old fortifications, 3¾ miles from the outskirts of the city, both well protected from damp, changes of temperature, and artificial vibrations and provided with Galitzin, Wiechert, Milne-Shaw, and Wood-Anderson seismographs. The second station, containing a set of Galitzin pendulums, is erected at Scoresby Sound, on the east coast of Greenland (lat. 70° 29′ N., long. 21° 57′ W.), and has been at work since January 1928.

IN a recent weekly circular issued by the Ministry of Agriculture, attention is directed to the scheme of exchange of British and Danish agriculturists inaugurated in 1924, under which Danish students are enabled to live and work on farms in Great Britain in order to study English farming practice, and an equal number of young British agriculturists are afforded equivalent opportunities in Denmark. The students are required to pay their own travelling expenses and to undertake regular farm work for a period of from three to twelve months, in return for which free board and lodging is provided but no money paid. Up to the present, only a few students from England have visited Denmark, although the young Danish farmers have made a much fuller use of the exchange scheme. It is, therefore, hoped that more British students will avail themselves of the advantage of this unique opportunity of gaining, at very low cost, an insight into the farming practice of one of the leading agricultural countries. Dairy farming in general, the scientific economic feeding and breeding of dairy cattle, co-operative production, marketing, etc., are the chief branches that may be studied. Those intending to proceed to Denmark for a period of six months or less should arrange to start either early in November or early in May. Agricultural students in England and Wales wishing to take advantage of the scheme should make application through the principal of their college or farm institute (if they have attended such an institution), or through the agricultural officer of the county in which they are resident.

MR. JAMES J. JOICEY, in continuation of a policy pursued by him for many years to the great benefit of the British Museum (Natural History), has presented to the Department of Entomology a further selection consisting of 800 butterflies of very great value and interest from the point of view of the systematic student. These are nearly all 'type' specimens, some of which are unique, that have formed the basis of original scientific work published by Mr. Joicey himself or by other well-known entomologists whose collections have passed into his hands. Two nearly complete skeletons of the reptile *Pachypleurosaurus* from the Alpine Trias have been acquired by the Department of Geology. These animals were shaped like lizards, less than a foot long, and probably lived partly in and partly out of the water. Acquisitions for the Department of Minerals include a small fragment sawn from the 12-ton mass of meteoric iron found in October 1930 near Mbosi, between Lakes Nyasa and Tanganyika, in Tanganyika Territory, presented by Mr. H. V. B. Lloyd Phillips. A fragment of a meteoric stone has been detected amongst the rocks and minerals collected by Mr. Bertram Thomas during his recent expedition across Central Arabia. The Department of Botany has purchased the collections which formed the basis of Dr. Albert Pilát's monographs on Stereaceæ and Aleurodiscaceæ containing 727 specimens of fungi.

THE Imperial Sugar Cane Research Conference, held by the Empire Marketing Board, which concluded on July 24, has recommended the establishment of a chain of four central cane-breeding stations to assist the Empire's sugar industry. Barbados was selected as the site for a cane breeding station in the West Indies. It was recommended that one-third of the expense should be met from Imperial funds and two-thirds by Barbados itself. The three other cane breeding centres would be located in India, Mauritius, and Australia. It was also recommended that a quarantine station should be set up in the West Indies, through which all canes being imported or moved about should pass. Fungus diseases often cannot be detected at once by the most experienced expert, and sometimes they lie dormant in the cane for over a year.

Research on the improvement of agricultural methods, the better interchange of information, and the exchange of workers, are aspects of scientific work which the Conference desires to see extended. It recommended that work on the biological control of insect pests should be continued in the West Indies, and provision should be made for its extension to other Empire countries as occasion may demand.

IN a pamphlet entitled "Mass Production" (Pelican Press, London, 6*d*.) Sir Eric Geddes argues that a protected home market is essential to enable British manufacturers to compete with foreign mass production. He points out that since the War the methods of mass production have developed with great rapidity and its power for the well-being of mankind is enormous, since by cheapening prices it has brought articles of convenience and luxury into the homes of millions who last century could never have dreamed of being able to afford such things. In illustrating the advantages of mass production, Sir Eric Geddes utilises some very interesting diagrams. One of these refers to the drilling of holes in a metal plate, which if done accurately by hand would require a high degree of skill. If performed by a machine, the work no longer depends on the skill of the operative but on the accuracy of his tool, and the cost is seventy-seven times less than that of hand production. In another diagram it is shown that the proportion of labour cost may fall from 50 per cent to 25 per cent when mass production methods are used. To-day the cost of research, experiment, planning, equipment, power, and the maintenance and depreciation of machinery overshadows the cost of productive labour in importance. In the British motor industry, through the partial adoption of mass production methods, workers' earnings have been about doubled since 1914 although prices to the consumer have fallen about one-half.

IT is announced in the *Scotsman* of July 25 that St. Kilda, having been in the hands of the Macleods of Macleod for centuries, has changed owners. Naturalists in general, and ornithologists in particular, will rejoice that its new ownership ensures that the fauna and flora will remain undisturbed, and that the island may be recognised as a natural sanctuary for beasts and birds. Here, if anywhere, the study of the effects of isolation upon species is likely to yield good results. The new owner is the Earl of Dumfries, the eldest son of the Marquess of Bute. Lord Dumfries, born in 1907, is a keen ornithologist who has a first hand knowledge of the birds of southern Europe as well as of Great Britain, and has taken an interest in the arranging of the bird collections in the museum at Rothesay. We understand that all the amenities of St. Kilda will be carefully preserved and safeguarded by the new proprietor, who does not intend to put the island to any commercial use whatsoever.

THE census of Indian mosses (with analytical keys to the genera) published by P. Brühl in the *Records of the Botanical Survey of India*, vol. 13, No. 1, is a large undertaking on which he should be congratulated. The census is at present far-reaching, including Malay to the east and the Caucasus and intervening countries to the west, but as the mosses of these various regions show affinities with those of the various regions of India the wider nature of the census is justified. The addition of keys to the genera and the great advantage gained by the identifications being made possible on vegetative characters will add greatly to the value of the work. Even in Great Britain, it is of enormous advantage to be able to name a moss in the absence of sporogonia, and this must apply much more to bryology in India. Such a census, combined with the keys, should be a big step towards attracting workers in India to bryology; and if students are able to identify a specimen at least so far as to place it in a genus, this should enable them to contribute much to the more detailed knowledge of the mosses and their distribution and, at the same time, to do so without adding unnecessarily to the work of the experts on whom the ultimate identification is almost bound to devolve at the present time.

GENEVA is now the centre not only of the Société des Nations and of the Bureau international de Travail, but also of numerous other societies which have already grouped themselves together in the Fédération des Institutions internationales (semi-officielles et privées) établies à Genève; secretary, Bertram Pickard, 5 Place de la Taconnerie. A list of these will be found in the "Annuaire international de Genève", published by the Centre permanent d'informations internationales, Place des Bergues, 3, Genève. Reference to the League of Nations "Handbook of International Organisations", 1929 edition, shows in the index pages how organisations are developing at other world centres: for example, 14 societies in Vienna, 54 in Brussels, 101 in Paris, 51 in London. Those in Brussels have a possible rallying point in the Palais Mondial, Parc du Cinquantenaire; in Paris the Institut International de Coopération Intellectuelle (2 rue de Montpensier, Palais Royal, Paris, 1er) already organises ententes and liaisons, and its news is published monthly in a *Bulletin de la Coopération Intellectuelle*.

THE late Dr. Bashford Dean, organiser and curator of the Department of Fishes, Recent and Fossil, in the American Museum of Natural History, New York, was remarkably skilled in making drawings of zoological and anatomical preparations. He left many valuable original drawings to illustrate the embryology of three of the lowest existing fishes, and some of his former colleagues and students have now decided to publish these drawings, with explanatory text based so far as is possible on Dean's own notes. The whole will form one quarto volume, entitled "The Bashford Dean Memorial Volume—Archaic Fishes", and will be edited by Dr. Eugene W. Gudger. A preliminary part of the volume, which has already appeared, contains an admirable memorial sketch of Dr. Dean by Prof. William K. Gregory, accompanied by a photogravure portrait, five other portraits which were taken at different periods of his life and activity, and photographs of the tablets to his memory which have been placed in the American Museum of Natural History and the Metropolitan Museum of Art, New York. There is also a complete list of Dr. Dean's writings, including both those on biological subjects and those on armour.

THE Engineering Societies Library of America announces the completion of arrangements for the publication of a series of technical treatises to be known as "Engineering Societies Monographs". The editorial supervision of this series will be in the hands of a committee consisting of Harrison W. Craver, director of the Engineering Societies Library, chairman, and two representatives appointed by each of the following engineering societies: American Mining and Metallurgical Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. The aim will be to publish important technical manuscripts which have proved too extensive for publication in the periodicals or proceedings of engineering societies or in other journals, and of too specialised a character to justify ordinary commercial publication in book form. The Engineering Societies Library will share in any profits made from publishing the monographs; but the main interest of the societies is service to their members and the public. The monographs will not be a series, in the common use of that term. Physically they will have similarity, but there will be no regular interval in publication or uniformity in price, or relation in subjects. The first volume projected for the series is "Plasticity", by Dr. A. Nadai. It is an adapted and revised translation of Dr. Nadai's well-known treatise in German on this subject.

WE have received from P. J. Kipp and Zonen, of Delft, Holland, a leaflet describing an interesting type of ammeter for measuring very minute alternating currents. It consists of four vacuum thermocouples arranged like the arms of a Wheatstone bridge. A sensitive galvanometer is arranged across one of the diagonals and the terminals are at the extremities of the other: when no current flows, the thermocouples are in equilibrium, the total resistance being twenty-five ohms. An A.C. of one milliampere generates a P.D. of 22·5 microvolts across the terminals of the galvanometer. With a Moll galvanometer, we get a deflection of 500 mm. at a distance of one metre. The four thermocouples are protected against outside disturbances by double-walled metal covers. The instrument can be loaded up to a hundred milliamperes, and can be calibrated with direct current. The Moll galvanometer has a resistance of 50 ohms and a sensitivity of 6×10^{-9} amp. per mm. when the scale is one metre away. The *Zc* galvanometer has a resistance of fifteen ohms and a sensitivity of 10^{-10} amperes.

THE liver treatment of pernicious anæmia is now well established: there are very few cases which do not respond to the administration of fresh liver or a potent extract, and very few which relapse when the treatment is continued regularly. Liver, in fact, has completely changed the outlook for the patient suffering with pernicious anæmia. More recently it has been found that stomach, especially that of the pig, is as effective as liver, and that dried stomach is as potent as fresh. Achlorhydria is an invariable sign in pernicious anæmia. This suggested to Castle that the disease might be due to the failure of the stomach to secrete some principle which formed the anti-anæmic substance from the food, or which was itself a potent source of this substance. Reports from numerous observers indicate that desiccated stomach is as effective as, or even better than, liver in the treatment of pernicious anæmia. The British Drug Houses, Ltd., now issue a potent preparation under the name Gaster Siccata B.D.H. The curative dose is about 30 gm. daily and the maintenance dose 10 gm. The material is almost fat free, odourless and tasteless, and forms a smooth, palatable mixture when suspended in milk.

A LARGE meeting of biologists, including leading representatives of genetics, medicine, and anthropology, was held at the London School of Economics on July 21, to consider the question of the present state of research in human genetics and to explore the possibilities of its immediate development. The lack of facilities for research in a subject so vital to the human race as human genetics was generally deplored, and it was decided to seek ways and means to establish in London a central body of experts, who would organise, develop, and foster sound research in human genetics within the Empire by means of grants obtained from various sources. The following Committee, with power to add to its number, was appointed to take immediate action: Sir Daniel Hall (*chairman*), Sir William Beveridge, Prof. F. A. E. Crew, Sir Walter Morley Fletcher, Prof. R. Ruggles Gates, Prof. J. B. S. Haldane, Prof. Lancelot Hogben, Sir Bernard Mallet, Dr. Redcliffe Salaman, Prof. C. G. Seligman, and Dr. C. C. Hurst (*secretary*).

FOR several years Mr. W. R. Dunlop, of 2 Lynton Road, Hythe, Kent, has been engaged in an objective study of individual mental activity amongst men of business. The field is a new and difficult one and nothing has yet been published. Mr. Dunlop asks for the co-operation of other scientific workers in order that he may investigate the possibilities of a comparative inquiry. He wishes to obtain information which will enable him to compare the working of the mathematical mind with that of the business mind. He wants, especially, information as to how mathematical concepts arise, particularly the extent to which they are definitely suggested by environmental experiences. The opportunity of making a brief systematic analysis of the working of the mathematical mind generally is desired, and Mr. Dunlop asks whether any readers of NATURE would be interested and kind enough to put him in touch with one or more originally-minded mathematicians who would be prepared to co-operate as subjects in a very brief preliminary inquiry.

A SPECIAL exhibition of primitive rafts and canoes, which has been designed to show the successive developments by which these primitive craft have given rise to the built boats of modern Europe, is on view in the entrance hall of the Science Museum, South Kensington, and will remain there until September. These will be illustrated by means of about forty models, and also by sixty illuminated photo-transparencies showing native canoes in actual use. Of special interest is a comparison between the method used by the ancient Egyptians in boat-building and that which is still employed in the almost exactly similar boats of the Ganges; a suggestion is also made of the origin of the Chinese sampan as a development from the catamaran of the Madras coast. Among other primitive types are models illustrating the ways in which the ancient Babylonians, like their modern descendants, used oxhide as a means of transport on the Tigris. A contemporary model of the double-hulled boat built by Sir William Petty in 1663, which has been lent by the Royal Society, provides a very interesting comparison with other double-boats from many parts of the world.

PROF. ENGLEDOW, the chairman of the National Institute of Agricultural Botany, who presided at the annual general meeting of fellows at the Institute's headquarters, Cambridge, on July 24, addressed the audience on the policy of the Institute, and laid particular emphasis on the value of co-operation between national and county organisations and the progress already made in this direction. The Institute with its own seven trial stations has gone far in sifting existing material and stimulating plant breeding, and it is already dealing with thirteen crops and hundreds of varieties. Co-ordinated trials are in progress at 107 centres in 46 counties. This unique undertaking, on a national scale, will provide information of first-rate importance and at the same time ensure that the results are brought home to the farmer. Co-operation of this sort is of inestimable benefit to agriculture; it cannot be too widely known that the Institute's accumulated experience and resources are ever at the service of all who need them, and in particular of county organisers.

THE president of the Board of Education has appointed Sir Richard Glazebrook to be chairman of the Advisory Council of the Science Museum in succession to the late Sir Hugh Bell, Bart.

SIR HUBERT WILKINS, who is contemplating a journey under the ice-cap to the north pole by means of his submarine *Nautilus*, was presented with the gold medal and diploma of the Italian Royal Geographical Society on July 23 on board the *Nautilus*, in recognition of his services to science in connexion with polar research work.

THE Development Commissioners have appointed Prof. G. C. Bourne, Linacre professor of zoology and comparative anatomy in the University of Oxford, to be chairman of their Advisory Committee on Fishery Research in succession to Sir William Hardy, who has resigned. Sir William will remain a member of the Committee, of which he has been chairman for twelve years.

BY an order of the Committee of Privy Council, made after consultation with the Medical Research Council and with the president of the Royal Society, the Right Hon. Lord Dawson of Penn, president of the Royal College of Physicians and physician to the London Hospital, and Prof. Edward Mellanby, professor of pharmacology in the University of Sheffield, have been appointed members of the Medical Research Council in succession to Prof. T. R. Elliott, and Prof. J. B. Leathes, who retire in rotation on Sept. 30.

THE Minister of Health received on July 15 a deputation of members of parliament on the question of the abolition of compulsory vaccination. Mr. Leach said that their object was to secure that compulsory vaccination should be abolished, and they hoped that the Government would introduce, or give facilities for, the necessary legislation. The Minister pointed out that the administration of the Vaccination Acts is now in the hands of the larger local authorities, and the Government would await the experience of the operation of the Acts before contemplating any drastic amendment of the law, to secure which, complicated and highly controversial legislation would be necessary.

A CATALOGUE (No. 17) of some 800 second-hand works on natural history, botany, and horticulture has recently been issued by Mr. J. H. Knowles, 92 Solon Road, S.W.2.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A chief dairy instructor at the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Essex County Council, Shire Hall, Chelmsford (Aug. 10). A lecturer in mechanical engineering at the Birmingham Central Technical College—The Principal, Central Technical College, Birmingham (Aug. 10). An assistant in agricultural zoology under the Ministry of Agriculture for Northern Ireland—The Secretary, Civil Service Commission, Stormont, Belfast (Aug. 14). A senior demonstrator in anatomy at St. Thomas's Hospital Medical School—The Dean, St. Thomas's Hospital Medical School, S.E.1 (Aug. 15). An assistant lecturer in mechanical engineering at the Hull Municipal Technical College—The Director of Education, Education Offices, Guildhall, Hull (Aug. 15). A physiological chemist at the Cancer Hospital—The Secretary, Cancer Hospital, Fulham Road, S.W.3 (Aug. 22). A demonstrator in zoology in the University of Leeds—The Registrar, University, Leeds (Aug. 24). A research metallurgical analyst under the British Non-Ferrous Metals Research Association —The Director, British Non-Ferrous Metals Research Association, Regnart Buildings, Euston Street, N.W.1 (Aug. 24). A junior assistant in civil engineering at the Queen's University of Belfast—Prof. Hummel, Queen's University, Belfast (Sept. 1). A university reader in pathology at Westminster Hospital Medical School—The Academic Registrar, University of London, S.W.7 (Sept. 18). A Wandsworth scholar at the London School of Hygiene and Tropical Medicine—The Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1 (Sept. 29). An Oxford or Cambridge graduate in physics to teach physics at Clifton College—The Headmaster, Clifton College, Bristol. An assistant pathologist at the Royal Northern Hospital, Holloway—The Secretary, Royal Northern Hospital, Holloway, N.7.

ERRATUM.—In the obituary notice of Major T. F. Chipp in NATURE of July 25, p. 142, par. 2, line 1, for "1919" read "1929".

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Method of Recording Coincidences between Geiger Counters.

RECENTLY the recording of coincidences between Geiger counters has become of considerable interest, and several experimental arrangements have been described for this purpose.[1] A common property of these arrangements is that the resolving power is of nearly the same magnitude as the duration of an impulse from the counter (about 2×10^{-3} sec.). Impulses occurring within a time interval shorter than this are recorded as true coincidences. The method to be described here gives a resolving power about ten times higher; at the same time, it suffers from the disadvantage that the coincidences must be recorded photographically and not by mechanical summation, as is the case with the arrangements mentioned above.

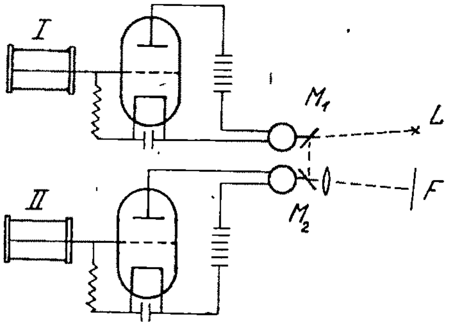

FIG. 1.

Two Geiger counters *I* and *II* (Fig. 1) are connected to the grid of amplifying valves with grid leaks of 5×10^8 to 5×10^9 ohms. The anode current of the valves is sent through moving iron oscillographs of a type similar to that described by Wynn-Williams and Ward.[2] Light from an arc lamp *L* is reflected successively from the plane mirrors M_1 and M_2 of the oscillographs and concentrated by a lens on a slowly moving film *F*. The deflections of M_1 and M_2 are crossed, so that one mirror gives a horizontal deflection, the other a vertical one.

In Fig. 2, *x* represents the direction of the movement of the light spot on the film, and *I* and *II* indicate deflections given by the two mirrors independently. With a natural frequency of 1000 of the oscillograph, the time taken by the light spot to reach full deflection is nearly equal to the duration of the impulse from the counter; the movement of the light spot back to zero deflection is determined by the discharge of the grid capacity over the grid leak, and can be varied at will within certain limits. If a coincidence occurs, the two mirrors commence their movements simultaneously, and the deflection obtained on the film makes an angle of 45° with the direction of *x* (Fig. 2, *a*). If the impulses from the counters occur with a time difference, the deflection appears as a broken line, as indicated in Fig. 2, *b* and *c*, where the time difference is shorter or longer respectively than the duration of the impulse. The position of the kink gives an estimate of the time difference between the impulses. On actual photographs, the smallest time difference which can be detected with certainty is about a tenth of the time taken to reach a full deflection, or about 2×10^{-4} sec. This quantity represents the resolving power of the arrangement. The same value for the resolving power was obtained by counting the number of coincidences when the counters were excited by γ-rays, the coincidences being regarded as accidental. When the same particle (α- or β-particles) was sent through both counters, all coincidences were true (apart from natural effect), so that the time lag in the action of the counter, if it exists, must be identical for the counters used to within 2×10^{-4} sec.

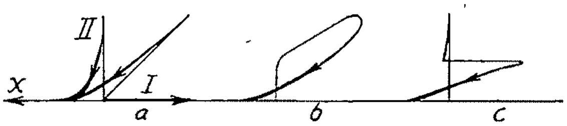

FIG. 2.

J. C. JACOBSEN.

Institut for teoretisk Fysik,
Copenhagen, June 20.

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[1] W. Bothe, *Zeit. f. Phys.*, **59**, 1; 1930. Bruno Rossi, NATURE, **125**, 636; 1930. Hummel, *Naturwiss.*, **18**, 567; 1931.

[2] *Proc. Roy. Soc.*, **131**, 391; 1931.

An Investigation of Infra-Red Radiation from an Engine.

A PRELIMINARY investigation of infra-red radiation from a small single cylinder Otto cycle engine delivering power has just been completed.

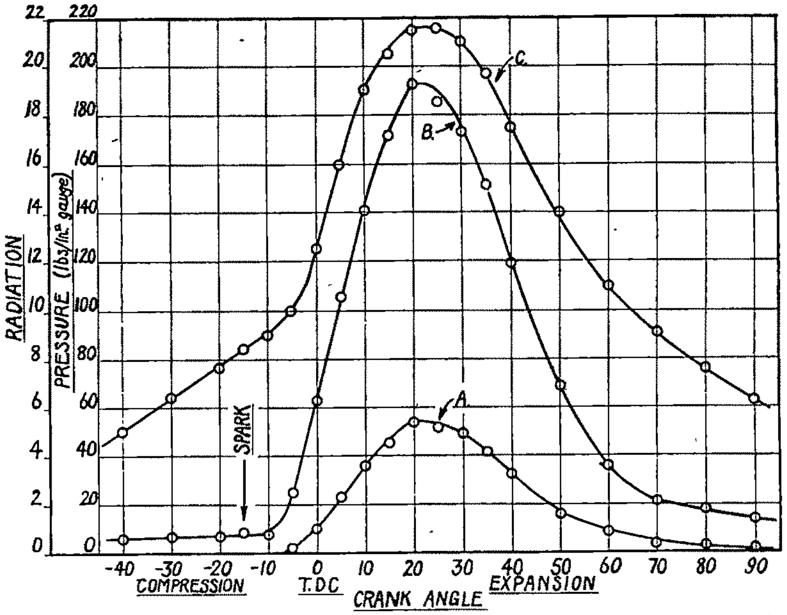

FIG. 1.

The radiation passes through a fluorite window, slightly greater than three millimetres in diameter, and three millimetres thick. Thirty-one positions symmetrically distributed over the combustion chamber are available for the window, and in each a view is obtained through a small depth of charge, in a direction perpendicular to the motion of the flame. By a system of surface silvered mirrors the radiation is brought to a focus on the slit of a stroboscope, which can be adjusted to remain open for any period up to twenty degrees of crank angle, at any point of the cycle. The divergent beam of radiation beyond the stroboscope is reflected from a short focus silvered mirror and focused on a sensitive single junction antimony-bismuth vacuum thermocouple. The e.m.f. generated is measured on a Moll galvanometer with scale at two metres, mounted near the engine on large concrete blocks insulated by heavy rubber, which absorb the engine vibrations at all operating speeds.

The curves submitted (Fig. 1) are plotted on a crank angle base, and show: (*A*) Radiation to 4·4 μ; (*B*) radiation to 10 μ; (*C*) pressure in the combustion space. Curve (*A*) was obtained by placing a piece of plate-glass 4·5 millimetres thick in the path of the rays. The engine was operating without detonation on a commercial petrol (sp.gr. 0·733) at 900 r.p.m., and the radiation was measured through a window two centimetres from the sparking plug, with the stroboscope open for eight degrees.

By using a more sensitive galvanometer the stroboscope opening may be reduced to one degree, with an increase in the significance of the readings. Liquid and gaseous fuels can be used in the engine, and filters will permit measurements to be made over predetermined wave bands. Information on combustion, depth of the reaction zone behind the flame front, and detonation will be sought.

The study of infra-red radiation from an engine, conceived as a promising piece of graduate research, was fortunately considered complementary to an investigation (for the National Advisory Committee for Aeronautics) of combustion in an engine cylinder, proceeding at the Automotive Power Plants Section of the Bureau of Standards; permission to co-operate was very kindly granted by Dr. H. C. Dickinson. The apparatus used for the radiation measurements, and much valuable advice, was furnished by Dr. W. W. Coblentz, of the Bureau, and by Prof. A. H. Pfund, Dr. F. O. Rice, and Dr. D. H. Andrews, of the Johns Hopkins University, where the writer holds a Commonwealth Fund fellowship. SYDNEY STEELE.

Bureau of Standards,
Washington, D.C.,
June 15.

Temperature and Humidity Relations of the Cockroach.

IN a recent paper, Bodenheimer[1] has recorded observations on the temperature-preference of various insects. In his apparatus there is a gradient of temperature, and a number of animals which he puts into the apparatus are free to move along the gradient. The temperature at which each animal comes to rest can be read off, and the arithmetic mean of such temperatures is the preferred temperature. He finds that the humidity of the air in which the animals are kept *before* the experiment has an effect on the preferred temperature. For example, *Adesmia clathrata* (tenebrionid beetle), when kept in moist air before the experiment, preferred a temperature of 39·4° C., and when kept in drier air before use, preferred 36·6° C.

In September 1929, I obtained similar results in the course of work on the cockroach, *Blatta orientalis*. The animals were kept in an apparatus similar to the above for four days. In one experiment the air was dry, and in the other it was moist (15·4 mm. v.p., saturated at 18° C.) though not saturated at any but the lowest temperature. At intervals during the four days the temperature-preference was found: the animals were stirred up and then given 20–30 minutes to come to rest before the temperatures were read. The accompanying diagram (Fig. 1) shows how, as time goes on, the insects settle at progressively lower temperatures; each point on the graph represents the average of at least sixteen temperature readings. The change in temperature-preference is much more rapid in dry air than in moist. (I think that the flattening of the dry air curve at about 20° C. is due to the fact that much lower temperatures were not available to the animals, and that the fall in preferred temperature would have continued below 20° C. had the cold end of the gradient been colder. Certainly I have since then had animals which preferred lower temperatures.)

It is well known that insects lose water by evaporation. My experiments show that adult male *B. orientalis* lose water at a rate that is, very roughly, proportional to the drying power of the air, that is, to the difference between the vapour pressure of water in the air and saturation pressure (both in millimetres of mercury) at the same temperature. Such loss may be very rapid. At 30° C. in dry air these animals lose daily an average amount of water equal to about 9 per cent of their original weight, and this continues until they die (four days). With these two observations in mind, I proceeded to investigate the temperature-preference of individual animals, and then—by drying them to constant weight at 100° C.—to find the proportion of water they contained. The investigation is

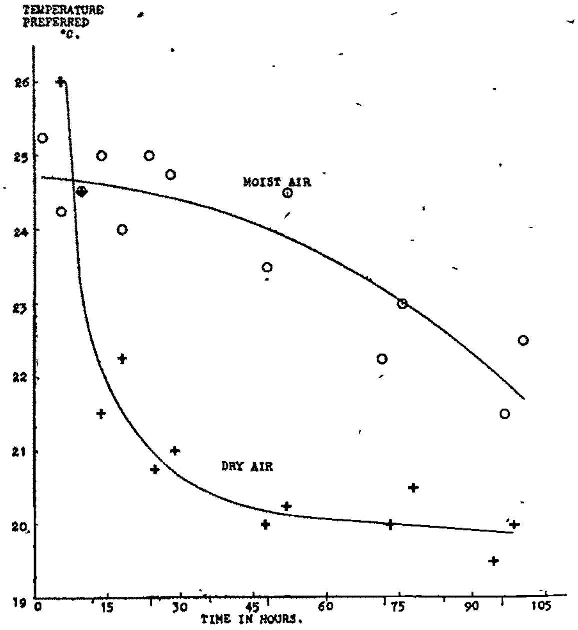

FIG. 1.

Animal.	Percentage of dry weight.	Temperature preferred.
*P*3	25·2	25½
*P*1	28·0	24½
*P*4	28·7	25½
*P*10	29·6	25
*P*2	30·8	19½
*P*6	30·9	18
*P*5	31·3	20½

still in progress and complete results for *B. orientalis* are not yet available, but a few observations which I have made on *Periplaneta americana* show a correlation between dry weight percentage and temperature-preference.

It appears that when the percentage of water has fallen below a certain minimum, the animal seeks a lower temperature than it did previously. Thus, when the animal is kept in air which is not saturated, it loses water at a rate which depends on the drying power of the air. Its percentage of water falls and it then has a lower preferred temperature, with the result that, whether the air is dry or not, it finds itself in air of lower drying power than previously and further loss of water is reduced.

Further work has shown that the food which *Blatta* is given also affects its temperature-preference, and in particular a diet of nothing but sugar solution has a marked effect. A full description of my experiments will be published shortly.

D. L. Gunn.

Department of Zoology,
The University, Birmingham,
July 2.

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[1] *Zeit. fur vergl. Physiol.*, vol. 13, p. 740; 1931.

The Pyranoid Structure of Glucuronic Acid and of Theophylline Arabinoside.

In the course of an investigation of the structure of glucuronic acid, we have obtained results which clearly prove that this acid, like the related hexose *d*-glucose, possesses a pyranoid structure. Our starting material was bornyl-*d*-glucuronide (borneol glucuronic acid) isolated as the zinc salt from the urine of humans and dogs receiving small doses of borneol.

Bornyl-*d*-glucuronide has been methylated and the resulting methyl ester of trimethyl bornyl-*d*-glucuronide, which was obtained crystalline, has been converted to the methyl ester of trimethyl methyl-*d*-glucuronide by the use of 1 per cent sulphuric acid in methyl alcohol at 100°. The fully methylated glucuronide, obtained as a liquid mixture of the α- and β-isomerides, has been oxidised with nitric acid ($d = 1{\cdot}42$), using the method first described by Hirst and Purves.[1] The product consisted of a mixture of *d*-dimethoxysuccinic acid and *i-xylo*-trimethoxyglutaric acid. These were purified by distillation as the esters and identified as the crystalline diamides. The final result is therefore similar to that obtained by Hirst [2] in his study of the structure of the normal derivatives of glucose, and a similar conclusion may be drawn in the present case, namely, that the glucuronic acid residue in bornyl glucuronide possesses a ring structure of the pyranoid type.

Challinor, Haworth, and Hirst,[3] from a comparison of the rates of hydrolysis of trimethyl-β-methyl glucuronide and β-methyl glucopyranoside, have deduced a pyranoid structure for the glucuronic acid component of the aldobionic acid from gum arabic. Our direct chemical evidence from material obtained by synthesis in the living animal therefore agrees with that derived from a product of plant origin. In a further series of investigations it has been found possible to methylate *d*-glucurone (the lactone of glucuronic acid) to yield two stereoisomeric crystalline trimethyl glucurones. It seems probable that the second ring system in these compounds is of the furanoid type, but our results do not yet permit us to state that this is so.

Investigations in progress in this laboratory concerning the nature of the sugar of nucleic acids necessitated the synthesis of a purine pentoside. Theophylline arabinoside was selected on account of the stability of its purine residue, and having the material at our disposal the structure of the pentose residue was investigated by the standard methods. The synthesis of theophylline-*l*-arabinoside has been described by Helferich and Kühlewein,[4] and their procedure, using silver theophylline and triacetyl arabinosidyl bromide, has been followed with excellent results.

In view of the method of synthesis adopted, the question of structure possesses a further interest in that a proof of the structure of the pentose residue in the arabinoside establishes by implication the structure of the triacetyl arabinosidyl bromide used in the initial step of the synthesis. No difficulty was experienced in methylating completely the arabinoside and the trimethyl theophylline *l*-arabinoside obtained crystallised readily. The latter was subjected to the action of nitric acid ($d = 1{\cdot}2$) and the main oxidation product of the pentose residue proved to be *d-arabo*-trimethoxyglutaric acid, which was isolated in excellent yield as the dimethyl ester and identified as the crystalline diamide described by Hirst and Robertson.[5] We therefore infer that theophylline arabinoside and triacetyl arabinosidyl bromide are pyranoid compounds. The purine residue of the original arabinoside was isolated as a yellow crystalline compound (m.p. 275°) which reacted and analysed as a nitro-theophylline having the composition $(C_7H_7N_4O_2 . NO_2)_2 . H_2O$. Brunner and Leins[6] have described a nitro-theobromine, but we have been unable to find any reference in the literature to nitro-theophylline. Our compound is presumably 8-nitro-theophylline.

John Pryde.
R. Teowyn Williams.

Physiology Institute,
Newport Road, Cardiff,
July 3.

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[1] *Jour. Chem. Soc.*, **123**, 1356; 1923.
[2] *Jour. Chem. Soc.*, 350; 1926.
[3] *Jour. Chem. Soc.*, 258; 1931.
[4] *Ber. der Deutsch chem. Gesell.*, **53**, 17; 1920.
[5] *Jour. Chem. Soc.*, **127**, 358; 1925.
[6] *Ber. der Deutsch. chem. Gesell.*, **30**, 2584; 1897.

A New Virus Disease of the Tobacco Plant.

In recent years investigators have recognised many virus diseases of the tobacco plant, all, however, producing chlorosis or necrosis of the leaves. I have investigated at Amani a disease of different manifestation, which I believe to be caused by a virus. The characteristic symptom of this disease is leafy outgrowths from the veins on the lower surface of the leaves, sometimes up to a centimetre wide, but usually amounting to no more than a dark green thickening of sections of the veins. Combined with this feature is a stunting of the whole plant and twisting and curling of the leaves. The manifestation of the disease varies greatly according to environmental conditions and the variety of tobacco concerned. I have, however, never observed chlorosis or necrosis in affected plants.

I have successfully transmitted this disease to healthy tobacco plants by grafting diseased scions on to them. I have also produced the disease in healthy plants by transferring to them an undetermined species of whitefly (Aleurodidæ) collected on diseased plants. These experiments carried out under controlled conditions afford evidence which, with my failure to detect a visible parasite, justifies the inclusion of this disease in the virus group.

A condition of the tobacco plant in which the leaves are curled has been reported to occur in most of the tobacco-growing districts of South and East Africa. It is uncertain, however, whether the condition of the plants in any of these regions is due to the same cause as that which I have studied at Amani. Doubtless several forms of leaf-curling occur, attributable to different causes. Workers in South Africa have recognised two types; one, 'curly-leaf', shown by them to be an hereditary abnormality, and a second, 'crinkly-dwarf', of unknown cause.[1] Their description of 'crinkly-dwarf' agrees well with the Amani disease. Roberts[2] attributed a leaf-curl of tobacco in Southern Rhodesia to injury by a capsid bug. Other workers have regarded leaf-curling as a reaction to unfavourable soil conditions. It is possible that the investigation of some of the curly-leaf conditions elsewhere upon the lines which I have followed may demonstrate their identity with the Amani disease.

It is a matter of interest that another whitefly-transmitted virus disease, the leaf-crinkle of cotton, is also characterised by leafy outgrowths from the lower surface of the leaves.[3] H. H. STOREY.

East African Agricultural
Research Station,
Amani, Tanganyika Territory, June 17.

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[1] *Rept. of Proceedings*, Pan-African Agricultural and Veterinary Conference, Pretoria, 1929, p. 91.

[2] Roberts, *Bull. Ent. Res.*, 21, pp. 169-183.

[3] Kirkpatrick, *Bull. Ent. Res.*, 21, pp. 127-137.

Intensity Anomalies in Rare Gas Spectra.

IN Paschen's analysis of the neon spectrum, and in Meissner's analysis of the argon spectrum, there occur curious irregularities in the d-term sequences, and similar deviations are shown in the spectra of krypton and xenon investigated by Meggers, de Bruin, and Humphreys.

An extension of the system of d-terms in rare gas spectra, to be published elsewhere by one of us (E. R.), has shown intensity irregularities running parallel with the deviations in the term values. The argon spectrum will serve as an example.

The two terms 3302·90 and 1828·40, the classification of which has hitherto been uncertain, are now, due to the observation of several new combinations, definitely classified as $6d_3$ and $8d_3$. These two terms deviate strongly from the Ritz formula. Comparison was then made of the intensities of the lines in the series $2p_{10} - md_5$ and in $2p_{10} - md_3$, which for $m = 5$-7 and 9 are about equally strong, but for $m = 6$ and 8 the combinations are found to be much weaker with d_3 than with d_5. That is to say, intensity anomalies take place for those terms where the greatest deviations from Ritz's formula occur. Exactly the same thing is found in the spectrum of krypton.

In a theoretical interpretation of the origin of these term anomalies a study of the intensity anomalies is certain to play an important part. Therefore one of us (H. S.), engaged in photographic intensity measurements in rare gas spectra, has undertaken quantitative measurements also for the mentioned combinations.

The following intensity ratios indicate the type of deviations which are found:

$$\frac{I(2p_{10} - 5d_3)}{I(2p_{10} - 5d_5)} = \frac{1}{1} \quad \frac{I(2p_{10} - 6d_3)}{I(2p_{10} - 6d_5)} = \frac{1}{6} \quad \frac{I(2p_{10} - 7d_3)}{I(2p_{10} - 7d_5)} = \frac{1}{1}$$

Further measurements are in progress.

We are indebted to Prof. Bohr for his interest in this problem, and one of us (H. S.) has had the privilege of a fellowship from the American-Scandinavian Foundation. EBBE RASMUSSEN.
HUGO SWENSON.

University Institute for Theoretical
Physics, Copenhagen, June 25.

Effect of Pressure on Raman Spectra.

THE influence of its neighbours on the rotation and vibration states of a molecule in a gas is due partly to the general intermolecular field and partly to actual collisions. From the kinetic theory of gases, it is known that the mean frequency of collisions which a molecule undergoes is given by the ratio P/η of the pressure to the viscosity of the gas. The perturbing influence of collisions on molecular rotation may be expected to be small so long as this frequency is low, but would become considerable when the mean frequency of collision approaches a value comparable to that of molecular rotation. By taking P/η to be equal to the frequency of rotation of the molecule in the one-quantum state, we may obtain an estimate of the pressure at which the distinctness of quantisation of the different rotations would disappear. In this way, the following estimates of pressure in atmospheres at 30° C. are obtained for the different gases: Hydrogen, 450; methane, 48; nitrogen, 29; oxygen, 25; acetylene, 10; carbon dioxide, 5; hydrogen chloride, 128; ammonia, 83; nitric oxide, 25.

These estimates agree remarkably well with actual observations of the pressures above which the discrete lines in the rotational Raman spectrum of the gas disappear and are replaced by a continuous spectrum. I have found that oxygen and nitrogen show the rotational fine structure at a pressure of 20 atm., while only an unresolved band is obtained at a pressure of 30 atm. Houston and Lewis report a similar result for carbon dioxide above 5 atm. pressure.[1] In the other cases, the calculated pressures are uniformly greater than those at which Rasetti and others have actually succeeded in recording the rotational fine structure. It is not improbable that in the case of polar molecules the fine structure might disappear at somewhat lower pressures than those given above, in consequence of the intermolecular fields.

S. BHAGAVANTAM.

210 Bowbazar Street,
Calcutta, India,
June 22.

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[1] *Proc. Nat. Acad.*, vol. 17, p. 229; 1931.

The Slow Combustion of Methane and Ethane.

NOT knowing on what experimental evidence (if any) Dr. Mardles[1] bases his conclusions about the initial 'peroxidation' of methane and ethane to 'methyl hydrogen peroxide' and 'ethyl hydrogen peroxide' respectively during slow combustion in air, may I inquire whether (and, if so, how) he has isolated and identified any such substances so produced? For, as was pointed out in the paper on "The Slow Combustion of Ethane" recently published by Mr. S. G. Hill and me,[2] there has been, so far, no real experimental proof about the initial 'peroxidation' of the hydrocarbons in question in slow combustion; although, as was then shown, the fact that in the case of ethane some slight 'peroxidation' of the intermedially formed acetaldehyde may occur has perhaps confused the issue in some minds and misled some observers.

All I can testify is that, as the outcome of many years' careful experimental study of the combustion of methane and ethane over a very wide range of conditions in my laboratories (both earlier on in Manchester and more recently here in London), no evidence whatever of an initial 'peroxidation' has yet been discovered; on the contrary, the weight of cumulative evidence is so overwhelmingly in favour of an initial 'hydroxylation' that I still regard it as the best interpretation of the known facts.

Moreover, when in due course the details are published of the further experiments recently carried out here (1) by Dr. D. M. Newitt and Mr. A. E. Haffner on the pressure-oxidation of methane and (2) by Mr. R. E. Allum on the kinetics of its slow combustion at atmospheric pressure, I think there will remain but little room for doubt about methyl alcohol being the initial product, unaccompanied by any vestige of a hypothetical 'peroxide'.

If, however, Dr. Mardles can adduce satisfactory experimental proof of his supposed initial formation of 'methyl-hydrogen-peroxide' during the slow combustion of methane, by actually isolating and identifying it among the products, there will be grounds for reconsidering the matter, but otherwise not.

WILLIAM A. BONE.

Imperial College of Science,
London, S.W.7, July 20.

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[1] NATURE, July 18, p. 116.

[2] *Proc. Roy. Soc.*, A, 129, p. 424.

Unusual Lightning.

ON the night of July 12 we witnessed a display of atmospheric electricity which was sufficiently unusual to merit description.

The display was confined to one cloud, low on the horizon in the direction north by west, and apparently at a considerable distance. To one of us, observing from 10.15 P.M. to 10.30 P.M., the phenomena appeared as flame-coloured discharges which recurred in the cloud with considerable regularity at intervals of about a minute and were remarkable for their duration, which was sometimes as great as one second. No thunder was audible.

To the other, observing independently from 10.30 P.M. to 11.30 P.M., the discharges seemed to have their origin in the upper part of the cloud, for each one showed the dark upper edge of the cloud in strong relief: glows of flame-coloured light shone upward and illuminated higher clouds. Sometimes the glow would extend over the whole cloud, sometimes only over a portion of it, and occasionally would start at one end of the cloud and move to the other before being extinguished. The discharges occurred at intervals of one to one and a half minutes, and frequently lasted for a second, in marked contrast to the apparent instantaneity of forked lightning.

Dr. Simpson has suggested that the description tallies well with that of *Flachenblitz*, which appears to be a silent discharge over the surface of a cloud. In his Robert Boyle Lecture (1930) he states that very little is known about this form of discharge and that it is probably due to a kind of St. Elmo's Fire over the whole surface of a cloud.

There is no mention of this form of lightning in the "Encyclopædia Britannica".

H. E. BECKETT.
A. F. DUFTON.

Building Research Station,
Garston, Herts, July 20.

Valency and Diamagnetism of Titanium in the Tetrachloride.

TITANIUM (atomic number 22) is known to be paramagnetic. It shows anomaly in that its paramagnetism after decreasing from $1·6 \times 10^{-6}$ at $-170°$ to $1·25 \times 10^{-6}$ at $-80°$ becomes constant. All its compounds so far studied are also known to be paramagnetic; TiO_2, Ti_3O_5, TiS_2, and Ti_2S_3 having values 0·066, 8·1, 0·56, and 0·91 ($\times 10^{-6}$) respectively, for the specific susceptibility (Int. Crit. Tables).

In a recent paper, Weirl[1] has found by electron diffraction that titanium tetrachloride has tetrahedral symmetry with the titanium atom in the centre and the Ti–Cl bonds, being equally and symmetrically directed towards the corners of a tetrahedron. In this case, the titanium central atom has 18 electrons forming a completed group and the four valency electrons symmetrically distributed with respect to the centre, and titanium chloride must be expected to show diamagnetism as contrasted with other compounds of titanium.

An accurate investigation of titanium chloride (a strongly fuming liquid) was made with a sensitive Curie balance, with quartz suspension and retorsion head. The liquid was contained in thin sealed capsules, correction being applied for the latter. The liquid was found to be diamagnetic with a value ($-0·287 \times 10^{-6}$) for the specific susceptibility at 35° C.

This suggests that the paramagnetism of the element titanium is due to the two pairs of valency electrons being in different orbits and giving rise to a resultant paramagnetism, and similarly in the compounds of titanium, the paramagnetism in the compounds is due to the unsymmetrical nature of the valency links. When all the valency links are symmetrically distributed as in titanium tetrachloride, the paramagnetism disappears.

V. I. VAIDHIANATHAN.

Department of Physics,
F.C. College, Lahore,
June 24.

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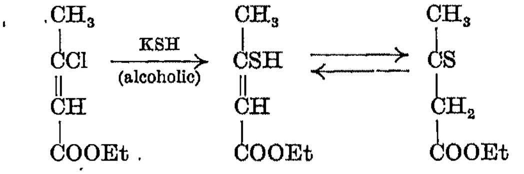
[1] *Ann. der Phys.*, vol. 8, ser. 5; 1931.

Synthesis of Ethyl Thio-aceto-acetate.

WITH the view of investigating the negative character of the methylene group due to the proximity of : C : S group, Mr. E. K. Mitra, Sir T. N. Palit research scholar, working in my laboratory, has succeeded in effecting the long-looked-for synthesis of ethyl thio-aceto-acetate in the following way:



The mercaptan at the moment of its formation tautomerises as indicated above.

The so-called thio-ester described in the text-books is really diacetoacetic ester sulphide, as is evident from the mode of its preparation and reactions. The new ester behaves exactly like ethylacetoacetate in its reactions towards hydrazines, hydroxylamine, aromatic amines, etc., with the formation of heterocyclic ring compounds. It undergoes Grigniard's, Reformatsky's, and Michael's reactions, resulting in a vast series of interesting compounds. In Knoevenagel's reaction, however, the course taken up is a novel one, giving rise to the formation of thio-aldehydes, hitherto almost unknown in a very good yield. The characteristic behaviour of these true thio-aldehydes and their relationship with ordinary aldehydes are also being closely studied. A detailed account of the investigation will in due course appear in the *Journal of the Indian Chemical Society*.

P. C. RÂY.

University College of Science and
Technology,
Calcutta, June 6.

Research Items.

South Russian Steppe Graves.—The chronological significance of the 'Copper Age' graves in the Pontic steppes is discussed by Prof. V. Gordon Childe in *Man* for July. Both their relative and absolute age are ambiguous. Recently, A. W. Schmidt, of Leningrad, who distinguishes three chronological stages, has assigned the 'Early Kuban phase' to the first half of the third millennium B.C. and the 'Middle Kuban' to 2300–1600 B.C. A. M. Tallgren, on the other hand, would abbreviate the first phase (Maikop and 'royal kurgans') and synchronise it with the Danish Passage-Graves epoch with a date rather after 2000 B.C. The later phase ('catacomb graves') would be parallel to the Long Stone Cists of Denmark, and occupy from 1800 to 1400 B.C. Recent excavations in Denmark and Macedonia have produced decisive evidence. A hammer-headed pin of bone or metal assigned to the Copper Age of the Middle Kuban phase is peculiar to South Russia from the Dnieper to the Caspian. A bone hammer-pin, with all the peculiarities of the South Russian type, was recently found in a passage-grave on Lolland. It belongs to the second of the four phases of the Passage-Grave epoch. Further, an unfinished stone battle-axe of a peculiar form has been discovered in the early Macedonian stratum at Hagios Mamos in Chalcidice. It agrees in smallest detail with one from a grave at Konstantinova near Piatigorsk, associated with grave goods typical of the Middle Kuban phase. Middle Kuban and early Macedonian thus overlap. The early Macedonian is dated about 2000 B.C., which confirms both the third millennium for the Middle Kuban and about 2000–1800 B.C. for the Passage-Grave period in Denmark.

Colorado and Folsom Points.—Flaked points from Colorado, New Mexico, Texas, and Wyoming, which differ in appearance, technique, shape, and quality from those usually found in collections of Indian artefacts, are the subject of a typological study by Dr. E. B. Renaud in the *Proceedings of the Colorado Museum of Natural History* for March 1931. The Colorado points fall into four types, with sub-types in two cases. Broadly, they either have parallel sides tapering to the tip, or are triangular. The base is either square, convex, or concave. The flaking was produced roughly by percussion with a stone, and was finished by pressure with bone or horn. It is on both sides, and some specimens have a marginal retouch. The flaking is parallel and oblique, in some cases extending from edge to edge, in others proceeding from both edges, leaving a central ridge. The flaking of the base was effected as a means of thinning the implement to facilitate hafting. It is also significant, as it leads by stages up to the highly specialised Folsom type. The characteristic Folsom point has as its type station Folsom, New Mexico, but it is also found in Colorado, Wyoming, and elsewhere in New Mexico, presumably being a product of the same culture as occurs at Folsom. Others from these areas approximate to the type. The Folsom point is narrower at the base, which is deeply concave, than at the maximum width of the blade. The characteristic feature, however, is the longitudinal groove. It appears to be the climax, or a late stage, of evolution; but although the Colorado points leading up to it would appear morphologically older, there is no objective proof of their greater antiquity. The Folsom points are said by competent geologists and palæontologists to come from Pleistocene gravels, in which they are associated with a large and extinct species of bison and other fossils. Points from Hugo, Carson, and other sites in the Sandy Rush Creek district, are from 'blow outs', in which, owing to the action of the wind, all objects, irrespective of age, are lowered to a common level.

Bodily Position in Restful Sleep.—It is probably not usually appreciated how much movement takes place during sleep. Investigations at the Mellon Institute, Pittsburgh (" Bodily Positions in Restful Sleep." By Dr. H. M. Johnson. Pp. 24. Pittsburgh: Mellon Institute of Industrial Research, 1931), show that the healthy adult during deep sleep makes some gross change of bodily position on an average every 7–8 minutes. Every sleeper has a repertory of a dozen or more very different poses in which he takes his rest. On any typical night he will make use of all, or nearly all, of this dozen, changing from one to another twenty to sixty times, according to his sensitivity to various kinds of bodily irritation. Among different persons, some have a strong preference for supine positions, others favour prone ones. By means of an ingenious device, photographs were obtained of every change of position assumed by a sleeper during a night, and show an extraordinary range of positions.

Land Birds of Sonora, Mexico.—A study of the birds of Sonora, represented by some 4000 skins, shows that the area, which lies east of the Gulf of California, contains four faunal districts or differentiation areas. The Colorado desert district marches with an extension of the eastern plains area, having many characteristic races. On the other hand, the Tiburon Island district is poorly characterised as regards endemic bird life, although within the most southerly district, Alamos, a great number of resident land birds as well as several littoral species have developed local races. The bird population upon which these districts have stamped local characters is derived from three distinct sources. Most abundant are southern species, which here reach the limit of their range; then follow local representatives of wide-ranging species; and poorest in numbers are birds of northern derivation, also at the extreme of their range. This faunal aggregation forms a strong contrast with that on the other side of the Gulf of California, where, instead of the greater portion of the avifauna, only one species (*Hylocharis xantusii*) possesses southern affinities (A. J. van Rossem in *Trans. San Diego Soc. N.H.*, vol. 6, p. 237, 1931).

Polyembryony in a Braconid Parasite.—*Technical Bulletin* No. 230, March 1931, of the United States Department of Agriculture is devoted to an article by H. L. Parker, who shows that the braconid, *Macrocentrus gifuensis* Ashm., which parasitises the European corn borer in France, undergoes polyembryonic development. While polyembryony is well known in insects, among certain of the Chalcidoidea and Proctotrypoidea, Dr. Parker's studies bring to light the first proved example of its occurrence among Ichneumonoidea. The general details of the process, and the rôle played by the polar bodies, are very similar to what is already known in other groups. There is, however, no proliferation of the host tissue around the embryos to form a definite cyst as in *Encyrtus*. The maximum number of individuals arising from the division of a single egg appears to be eight or ten. Most of the host corn borer larvæ contain several eggs of the parasite owing to the repeated oviposition by the female *Macrocentrus*. As a result, there are usually many more parasite larvæ and embryos present in the host than it can nourish. These supernumerary embryos and larvæ become destroyed during feeding and growth. The *Macrocentrus*, it appears, destroys up to about thirty-six per cent of its hosts, but its efficacy in this respect seems to vary a good deal in different regions of France. The author discusses the most favourable conditions under which consignments of the parasite should be imported and colonised in the United States, as an auxiliary measure in the biological control of the corn borer.

Illumination and Tree Growth.—The *Scientific Proceedings* of the Royal Dublin Society, vol. 19 (N.S.), No. 45 (Oct. 1930), print Part 3 of the investigations on "Photo-electric Measurements of Illumination in Relation to Plant Distribution", by W. R. G. Atkins and Florence A. Stanbury. This part deals with "Certain Spruce, Larch, Oak and Holm Oak Woods". In Part 2 (1929) a description was given of measurements of illumination made with portable galvanometers. The intensities of the illumination in four different types of woodlands were measured, and a study of the floras found at the shaded sites makes it possible to correlate light intensity with plant distribution. The effect of different densities of shade on the ground flora was examined by obtaining data from different woods, such as *Picea excelsa*, pure stand; *Larix europæa*, nearly pure stand; mixed *Quercus ilex*, where undergrowth of *Hedera* prevailed beneath *Quercus robur*; but under *Ilex aquifoliumi* with much reduced light, nothing grew. These investigations should prove of considerable interest, and might not be without their importance to the forester; for example, investigations to show the intensity of the light required for the optimum development of seedlings of the above-mentioned species under the shade of the parent trees.

Marine Algæ from the Pacific.—In a paper entitled "Marine Algæ of the Revillagigido Islands Expedition in 1925" (*Proceedings* of the California Academy of Sciences, fourth series, **19**, 11, Dec. 1930), W. A. Setchell and N. L. Gardner record and describe a large number of Algæ collected by Mr. Herbert L. Mason on the expedition sent out by the California Academy of Sciences. With these are included a few previous records of Algæ from Guadalupe Island, one of the principal islands of the group. The climate is fairly cold, owing to the prevalent north-west winds, and the flora is northern for the latitude and somewhat similar to that of California and lower Oregon, the chilling, at least of the shallower waters, affecting the distribution of the Algæ. One hundred and twenty-five species are recorded, including a few from near the mainland of Mexico; 98 occur on Guadalupe Island and 30 on Clarion Island (the most westerly). Only 5 species are common to both. Two new genera and 29 new species are described. As at present known, 127 species are restricted to Guadalupe and 7 to Clarion Island. The remainder occur also in various parts of the world. An interesting case of distribution is that of *Halothrix lumbricalis*, which occurs locally, always in May only, in western Europe, north-eastern North America, and Guadalupe Island. Good illustrations are given in 15 plates at the end of the paper.

Supernumerary Cell Divisions in Maize.—Last year Mr. George W. Beadle described a variety of maize showing asynapsis, or failure of the chromosomes to pair in meiosis. He now gives an account of a variety in which supernumerary cell divisions occur in connexion with the pollen development (*Mem.* 135, Cornell Univ. Agric. Exp. Sta.). In meiosis the chromosome behaviour is much like that of haploids, that is, the chromosomes do not pair, but are distributed irregularly in both meiotic divisions without splitting. Following these, further mitoses of a similar kind occur, giving rise to as many as 32 cells, some of which frequently have a single chromosome. The pollen of such plants is completely sterile, and very few seeds are produced if the strain is pollinated from the normal. The variety is called *polymitotic*, and the condition is inherited as a simple Mendelian recessive in crosses. It is found to belong to the *Y-Pl* linkage group, and not to be allelomorphic with the gene causing asynapsis. But it is inherited as a sporophytic character, and this can only be accounted for by assuming that the dominant influence of the normal condition continues in the cytoplasm of the young gametophytic cells—cytoplasm which they have received directly from that of the pollen mother cells, in which some stimulus to further cell divisions is present.

Pre-Cambrian Tillite in South-West Africa.—In the *Trans. Geol. Soc. S. Africa*, **34**, pp. 1-17, 1931, Dr. T. W. Gevers describes a tillite from the Pre-Cambrian complex of western Damaraland, which he considers may be even older than the Huronian cobalt tillite of Canada. The tillite occupies a horizon between the quartzite and marble series of the Damara system, the latter being provisionally regarded as equivalent in age to the Swaziland system of South Africa. It has a remarkable resemblance to the Dwyka tillite; is unbedded and unassorted through a thickness of 500-600 ft. and contains numerous faceted boulders and pebbles. The matrix may be argillaceous (now biotite-schist) or arenaceous (now a dense greenish black siliceous rock). Rapid alternations of these are suggestive of varves. The lithological succession as a whole seems to indicate eight or nine major advances of the ice front. In some horizons the quartzites are ripple-marked by currents that flowed from the west. The tillite has already been proved over an area of 5000 square miles, and future exploration is likely to extend this very considerably. The paper includes a tentative classification of the Pre-Cambrian rocks of South-West Africa. The Nama system is regarded as doubtfully Cambrian in accordance with recent fossil discoveries. The Damara system is older than the 'older' gneissose granites, but there are still more ancient rocks: the Pre-Damara gneiss and the Abbabis system.

The Nature of the Aurora.—The *Bulletin* of the American Physical Society published on June 5 contains a note by J. Kaplan on the production of the auroral spectrum in discharge tubes. This has been accomplished by working with air at low pressures (less than 10^{-3} mm. mercury), running the discharge continuously for long periods, and observing it in particular at those periods when after admitting fresh gas to replace that which disappeared during the passage of the current the discharge was again flickering and on the point of being extinguished from lack of gas. Apparently the effect for running a discharge for long periods is to modify the surface of the tube in some way that prevents it destroying the active atomic systems which are responsible for the curious features of the auroral spectrum. From the analogy, Dr. Kaplan draws the conclusion that auroral displays are electrical discharges at low pressures under conditions which are ideal for the production of the nitrogen after-glow. The auroral green line and certain allied lines which arise from atomic oxygen have, of course, been found previously in discharge tubes, but it appears that Dr. Kaplan has succeeded in reproducing the novel features presented by the nitrogen bands in the aurora for the first time.

Spectrum of Carbon Disulphide Flames.—An investigation of the flame of carbon disulphide burning under various conditions is described by Prof. A. Fowler and W. M. Vaidya in the July number of the *Proceedings of the Royal Society*. The band spectra associated with sulphur and many of its compounds are fairly well known, although they are not as yet completely analysed, and it was thought that examination of the light should give information about the chemical processes involved. The ordinary 'hot' flame shows principally the bands of the S_2 molecule. Some of these appear normally not in emission but in absorption, although they can be made to appear in emission by slightly altering the conditions of combustion. Emission bands of the substance SO, which is not known as a chemical individual, appear faintly, whilst if the carbon disulphide is burnt in a chimney, absorption bands of the dioxide (SO_2) also appear. Carbon disulphide can give a colder or 'phosphorescent' flame, and it was already known from the work of H. J. Emeléus that this had a different spectrum. In this, Prof. Fowler has now identified bands of SO and CS, the former being relatively much stronger than in the hot flame. Some preliminary measurements have also been made of a new ultra-violet group of bands, not found in flames, which have been provisionally ascribed to carbonyl sulphide (COS). The spectroscopic evidence gives no evidence for or against the presence of peroxides or carbon monoxide in the flames, but is not completely conclusive.

Rhenium Compounds.—The selenides of rhenium have not previously been described, and considerable uncertainty existed as to the sulphides higher than the disulphide. Briscoe, Robinson, and Stoddart, in the June number of the *Journal of the Chemical Society*, describe experiments which show that the heptasulphide, Re_2S_7, is precipitated incompletely by hydrogen sulphide from ammoniacal solutions of potassium per-rhenate. It is a black amorphous powder, formerly described as ReS_2 or ReS_3. The disulphide, ReS_2, is obtained as a black powder by heating rhenium to redness with excess of sulphur in a Rose crucible under hydrogen sulphide, or by heating the heptasulphide to redness in a vacuum. No evidence was obtained of any sulphide between Re_2S_7 and ReS_2 when the heptasulphide was heated to 250° in an atmosphere of nitrogen. The heptaselenide was obtained in the same manner as the heptasulphide by substituting hydrogen selenide for the sulphide. It is a black powder. On heating in a vacuum at 325°-330° for nine hours it loses selenium, leaving the diselenide stable in air and not attacked except by strong oxidising acids.

Cellulose Lacquers.—The solvents and plasticisers used in the modern manufacture of cellulose lacquers are described in the *Chemical Age* for June 27 by T. H. Durrans. The world's consumption of solvents is estimated at 100,000 tons annually, acetone and the acetates of ethyl, butyl, and amyl being most largely used. Most of the largely used solvents are produced by bacterial fermentation, although there have recently been striking advances in synthetical as well as fermentation processes. The range of commonly used resins and plasticisers is also restricted, the main consumption of plasticisers being confined to triacetin, benzyl alcohol, triphenyl and tricresyl phosphates, and the phthalic esters, whilst ester gum and its derivatives are the only resins universally used. The plasticiser is a most important constituent, the nature and quality of the film depending upon it to a very large extent. The plasticiser is, as Dr. Durrans says, "the master of the cellulose ester film and controls its career throughout its life". A property which is receiving much attention is that of toxicity: unsuspected dangers have been disclosed, as, for example, in the case of glycol chlorhydrin. The same issue of the *Chemical Age* contains other interesting articles on solvents, from which it appears that butyl alcohol and acetone are obtained in America by the fermentation of corn starch, the hydrogen and carbon dioxide evolved being converted into synthetic methyl alcohol, the excess of carbon dioxide being turned into solid, used as a refrigerant under the name of "dry ice". Non-inflammable solvents made on the large scale in England include chlorinated acetylenes (trichlorethylene, perchlorethylene, tetrachlorethane), used for oil extraction, dry-cleaning, degreasing wool, and textile scouring. Artificial resins include the coumarone resins, polymerised from coumarone, a constituent of coal tar.

Astronomical Topics.

New Comet, 1931*b*.—*U.A.I. Circ.* No. 327 announces that a new comet was discovered by Mr. Nagata, and confirmed photographically by Mr. Moore at Mt. Wilson; the following rough position is given:

U.T.	R.A.	N. Decl.
July 17ᵈ 16ʰ 26ᵐ	10ʰ 41ᵐ	9° 48′

The comet is an evening object, too low in the west for convenient observation. There is no information about motion or brightness. The news was transmitted by Mr. van Maanen and Prof. Shapley.

Rapid Current on Jupiter.—The *Observatory* for July contains a report of Mr. B. Peek's paper to the Royal Astronomical Society in which he examined the outbreak in 1929 of rapidly moving dark spots on the south edge of the North Temperate Belt. He noted that there were similar outbreaks in the same zone in 1880, when the late Mr. W. F. Denning found a rotation period of about $9^h\ 48^m$, and in 1891, when Prof. Barnard found a period of $9^h\ 49^m$. The spots of 1929 had a similar short period, though it grew longer towards the end of the year, when the spots were fainter. The period found is even shorter than the average period for the planet's equator ($9^h\ 50^m\ 30^s$) and very much shorter than the average for the temperate zone ($9^h\ 55^m\ 40^s$). Mr. Peek thinks that there may be a permanent rapid current in this region of the planet, and requests that it should be kept under regular observation.

Star Density in Different Galactic Latitudes.—*Mon. Not. Roy. Ast. Soc.* for May contains a paper by Mr. P. J. Melotte which gives the results of star-counts in forty Kapteyn areas photographed at Greenwich with the 26-inch refractor.

The following abridgment of his table gives the logarithm of the number of stars per square degree in the different zones down to the limiting magnitude stated:

	Log. of No. of Stars per Square Degree.		
Limiting Magnitude.	Gal. Lat 0° to 20°.	Gal. Lat. 20° to 40°.	Gal. Lat. 40° to 90°.
11·0	1·34	1·03	0·87
12·5	1·94	1·63	1·32
14·0	2·58	2·11	1·80

In the lower latitudes the logarithms are greater than those of Seares and van Rhijn by about 0·12; the difference tends to disappear in the higher zone. It will be seen that down to mag. 14 the galactic zone is six times as rich as the polar zone. The ratio steadily increases as fainter stars are included.

Textile Research.

THE report of the proceedings of the Imperial Wool Research Conference, 1930, recently published, contains the recommendations of the Conference, with observations on them made by the Imperial Conference, and the papers and addresses given at the Conference, some of which have already been noted in NATURE. A further paper by Mr. A. Frobisher, secretary of the Wool Industries Research Association, entitled "Textile Research on the Continent", which, owing to the pressure of time, was not read at the Conference, is included as an appendix. This paper gives a brief account of the Deutsches Forschunginstitut für Textilindustrie at Dresden, about one-third of the activities of which is devoted to wool problems. At these well-equipped laboratories much fundamental research is carried out under the direction of Dr. Krais, as well as the investigation of purely technological problems, such as the strength and elasticity of yarns, resistance of fabrics to friction, fracture, and folding or creasing. At the Institut für Faserstoffchemie, Berlin-Dahlem, under the direction of Prof. R. Oliver Herzog, pure research on textile fibres is being carried out, the equipment for investigation of the ultimate structure of fibres by X-ray methods being very complete. Excellent facilities are provided for research workers, including visitors from other countries.

Numerous papers on fundamental research on wool improvement have also been published by the Institut für Tierzucht und Vererbungsforschung der Tierartzlichen Hochschule, Hanover, although an important function of this institution is the training of students.

Hitherto there has been no institution in Italy engaged entirely on the solution of problems connected with the woollen and worsted industries, although some wool research is carried out at the textile schools. An institute intended mainly for wool investigations is now being built in Biella and this will be financed entirely by the industry. Wool research in Switzerland is carried out at the Experimental Station, St. Gall, where three research workers are engaged on such problems. In France, industrial research work is largely supervised and financed by the National Office for Scientific, Industrial, and Agricultural Research at Bellevue, near Paris, most of the research work being carried out at the Laboratoire des Services Textiles du Conservatoire National des Arts et Métiers, Paris, and at the laboratory at Roublaix.

In Belgium, collaboration between manufacturers and the research laboratories financed by a national fund for scientific research was ensured in 1929 by the formation of a special Bureau of Industrial and Scientific Relations. Under the agreement, manufacturers may submit special research problems connected with their industries to the laboratories, provided the problems are of general interest. In such cases, the direct expenses of the research are defrayed by the manufacturer.

Textile research has been carried on at the Masaryk Labour Institute in Prague since February 1926, and in 1929 an independent Czechoslovakian Textile Institute was founded to advise the industry on the elimination of waste and improve productive capacity. A Research Institute for the Textile Industry has also existed in Reichenberg for the past eight years and a new building is now being erected. This Institute covers all branches of the textile industry and it has recently constructed a special apparatus, the 'rapid lanometer', for measuring the fineness of wool.

A certain amount of wool research is carried out at Delft by the Dutch Government Information Service for the Textile Industry, and also at the textile schools at Enschede and Tilburg. The Ministry of Agriculture of Hungary has recently established a wool research institute; while a considerable amount of research on wool production is being carried out at the Experimental Station for Animal Husbandry, Boguchwala, ad Rzeszov, Poland, under Dr. Marchlevski. Wool research is also being developed at the Jagellonian University at Cracow, and research on sheep-breeding at the Zootechnical Department of the University of Bukarest.

Wool is included in the ambitious scheme of research for the five-year period drawn up by the Central Research Institute for the Textile Industries (Niti), of the U.S.S.R. The wool section had ten research workers during the first year, a number which is expected to reach fifty-six. The Five Years' Plan includes research on all that is fundamental in providing data for a complete reorganisation of the wool industry on scientific lines.

Textile research is being carried on in Great Britain, notably in the Clothworkers' Departments, University of Leeds. A research scheme was established in 1928 with the aid of a special grant from the Worshipful Company of Clothworkers, and the report for the session 1929–30 contains references to work on the elasticity of wool, the elastic properties of wool in organic liquids, the micelle structure of the wool fibre, and the action of caustic soda and sodium sulphide, which has already been published in NATURE or other scientific journals.

The earlier discovery, resulting from the study of the adsorption of water by wool, that the wool fibre is constructed from long-chain protein molecules arranged lengthways along the fibre, has formed the basis of the work of the past session. In addition, the discovery of a method for measuring the scaliness of different wools and hairs marks the first step towards establishing the milling process on a scientific foundation, the surface scale structure of the fibre being responsible for the felting and shrinking of wool fabrics in the milling process. Other technical investigations have related to the thermal conductivity of textile materials and fabrics, the transmission of water vapour through textile materials and fabrics, and the comparison of wool oils and creams.

Progress in the field of textile physics as a result of X-ray methods has already been noted in NATURE for April 11. The crystallographic picture of the molecular architecture of the wool fibre, although incomplete, has already thrown new light on many typical properties which are of great importance in manufacturing processes. Correct interpretations of conditioning, dyeing, and other adsorptive processes have been facilitated and our ideas of all operations involving the elasticity of the fibre have been clarified. The well-known 'permanent set' of wool fibres is a direct consequence of the action of steam on the stretched β-form of wool (and hair) but not on the unstretched α-form. Results of the X-ray investigation of the wool fibre are related to similar investigations on the structure of natural silk, which finds its counterpart in stretched wool and not in normal wool. Accordingly, silk does not show the long-range elastic properties of wool because it is already in the extended state. The X-ray investigations have also been related to the structure of cellulose, and the structure based on ideas current in Germany is considered unsound. The point is of technical interest in relation to mercerisation.

The Carnegie United Kingdom Trust.

THE seventeenth annual report of the Carnegie United Kingdom Trust gives, by way of introduction to its record of the events of 1930, a short general survey of the five years 1926–1930 and a statement of the main heads of policy which the trustees have decided to pursue during their fourth quinquennium, 1931–1935. Their operations range over a wide field, shared now with the Pilgrim Trust, of charitable enterprise in Great Britain and Ireland. They give preference among charitable objects to such as are of an experimental and national character and to schemes which are likely to become self-supporting within a reasonable time, since it was the founder's desire to provide means for fostering a perpetual succession of pioneer enterprises calculated to meet new needs as they arise. The fairy-godmother, in fact, whilst guaranteeing her protégées a fair chance of showing their quality and merits, is careful to disclaim all responsibility for their future maintenance.

The Trust's income of, roughly, £120,000 a year has been distributed since 1925 mainly in grants under the headings: libraries (47 per cent), playing fields and play-centres (21 per cent), rural development, adult education, and music and drama. In their library development work the trustees have exploited to the utmost the possibilities of co-ordination and co-operation, and this policy led to the establishment in December and January last of two regional schemes of the greatest experimental importance, one in the north of England, based on the library of the Newcastle Literary and Philosophical Society and embracing libraries in the four northern English counties; the other serving Warwickshire, Staffordshire, Worcestershire, Shropshire, and Herefordshire, and based on Birmingham City Library. In each area the trustees are meeting the initial cost of creating the necessary union catalogue. If these schemes, after a short trial period, turn out to be on sound economic and administrative lines, the trustees hope to invite the libraries of two or three other areas to adopt the same policy.

To 'special' libraries, including those of many industrial research and other scientific associations, grants amounting to more than ten thousand pounds were paid last year. These, in return, have made their collections available to the general public on application from the National Central Library. The Association of Special Libraries and Information Bureaux, which has enjoyed the financial support of the Trust during the six years of its existence, has recently decided against a projected amalgamation with the Library Association—a decision involving, the trustees observe, competition and possible overlapping with the university and research section of the Library Association.

The Trust's playing-fields policy, inaugurated in 1927 with an allocation of £200,000 spread over four years, has been carried into effect in collaboration with the National Playing-Fields Association. It has aimed at stimulating and encouraging local effort, and its success may be gauged by the fact that already 356 grants, varying in many cases from only one-tenth to one-sixth of the total cost, have sufficed to enable some 5000 acres to be preserved permanently for the playing of organised games. Apart from this playing-fields programme, the trustees have not during the past year been pursuing any concerted policy for ameliorating the physical welfare of the masses, but they have offered a grant of £30,000 for the erection of a Physical Training College for Men Teachers at Leeds and have helped the National Council of Girls' Clubs to employ two physical training instructresses. The main feature of the college will be a one-year course based on the principle that physical instruction is better given by teachers who also take part in the ordinary work of the school than by specialists with no other qualification and with little, if any, hope of being usefully employed after they reach 40–45 years of age. The Girls' Clubs instructresses conduct short intensive courses in large towns, giving special attention to instruction in the organisation of team games for clubs with limited playing spaces. The experiment is an entirely new one and the results so far are reported to be most encouraging.

A new policy in reference to public museums has recently been decided on by the trustees. Its main feature is a demonstration in public museums, in small towns, designed to show what can be done at a very small cost to make them interesting and educationally valuable. The amount set aside for this purpose is £7000, and will be available solely for re-organisation purposes, in general accordance with the recommendations contained in the report prepared for the Trust by Sir Henry Miers and published in 1928, on "Public Museums of the British Isles". The trustees are also examining the possibility of encouraging the circulation of museum exhibits from urban or county centres to village schools and institutes, and, as a preliminary step, will assist the Museums Association to hold an exhibition of suitable objects, cases, etc.

Appended to the report are useful supplementary notes on the National Central Library and branches, regional library schemes, village halls, and rural community councils.

Atomic Synthesis and Stellar Energy.

By Dr. R. D'E. ATKINSON, Rutgers University.

SOME time ago F. G. Houtermans and the present writer investigated the possibility of synthesis of elements, in stellar interiors, by the wave mechanics process of penetration of nuclei by protons.[1] The theory was not strictly correct, and various modifications have been proposed since, of which the theory of Wilson [2] is perhaps the most important; all theories, however, lead to a probability of proton penetration having the same exponential dependence on both the temperature, T, and the atomic number, Z. The importance of this factor far outweighs that of the multiplicative forefactor which alone is different in the different theories, and it seems therefore desirable to discuss somewhat more fully the consequences of the assumption that any of these theories will give the right order of magnitude for the temperature at which synthesis will occur in large amounts. The effect of the exponential is roughly to make the synthesis probability vary as T^{20}, or some comparable power, and thus even a change of 1000 in the forefactor does not seriously affect T. The investigation is being discussed fully in the *Astrophysical Journal*, but in view of the interest of the subject at present, and also of the comparative unfamiliarity of the line of attack, a short summary may both appeal to a wider audience and prepare the way for the more detailed treatment.

Direct synthesis of helium from hydrogen is clearly a very unsatisfactory process, but we do not need to assume its existence at all; as in the above paper, we assume that helium is produced entirely indirectly, by the spontaneous disintegration of unstable nuclei that must first themselves be formed. In addition to the known radioactive elements, Gamow's theory of nuclear stability [3] now indicates that we may expect a large number of lighter elements to be unstable if they were to be formed, and in fact we rely mainly on these. For example, if above argon the incorporation of electrons, which we clearly must suppose can occur, is somewhat difficult (and the existence of apparently permanent non-radioactive *isobars* seems to show that it can be extremely difficult), nuclei such as Fe^{52}, Ni^{56}, and Zn^{60} may be formed; according to Gamow, the last of these, and quite possibly all three, should be unstable. After emitting one α-particle, they would again collect four protons and two electrons in such order and at such intervals as they could, combine them into a fresh α-particle, and re-emit this one also in due course. At various points in this cycle they would also have to emit a total of just as much energy as would be set free by the direct synthesis of a helium nucleus; this energy can then be used to maintain the star's radiation. This method of evading the well-known difficulty of the 6-body collision as a source of helium obviously opens up important avenues; it is, however, not at all necessary to regard helium as the final product. In fact, since small Z-values favour synthesis, all the helium formed will be rapidly built up again. The energy developed is roughly the same, however, *per proton consumed*, whatever the products.

Since no other theory proposes a lower temperature for an energy source than ours turns out to do, we may take it that stars will at any rate contract until this process becomes operative; they will then be unable to contract further, since even a small contraction will enormously stimulate the energy development and orce them to expand again. Milne's theory seems in this way to be ruled out until such time as the hydrogen supply near the centre has run low.

Rosseland has shown that when there is no great xcess of hydrogen, electrostatic forces will tend to drive it from the centre, and the centre is in any case the only place where it is being consumed. Thus in any star a time will arrive when the disappearance of hydrogen near the centre prevents the generation of nergy there altogether; the star must then condense towards the degenerate state. It is known that the nergy of the white dwarfs may be entirely gravitational if their lifetimes may be supposed to be only of the order of 10^{11} years; in addition to explaining why tars intermediate between white dwarfs and the main sequence seem to be scarce, this theory explains why eavy white dwarfs should be the commonest [4] (the minimum radius is smaller and the square of the mass arger, so that they have very much more gravitational energy available).

So long, however, as hydrogen is present, synthesis hould continue. Since, now, the star's mass remains ractically constant, its energy generation must remain moderately so, and it is easily seen that this involves an approximate constancy of the helium upply, but with an ever-present possibility of adding little to it. This is the fundamental condition for tellar stability, and determines the central temperature. For a star to keep control, it must slowly decrease its central temperature, since the number of helium sources is being added to; thus, after an itial contraction to start the process, stars spend probably the greater part of their lives *expanding*. During ost of their lifetime the expansion is very slow, and the central temperature at any one mass is almost determinate; this accounts for the main sequence.

The actual value for the central temperature cannot, however, be what this simple theory would indicate. If iron is to be synthesised, a temperature of perhaps 200 million degrees would be necessary, and at this temperature all the light elements would be so readily converted to heavier ones that they could not become abundant at all. With a constant helium supply we can use the ordinary equilibrium law of radioactivity theory, namely, that the amounts of the various elements should be directly as their 'average lives'; the fact that we are dealing with synthesis and not disintegration does not affect the validity of the principle. Since the atomic number, Z, affects the synthesis probabilities, that is, the average lives, exponentially, all light elements ought to be very scarce; oxygen is, however, more abundant than anything except hydrogen, and a number of other elements near it are also at least as plentiful as iron.

In fact, it is easily seen that the most abundant element of all in a star must have an average life (until further synthesis) comparable with the past life of the star itself; otherwise some heavier element would be more abundant. If now we assume the central temperature is so low that oxygen is as long-lived as this, we find that it and the lighter elements are nevertheless abundant enough for their synthesis alone to supply enough energy, and that the actual temperature is about 16 million degrees in the sun. This is in agreement with the figure obtained on Eddington's theory for a polytrope of index about three and constitution rather above 50 per cent hydrogen by weight.

At this temperature there is, however, no synthesis of iron, and thus no further supply of helium, and the process will soon exhaust itself. The difficulty may be overcome by an arbitrary assumption, and it has been found possible to make one that accounts at the same time for the permanence and actual position of the main sequence, and for the relative proportions of all the elements in main sequence stars. The assumption is that there is a second synthesis process, which is more probable than the first when $Z>8$ and has a probability that increases somewhat with increasing Z; it must depend about as extremely on the temperature as the other process. Even if this assumption is wrong, it is probably valuable to have the theory investigated in detail; in point of fact, it does at least lead to a number of correct results.

Oxygen will now certainly be the longest lived element, and the products of synthesis will 'pile up' at and near this value of Z. It is, as a matter of fact, desirable to keep them from adding to the iron group which is supplying the helium, for a constant supply is wanted. The iron group itself must, however, be abundant enough to be in 'equilibrium' with the lightest elements, since it must produce as many α-particles per second as there are helium-lithium syntheses. It is found that the situation which will develop involves a marked minimum between the oxygen and the iron maxima and a marked fall after, say, zinc, in very good qualitative agreement with observation.[3] A consideration of Gamow's theory leads us to expect in addition a maximum among and below the lightest rare earths, and possibly one in the lead region; both are found. Practically the entire range of elements thus shows a qualitative agreement with what the theory requires.

The same will be true of any main sequence star; but since the age of the star at a point when it is, say, half hydrogen is much greater for small stars than for large ones, and the density is also larger in small stars, the central temperature must be smaller in them if oxygen is still to have a long enough lifetime. This is satisfactory, for Jeans's modification of Eddington's theory does involve a polytropic index varying systematically with the mass in about the right sort of way to produce this effect. Jeans's modification results from using the theoretical Kramers value for the absorption coefficient, and the main reason why it has not been more generally adopted (by followers of Eddington) than it has is probably that the absolute values obtained by Kramers' theory did not seem to fit the facts. When, however, we adopt Russell's high value for the hydrogen content of stars the discrepancy disappears.

The vast majority of the stars are thus accounted for. The main sequence consists of stars built on the Eddington-Jeans model, with central temperatures fairly sharply defined at any one mass and rising very slowly with the mass, and with a constitution very similar to that actually observed; the central temperature seems to be about 16-20 million degrees in the sun. The white dwarfs consist of a roughly parallel band of stars built nearly on the Milne degenerate model, with central temperatures up to about 3×10^9 degrees; they should have about the same constitution except for a shortage of hydrogen at the centre, and will be fainter for a given mass.

In addition to these two main classes we may account for the low density giants. These have a comparatively low central temperature and can only obtain their energy (*a*) if they have a large amount of free helium or unstable atoms already present, or (*b*) if some very light element can also be unstable. In case (*a*) they will not be able to live very long; but if they are very heavy their total lifetimes will be short anyway, and their life in this state may be a fairly large fraction of the total. The wave mechanics formula used shows that a star of mass 30 suns, if 10 per cent of it were helium and 80 per cent hydrogen, could develop enough energy for an absolute magnitude of -6 even at the density of an *M*5 supergiant, with a central temperature of only 4 million degrees. Such stars will, however, be 'overstable', that is, they will be liable to develop pulsations; these are well known to be a common feature of very massive red stars. If they are not very massive, only a small fraction of their lifetimes can be spent in this state, and they would, in addition, have a very large colour index indeed; we should thus scarcely expect to see any. In case (*b*) a long life would be possible, but as synthesis would now certainly result in an immediate increase in the amount of the unstable element, the stars would have to change their central temperatures over a fairly large range during their lifetimes. The unstable element is assumed to be the isotope Be^8, which exists in very small quantities on the earth and probably has in fact a mass defect (referred to helium as a unit) of very nearly zero. Many beryls contain a large and otherwise unexplained amount of helium, and when the idea of the instability of Be^8 was first proposed, Lord Rayleigh at once pointed out the significance of this fact.[6] The 'Hertzsprung gap' and its prolongation between the Cepheids and the *B* stars may be shown to follow if Be^8 has a long life, and its presence on the earth guarantees this. A long life is also in harmony with the $\mathrm{Be}^8/\mathrm{Be}^9$ ratio and the He/Be ratio.

A number of other observations may readily be fitted into the theory. We may mention in particular the absence of low density stars at medium and small masses, the occurrence of *R* and *N* types among giants but not among dwarfs, the existence of binaries in which the brighter star is the cooler and less dense, and the fact that the brightest stars in clusters are usually all red or all blue.

The arguments that have been urged in support of the 'long time scale' (10^{13}-10^{14} years) may all be met with some plausibility. In particular the well-known theory of Jeans for the eccentricities of binaries, and similar 'kinetic theory' arguments can all be reconciled with the 'short time scale' (10^{11} years) if the galaxy is expanding as fast as the universe in general is; this expansion (for the universe as a whole) seems to be demanded by the general theory of relativity.

It thus appears that as a result of the wave mechanics on one hand, and the general theory of relativity on the other, the universe may have developed its present complexity of stars and of atoms from an initial state consisting of a fairly dense, nearly uniform, nearly stationary mass of cold hydrogen. This comparatively simple beginning constitutes at least a pleasant ornament, if not an actual support, for our theory. It must, however, be admitted that there are still some serious difficulties; those that have been noticed are discussed in the full account which will shortly appear.

[1] *Zeits. f. Physik*, **54**, 656; 1929.
[2] *Mon. Not. R.A.S.*, **91**, 283; 1931.
[3] *Proc. Roy. Soc.*, **126**, 632; 1930.
[4] Cf. Russell and Atkinson, NATURE, May 2, p. 661, 1931.
[5] Russell, *Astr. Jour.*, **72**, 11; 1929.
[6] NATURE, **123**, 607; 1929.

Empire Travel for British Students.

FOR the past eight years, parties of Canadian undergraduates, numbering from 50 to 150, and representing most of the universities of Canada, have made a summer tour in Europe under the auspices of the Overseas Education League. The party usually leaves Montreal for Glasgow towards the end of June, and spends about a month in Great Britain, visiting such centres as St. Andrews, Edinburgh, Grasmere, Bangor, Stratford-on-Avon, Oxford, Cambridge, London, and the south coast of England. A further fortnight is then spent in Switzerland, Germany, and France, before the party embarks for Quebec. Last year the continental section of the tour included visits to Geneva, Innsbruck, Oberammergau, Munich, Stuttgart, and Paris.

These tours, of which the great educative value is obvious, represent one activity only of the Overseas Education League. Organised in 1910, on a definitely non-commercial basis, by Major Ney, of Winnipeg, the League was originally designed to foster understanding between Canada and Great Britain. Its scope has gradually widened, and now it "seeks to emphasise the significance attaching to citizenship in th British Commonwealth of Nations, to interpret Britai and France to the two great branches of the Canadia people through a closer educational and cultura association, and to develop a consciousness of the rôl of education as a means to international understanding and amity". It organises summer school of English, French, music, drama, etc., at Oxfor Paris, and other centres; and, in all, some six thousan teachers and undergraduates have taken advantage its arrangements. The Governor-General of Canad is honorary president of the League, and amon other patrons and supporters are the Governo General of the Union of South Africa, Lord Plume the Right Hon. L. C. Amery (honorary vice-presidents the Primate of all Canada (president), and Major F. Ney (vice-president and honorary organiser).

This summer, for the first time, a return visit t Canada of a party of university students from Grea Britain has been arranged under the auspices of th League. A group of about twenty men and wome students of the University of St. Andrews, represent tive of the various years and faculties, will sail for Canada this month in the company of the home-going Canadian undergraduates and various other Canadian parties. Prof. John Read, professor of chemistry in the United College, St. Andrews, will lead the party, and the tour will occupy a period of about five weeks. The visit will be restricted to the eastern provinces, and the party will visit such centres as Quebec, Montreal, Ottawa, Toronto, and Kingston. The return journey from Toronto to Quebec will be made by water via the Thousand Islands. Throughout the tour opportunities will be afforded the members of gaining a first-hand knowledge of the educational institutions, culture, home-life, and resources of the Dominion. The undertaking appears to provide the first instance of an organised visit to a British Dominion by a body of university students from Great Britain, and the evidence afforded by so interesting an experiment should be of particular value.

University and Educational Intelligence.

Edinburgh.—Dr. Charles McNeil, senior physician in the Royal Edinburgh Hospital for Sick Children, has been appointed to the newly founded Edward Clark chair of child life and health.

London.—On the occasion of the centenary meeting of the British Association in September next, the Senate has decided to confer the honorary degree of doctor of science on the president (General the Right Hon. J. C. Smuts), Sir F. Gowland Hopkins, president of the Royal Society, and on the following former presidents of the British Association: the Right Hon. Lord Rutherford of Nelson, Sir Charles Sherrington, and Sir J. J. Thomson.

The governing body of the Lister Institute has appointed Dr. Thomas Fotheringham Macrae to a research studentship in biochemistry.

Dr. Catherine C. Steele has been appointed lecturer in agricultural chemistry and physics at the Horticultural College, Swanley, Kent, and will take up her duties in September next.

Mr. F. N. Mowdawalla has been appointed professor of electrical technology in the Indian Institute of Science, Bangalore, in succession to Prof. J. K. Catterson-Smith.

Applications are invited for the following scholarships at the Huddersfield Technical College:—The Joseph Blamires research scholarship for research in colour chemistry, the value of which is £100 a year with remission of fees, and the British Dyes' research scholarship for research in colour chemistry, value £75 a year with remission of fees. Further particulars and forms of application are obtainable from the Technical College, Huddersfield.

School Life, issued monthly by the United States Office of Education, announces in its January issue that it is undertaking a new task. Not content with publishing notices of the numerous monographs prepared by the staff of the Office of Education, it is to ransack the offices of all government departments, commissions, boards, and other agencies for whatever is likely to be useful to teachers. The first-fruits of this new policy appear in the forms of a full-page advertisement of the Geological Survey's maps—which, by the way, are available to schools at a discount of from 40 to 60 per cent, as compared with the 25 per cent allowed by the Ordnance Survey of Great Britain—the 'Children's Charter' adopted by the White House conference on 'child health and protection', a prison education scheme, and a list of new government publications useful to teachers. The same issue contains articles on unemployment in the teaching profession, instruction classes for the unemployed, the rise of the land-grant colleges and universities, how the schools deal with individual differences, American educational progress in 1930, and a radio transmission station for the joint use of six State agencies, including the university and the departments of public instruction, health, highways, agriculture, and State conservation, of the State of Wisconsin.

Education in India in 1928–29 is reviewed briefly by the Educational Commissioner with the Government of India in a pamphlet recently issued by the Government Publications Branch, Calcutta (price 1*s*. 6*d*.). The number of scholars in institutions of all types in 1929, namely, 12,165,839, shows an increase of 3 per cent in twelve months. During the same period, expenditure on education increased by 5 per cent, to Rs. 27,07,32,253. Expenditure on universities and colleges, providing instruction for 94,257 students, amounted to 13·5 per cent of the total expenditure and showed an increase of 13 per cent over the expenditure of the preceding year. The report suggests doubts as to whether this rapidly increasing expenditure is justifying itself by results. Of the University of Bombay, it is recorded that "the average student does not bother to read his texts but is content to learn by heart second-hand opinions on them, gleaned from cheap bazaar cram-books". The University of the Punjab "is burdening itself, and is encouraging the colleges to burden themselves, with a very large number of students who have little or no chance of completing the course successfully and on whom the expenditure of money intended for higher education is very largely wasted". There is similar wastage also in the University of Rangoon. The number of Indian students in Great Britain is now well over two thousand. Including students at universities on the Continent and in the United States of America, the total number who are abroad in one year is not far short of 2500.

College and school athletics, as related to the educational process, have been dealt with by the Carnegie Foundation for the Advancement of Teaching in a series of publications, beginning in 1927, of which the latest is its Bulletin No. 26 on "Current Developments in American College Sport". In a preface by the president of the Foundation, Mr. Henry Suzzallo, attention is directed to a principle, said to have been long recognised in America but, to the serious detriment of the product of higher education in that country, not always acted upon, namely: "that final responsibility for the effective administration of American college sport belongs not to the alumnus, the down-town business man, or the newspaper writer, but to university or college officers". Many of the changes summarised in the bulletin point to an improvement in this respect. "At numbers of institutions attempts are clearly being made to modify and ultimately to eliminate certain abuses which have their roots in the prevalent commercialisation of American college sport." In several fields of sport, however, in which colleges have been used by professional sports promoters as training grounds for recruits, public aversion to such practices will need to be aroused to a much higher pitch than it has at present reached before their elimination can be looked for. Meanwhile a notable decrease of undergraduate interest in inter-collegiate athletics has taken place in recent years. Complaints by academic teachers that students' interest in the things of the mind is feeble are less frequently heard, and this is attributed to the introduction into intellectual pursuits of the competitive motives which prove so effective in sport.

Birthdays and Research Centres.

Aug. 7, 1864.—Mr. OSWALD H. LATTER, formerly senior science master at Charterhouse.

An investigation of the action of certain chemical substances in stimulating dormant storage organs of plants to activity—for example, ethylene chlorhydrin in the case of *Gladiolus* corms, potassium sulphocyanide in the case of potato tubers—might lead to valuable results.

Aug. 7, 1886.—Prof. P. G. H. BOSWELL, F.R.S., professor of geology in the University of London, Imperial College of Science and Technology, S.W.

To select for special mention from among the various branches of pure geology, oil technology, and mining geology is not easy in a department where students bring problems from many parts of the world and where more than thirty subjects of research are in progress. Detailed observations on the constitution, arrangement, and fossil contents of strata, for example, must proceed; as also the exploration of unknown or little known regions. By these means alone can we fill in the many gaps in the geological record and discover new links in the chain of life.

It is important, however, that the inductive methods of experimental research should be employed side by side with analytical investigations. Hence our aim at the Imperial College is to continue research on such problems as the rôle of water and other mineralisers in the genesis of igneous rocks and metallic ores; the imperfectly understood processes in the formation of clays; and the natural history of sedimentary rocks, both as a problem in pure geology and in its bearing on the origin of petroleum.

Aug. 8, 1857.—Prof. HENRY FAIRFIELD OSBORN, For.Mem.R.S., research professor of zoology in Columbia University and honorary curator of vertebrate palæontology in the American Museum of Natural History.

I began field study of palæontology in the month of August, 1876. I initiated the field explorations from the American Museum in 1891 and became fascinated with the origin and evolution of the proboscideans in 1899, leading to the Fayum Expedition of 1907, in turn to the increasingly intensive study of the evolution of the mastodont, stegodont, and elephantine divisions, especially since the year 1920, when the text of the Titanothere Monograph was completed and sent to the United States Geological Survey for printing. Both stegodonts and elephants have been close travelling companions of man for at least 1,250,000 years, and recently a most interesting discovery has been made that intensive measurement of the ridge plates of the grinding teeth of the proboscideans promises to afford a new and very precise means of dating not only the stegodonts and elephants but also their companion, hunter, and destroyer, prehistoric man.

Aug. 9, 1880.—Prof. M. GREENWOOD, F.R.S., professor of epidemiology and vital statistics in the University of London.

I am at present engaged on the statistical analysis of data of epidemics occurring in groups of mice, with particular reference to the mechanism and quantitative measure of immunisation against bacterial and virus diseases.

Aug. 10, 1865.—Col. Sir CHARLES F. CLOSE, K.B.E., C.B., C.M.G., F.R.S., chairman of the Palestine Exploration Fund; president of the International Population Union; president of the Hants Field Club; formerly president of the Royal Geographical Society.

Three groups of subjects are now of special interest to me. Now that Great Britain has the mandate for Palestine, all possible help should be given to the Palestine Exploration Fund and the British School of Archæology in Jerusalem; and it is most desirable that the headquarters and museum of the Fund should become a real centre and focus of information with regard to the history and archæology of Palestine. Secondly, it is to be hoped that the International Map of the World will make more rapid progress; though much has been done, some countries are lagging behind. In a similar geographical field, a comprehensive English text-book on map projections is badly needed. The admirable 'Germain' is much out of date. Thirdly, all interested in the subject should assist the International Union for the Study of Population Problems and the British National Committee of the Union. The Union is not propagandist and its work is purely scientific.

Aug. 11, 1895.—Dr. C. D. ELLIS, F.R.S., fellow of Trinity College and lecturer in physics in the University of Cambridge.

I am engaged in investigating the β- and γ-ray type of radioactive disintegration. Recent work has shown that there is a close connexion between the energy differences of the α-particle levels in the nucleus and the frequencies of the emitted γ-rays, and it seems a point of importance to ascertain accurately the intensities of the different γ-rays in order to establish correlation in this connexion also with the α-particles.

A further point of great interest which can be conveniently studied by the same type of experiment is the direct coupling between the nucleus and the electronic system which is shown by the so-called 'internal conversion' of the γ-rays.

Societies and Academies.

DUBLIN.

Royal Dublin Society, June 24.—**A. W. Conway**: The influence of the work of Sir William Rowan Hamilton on modern mathematical thought. Hamilton's mathematical work may be divided chronologically into four groups: optics, dynamics, general, and quaternions. His work on optics is dominated by his idea of the 'characteristic function' and his grasp of the fact that this had application either to a wave or to a corpuscular theory of light, representing principles of least (or greatest) time and least (or greatest) action, respectively, on the two theories. His application of the principle of varying action put the whole of dynamics on a new footing, and his methods are to-day freely used.—**Phyllis Clinch**: Cytological studies of potato plants affected with certain virus diseases. A histological and cytological study was made of the mosaic diseases of the potato designated simple and interveinal mosaic, crinkle, streak, and aucuba mosaic. The leaf modifications which underlie the mottling arise in part from underdevelopment of the mesophyll, from a reduction in the number and size of the chloroplasts, and from a paler colour of the chlorophyll. In aucuba mosaic the mottling is almost entirely due to the disintegration of the chloroplasts. Intra-cellular structures of the 'X- body' type occur in all the diseases mentioned, except aucuba mosaic, and in the case of streak only in the early stages. This study tends to emphasise the similarity of all the potato mosaics, except aucuba mosaic, and indicates that streak belongs to the mosaic group.—**W. R. G. Atkins**: Radiation and life. In view of the importance of an adequate degree of illumination for most species of plant and animal life, convenient methods of measuring daylight in various sites on land and in the sea are of considerable utility. Many such measurements have been made by the author and by others using various methods, of which, for general work, the photoelectric cell is, perhaps, the most convenient. Some of the methods used and the results obtained are discussed.

PARIS.

Academy of Sciences, June 8.—**H. Deslandres**: Simple relations between the molecular spectrum and the structure of the molecule. It is shown that apart from any special theory, and working with experimental data only, the molecular infra-red spectrum depends on whole numbers, and may furnish useful indications on the structure of the molecule.—**Georges Claude**: Human respiration in enclosed spaces under reduced pressure.—**Jean Baptiste Senderens**: The comparative hydration of sulphuric acid and of the alkaline bisulphates; its relations with the catalytic activity. The fact that potassium bisulphate treated with air saturated with moisture is hydrated more slowly than sodium bisulphate under the same conditions, is regarded as explaining why sodium bisulphate is a more active catalytic agent towards alcohols than potassium bisulphate.—**Paul Pascal and Mlle. Bernheim**: The study of a mode of transformation of calcium cyanamide into cyanide.—**Edgar Baticle**: The probabilities relating to intermittent phenomena of variable duration.—**Alfred Rosenblatt**: The unicity of partial differential equations of the first order.—**C. E. Winn**: The limits depending on the means of Holder and Cesàro.—**Nikola Obrechkoff**: The summation of Dirichlet's series.—**J. Le Roux**: The invariant expression of the law of gravitation.—**E. Callandreau**: Approximate solutions of the lines of rupture in a pulverent massif.—**Pierre Dive**: The attraction of homogeneous ellipsoids.—**G. Chapas**: The heats of solution of benzoic acid in toluene.—**M. Haissinsky**: The electrochemical and chemical behaviour of polonium in tartaric acid solution. The experimental results are best explained by assuming that the polonium is combined with the tartaric acid in the form of a soluble complex compound, slightly stable and easily hydrolysable.—**Nahmias**: The fluctuation of the path of the α-ray of polonium in different gases.—**Mme. Irène Curie and Marcel Lecoin**: A new gaseous compound of polonium. When polonium, deposited on a nickel needle, is heated in a current of nitrogen, practically the whole of the polonium is deposited in the cooler part of the tube. But if the nitrogen is replaced by a mixture of carbon monoxide and dioxide in equal volumes, about one half of the metal appears to be converted into a gaseous compound, possibly a polonium carbonyl similar to nickel carbonyl.—**Georges Allard**: Electrical moments and molecular constitution.—**W. Swietoslawski**: A boiling point apparatus for examining the purity of liquid chemical individuals.—**L. Lematte, G. Boinot, E. Kahane, and Mme. M. Kahane**: The use of a nitroperchloric mixture for the estimation of silica in vegetable substances. Details of the method, for which both rapidity and accuracy are claimed, are given.—**Sou Phou Ti**: The action of ethylmagnesium bromide on *N*-diethylmonochloracetamide. An unusual transposition takes place in this reaction, the alcohol produced proving to be $(C_2H_5)_2 . N . CH_2 . C(OH) . (C_2H_5)_2$. Suggestions for the probable course of the reaction are given.—**J. Hock**: The synthesis of some derivatives of arylacetic and β-arylpropionic acids.—**Raymond Delaby and Mme. S. Guillot-Allègre**: The α-β-ethylene aldehydes with a linear chain.—**Agostino Puppo**: The storm of July 24, 1930, in the Treviso-Udine district. The damage done by this storm, stated to be the most violent ever observed in Europe, is described. It included destruction of houses, high tension cables, animals, and trees. Human beings were lifted up and carried several hundred metres. The maximum velocity was calculated at 80 metres per second.—**A. Duparque**: The microscopic structure and origin of coking coals and bituminous coals.—**P. Lavialle and P. Jaeger**: The origin of fruit in its relations with pollenisation in *Knautia arvensis*.—**Fernand Moreau and Mlle. C. Morwzi**: Experimental researches on the formation of the perithecium in *Neurospora*.—**C. Charaux and J. Rabaté**: Contribution to the biochemical study of the genus *Salix*. A new glucoside, salipurposide, hydrolysable by emulsin, extracted from the bark of *Salix purpurea*. The new glucoside has the composition $C_{21}H_{22}O_{10}$; on hydrolysis it gives glucose and a substance salipurol, $C_{15}H_{12}O_5$.—**Pierre Gavaudan and Robert Cazalas**: Some teratological phenomena observed during the spermatogenesis of the Characeæ.—**E. Miège**: Strains with polycarpous flowers in a hybrid of *Triticum vulgare*.—**P. Regnier, L. Lespes, and C. Rungs**: The habitat of *Schistocerca gregaria* and the succession of generations in this species.—**A. M. Monnier**: A piezo-electric myograph. Its application to the analysis of the isometric jerk of muscles.—**Jules Amar**: The importance and the signification of the vital capacity.—**Mlle. E. Lebreton, and F. Mocoroa**: The number and nature of the proteolytic ferments of the pancreatic juice. The author concludes from the experiments described that the pancreatic juice as secreted contains, besides prokinase, only the tryptic ferments inactive proteinase and directly active carboxylpeptidase. The ereptic ferments found in the glycerol extracts of pancreas are endocellular and do not normally pass into the juice.—**J. Cayrol and L. Genevois**: The specific inhibition of the alcoholic fermentation of yeast cells without arrest of the respiration, of the Pasteur-Meyerhof reaction, or of growth. A repetition of Lundsgaard's experiment, with the substitution of monobromacetic acid for iodacetic acid, the former being more active and less toxic. Bromacetic acid in the proportion of 14 mgm. per litre completely inhibits fermentation without interfering with respiration, growth, or the Pasteur-Meyerhof reaction.—**Ch. Dhéré**: The fluorescence spectrum of protochlorophyll.—**Mlle. D. Van Stolk, J. Guilbert, H. Penau, and H. Simonnet**: Pure carotene and vitamin A. Full details of the methods of extraction and purification of carotene are given. It is concluded that very pure carotene is capable of maintaining weight equilibrium in the rat and of preventing phenomena of avitaminosis from developing in that animal.—**Cl. Fromageot**: The origin of the energy put at the disposal of micro-organisms in the course of the fermentation of the hexoses.—**Denier la Tour du Pin**: The elective fixation of medicinal ions by the electromagnet. The electromagnet can be used to direct the ions to spots accessible with difficulty; clinical results proving the efficacy of the method are given.—**Georges Blanc and J. Caminopétros**: The virus of exanthematic fever obtained from the blood of patients or from the organism of the tic is filtrable.—**Fréd Vlès, Mlle. Marguerite Prager, and Nissen Bernstein**: The relations between the isoelectric points of human serum and its alexic power.

CAPE TOWN.

Royal Society of South Africa, May 20.—E. L. Halliday: Correlations between the field changes due to lightning and the appearance of the flashes. A preliminary note upon certain results obtained in investigation of the polarity of thunderstorms in the Transvaal. Photographic records of the field changes due to lightning discharges have been combined with visual and photographic observations of the flashes. Of 273 flashes between the base of the cloud and the ground, 257 gave positive field changes and 16 gave negative field changes. Of 173 positive field changes at distances greater than 7 km., 159 were due to flashes to ground. Of 164 discharges within the cloud at distances greater than 7 km., 150 gave negative changes of field.—J. Schonland and C. A. Coppens: Point discharge measurements below thunderstorms. The arrangement used by the authors in Johannesburg and Graaff-Reinet utilises a suitably insulated point and a portable galvanometer. Its simplicity lends itself to the collection of statistical data on the sign and order of magnitude of the fields and field-changes. The arrangement leaves the observer fairly free to note the meteorological features and the distance of the storm.—M. Rindl: The alkaloids of the bark of *Strychnos henningsii*. Two alkaloids have been isolated, a crystalline and an amorphous one. The present paper deals with the methods adopted to isolate the amorphous alkaloid and the endeavours to obtain the base itself, or derivatives of it, in a crystalline form.

SYDNEY.

Royal Society of New South Wales, May 6.—O. U. Vonwiller (presidential address): A generation of electron theory. A review of developments in atomic and light theory since the 'isolation' of the electron, with special reference to the accompanying changes in the philosophic outlook of the physicist from the deterministic view general at the end of the nineteenth century to the uncertainty and probability principles of to-day. It is emphasised that the wave theory of light cannot be regarded as more than a convenient hypothesis in terms of which certain phenomena can be reconciled. Light waves may be considered as a mathematical device which can be used to express the probability of the presence of photons just as de Broglie waves can be used with electrons. The evidence for the objective reality of the waves is no greater in one case than in the other.

Official Publications Received.

BRITISH.

City of Leicester: Museum and Art Gallery. Twenty-seventh Report to the City Council, 1st April 1930 to 31st March 1931. Pp. 32. (Leicester.)

Sanatoria. List of Sanatoria and other Residential Institutions approved by the Minister of Health for the Treatment of Persons suffering from Tuberculosis and resident in England and Wales, with the names of the Administrative Counties and County Boroughs in which the Institutions are situate. List 10(d) Pp. 24. (London: H.M. Stationery Office.) 4*d.* net.

Imperial Bureau of Plant Genetics: Herbage Plants. Herbage Extracts, 1931 Vol. 1, No. 1, June. Pp. 39. 1*s.* 6*d.* Bulletin No. 3: The Breeding of Herbage Plants; Technique adopted at the Welsh Plant Breeding Station. Pp. 77+3 plates. 3*s.* (Aberystwyth.)

Empire Survey Review. Vol. 1, No. 1, July. Pp. 48+xviii. (London: The Crown Agents for the Colonies.) 3*s.*

City of Leicester Municipal Libraries. Fifty-second Report to the City Council, 1st April 1930 to 31st March 1931 Pp. 20. (Leicester.)

The Proceedings of the Physical Society. Vol. 43, Part 4, No. 239, July 1. Pp. viii+371-460. (London.) 7*s.* net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1375 (E. 47—G. 36, 39 and a): Possible Cause of Aircraft Fires on Crash. By W. G. Glendinning; with an Appendix by Staff of the Engine Department. Pp. 19+6 plates. 1*s.* net. No. 1255 (Ae. 404): The Flutter of Monoplanes, Biplanes and Tail Units (A Sequel to R. and M. 1155). By R. A. Frazer and Dr. W. J. Duncan. Pp. viii+179+12 plates. 7*s.* 6*d.* net. (London: H.M Stationery Office.)

Proceedings of the Royal Society of Edinburgh, Session 1930–1931. Vol. 51, Part 2, No. 14: Male Haploidy and Female Diploidy in *Sirex cyaneus* F. (Hymen.). By Prof. A. D. Peacock and Dr. R. A. R. Gresson. Pp. 97-103+1 plate. 1*s.* Vol. 51, Part 2, No. 15: Some New Facts about the Structure of the Cuticles in the Russian Paper-Coal and their Bearing on the Systematic Position of some Fossil Lycopodiales. By Jessie A. R. Wilson. With a Note on The Absence of Eliguate Heterosporous Lycopodiales in the Fossil-Record, by Dr. John Walton. Pp. 104-115+1 plate. 1*s.* 3*d.* Vol. 51, Part 2, No. 16: Fourier Integrals. By T. M. MacRobert. Pp. 116-126 1*s.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 20, N.S., Nos. 1-7: A Modified Form of Radon Capillary Apparatus, by Dr. H. H. Poole; The Exudation of Water from the Leaf-tips of *Colocasia antiquorum*, Schott., by Prof. Henry H. Dixon; The Application of Gamma Radiation to Deep-seated Tumours, II., by Dr. J Joly; Photo-electric Measurements of Illumination in relation to Plant Distribution, Part 4: Changes in the Colour Composition of Daylight in the Open and in Shaded Situations, by Dr. W. R. G. Atkins and Dr. H. H. Poole; Observations on the Photo-electric Measurement of the Radiation from Mercury Vapour Lamps and from the Sun, and on the Effects of such Radiation upon the Skin, by Dr. W. R. G. Atkins; Some Experiments on the Accuracy obtainable with Gas-filled Photo-electric Cells, by Dr. W. R. G. Atkins; A Method of distinguishing certain Strains of New Zealand Perennial Ryegrass (*Lolium perenne*, L.) by examination of Seedlings under Screened Ultra-violet Light, by P. A. Linehan and S. P. Mercer. Pp. 83+2 plates. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 7*s.*

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 415, July. Pp. 805-932+xxvi. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1930. Part 1, with Report of the Geological Survey Board and Report of the Director. Pp. iv+92+2 plates. (London: H.M. Stationery Office.) 2*s.* net.

British Empire Cancer Campaign. Eighth Annual Report of the Grand Council, presented at the Meeting held at the House of Lords, 20.7.31. Edited by J. P. Lockhart-Mummery. Pp. 202. (London.)

FOREIGN.

Bulletin of the National Research Council. No. 80: Physics of the Earth. 4: The Age of the Earth. Pp. v+487. (Washington, D.C.: National Academy of Sciences.) 4.50 dollars.

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Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 29, Part 4: The Primary Survey of the Vegetation of the Middle Kuriles. By Misao Tatewaki. Pp. 127-190+10 plates. (Tokyo: Maruzen Co., Ltd.)

Bulletin of the Utsunomiya Agricultural College. No. 1, April. Pp. 60. (Utsunomiya.)

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The Structure and Procedure of Cadastral Survey in Palestine. By Major C. H. Ley. Pp. ii+37+8 plates. (Jerusalem: Printing and Stationery Office.) 150 mils.

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Proceedings of the American Academy of Arts and Sciences. Vol. 66, No. 8: Researches on the Rotation of Permalloy and Soft Iron by Magnetization and the Nature of the Elementary Magnet. By S. J. Barnett. Pp. 273-348. 1.20 dollars. Vol. 66, No 9: Note on the Kelvin Scale Temperature of Freezing Water. By Frederick G. Keyes. Pp. 349-355. 35 cents. (Boston, Mass.)

National Research Council. Transactions of the American Geophysical Union, Twelfth Annual Meeting, April 30 and May 1, 1931, Washington, D.C. Pp. 229. (Washington, D.C.: National Academy of Sciences.)

Occasional Papers of the California Academy of Sciences. 18. The Avifauna of the Galapagos Islands. By Harry S. Swarth. Pp. 299. (San Francisco.) 3 dollars.

Palæontologia Sinica. Series D, Vol. 7, Fascicle 2: On an Adolescent Skull of *Sinanthropus pekinensis* in Comparison with an Adult Skull of the same Species and with other Hominid Skulls, Recent and Fossil. By Dr. Davidson Black. Pp. iv+144+16 plates (Peiping: Geological Survey of China.)

Japanese Journal of Mathematics. Transactions and Abstracts, Vol. 8, No 1, June. Pp. 64. (Tokyo: National Research Council of Japan.)

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Proceedings of the United States National Museum. Vol. 79, Art. 3: A New Species of Nematode Worm from the Sage Grouse. By Everett E. Wehr. (No. 2869.) Pp. 3. Vol. 79, Art. 5: Description of a New Genus and Species of Nematode Worm occurring in the Northwestern Belted Kingfisher, with a Key to the Genera of the Subfamily Acuariinae. By Everett E. Wehr. (No. 2871.) Pp. 4. (Washington, D.C.: Government Printing Office.)

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NATURE

SATURDAY, AUGUST 8, 1931.

CONTENTS.

	PAGE
The Royal Commission on the Civil Service	201
Magical Belief and Practice	204
The Formation of Atolls. By C. M. Y.	206
Spherical Astronomy	207
Short Reviews	208
The Architecture of the Solid State. By Prof. W. L. Bragg, F.R.S.	210
Determination of Position in High Latitudes, with Particular Reference to Aircraft Observation. By C. J. Stewart, O.B.E.	212
Obituary:	
Prof. F. W. Clarke	214
News and Views	215
Letters to the Editor:	
Acromegaly among the old Northmen.—Prof. C. G. Seligman, F.R.S.	221
New Isotopes of Strontium and Barium.—Dr. F. W. Aston, F.R.S.	221
Age of Certain Gravels in the New Forest Area.—M. C. Burkitt	222
Condition of Sparingly Soluble Substances in Gelatine.—Dr. T. R. Bolam; Dr. S. C. Bradford; Dr. B. N. Desai	222
Oxidation Reduction Potential of Complex Iron Compounds in Yeast.—Thomas B. Coolidge	223
Measurement of Ultra-Violet Radiation.—A. F. Dufton and H. E. Beckett	223
The Forbidden Lines in the High Frequency Discharge of Mercury, Cadmium, and Zinc.—J. Okubo and E. Matuyama	224
Part-Absorption in X-Rays.—Dr. B. B. Ray and B. B. Datta	224
Fine Structure of Raman Lines in Liquids.—Dr. A. Langseth	225
Occurrence of *Lithothamnion* in the South Indian Cretaceous.—Prof. L. Rama Rao	225
The Energy of Horizontal Atmospheric Motion.—Sir W. Napier Shaw, F.R.S.	226
Jubilee Celebrations of the Society of Chemical Industry.—Prof. G. T. Morgan, O.B.E., F.R.S.	226
Control of Prickly Pear by the Cochineal Insect.—W. B. Alexander	226
Research Items	227
Astronomical Topics	229
Centenary Meeting of the British Association. Programmes of Sections	230
Birthdays and Research Centres	234
Societies and Academies	234
Official Publications Received	236

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The Royal Commission on the Civil Service.*

READERS of NATURE will recall that when the present Government announced its intention of setting up a Royal Commission on the Civil Service, with terms of reference of a seemingly comprehensive character, our satisfaction was qualified by a contemplation of the list of the members of the Commission. Without in any way belittling the attainments and achievements of its sixteen members in their respective avocations, we were compelled to point out that not one was a scientific man or engaged in the application of science to the needs of the community, and that not one was known to have devoted consideration to the more fundamental problems of public administration.

The Commission has now issued a conscientious and painstaking Report, the character of which has confirmed all too well the misgivings which we expressed at the time of its appointment. The Commission shows itself to be dominated almost entirely by the official witnesses, who view with complacency an administrative structure designed by them in relation to the needs of an earlier and more primitive social organisation. It is entitled to credit for having studied and answered—though usually in the negative—the numerous and often constructive criticisms brought to its notice by staff organisations; but it must be rarely that a Royal Commission, confronted with a problem of the magnitude indicated by the terms of reference, can have been so sterile of constructive ideas of its own, and so content to put forward mere glosses on an existing structure, many features of which, so far as it has been modernised, were hurriedly improvised in the immediate post-War years.

Those of us who attribute in no small measure the difficulties with which Great Britain is confronted to failure to give full scope to the scientific and technical expert, had our hopes raised by the inclusion in the terms of reference of the Commission of an instruction to inquire into and report upon the "structure and organisation of the Civil Service". We have never pretended that scientific and technical men and women are not concerned with questions of remuneration, but it has always been our view that remuneration would adjust itself once the true function of the expert had been recognised and his status duly adjusted. The Commissioners, however, following the unfortunate precedent of the Carpenter Committee on the staffs of Government scientific establishments, have carefully avoided consideration of any fundamental questions of structure, including especially those arising out of the employment of specialists—to use a wide term to comprehend professional, scientific, and technical staffs—in the administrative departments of State. The Commissioners' interpretation of the above essential element in their terms of reference is as follows:

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* Royal Commission on the Civil Service, 1929–31 Report (Cmd. 3909.) Pp. viii + 252. (London: H.M. Stationery Office, 1931.) 3s. 6d. net.

> "It is not our duty to redistribute the functions of Government between Departments, or to re-organise or determine the staff of a Department. But, taking things as they are, it is our duty to determine the most satisfactory general principles to be followed, in regulating recruitment, in fixing terms and conditions of employment, in classifying grades or classes, in distributing functions between grades and classes, and in other like matters."

Two large-scale official inquiries, one dealing with the State scientific services and one dealing with the Civil Service as a whole, have thus seen fit to avoid investigating the wider questions of structure and organisation, beside which matters of staffing, remuneration, and conditions of employment fade into insignificance. There was much in the Report of the Carpenter Committee which could be welcomed as revealing some perception of the need for the development of a State scientific service, even although the problem was not actually visualised in this form, but was approached as a mere simplification of grading and scales of pay so as to ensure uniformity among staffs employed on comparable duties in different departments. Nevertheless, whatever the approach, the Carpenter Report represented progress. The present Royal Commission's Report, however, is little more than a laudation of the *status quo* and an endorsement of Treasury principles and practice based upon conceptions of the scope of public administration current in the latter part of the last century. Without touching on larger questions of administrative policy, however, there were certain proposals with which the Commission deemed itself competent to deal and which were elaborated in the evidence of the Institution of Professional Civil Servants and supported from other points of view by both the British Science Guild and the Association of Scientific Workers.

In the first place, specialist officers are denied a proper share in the formation of policy, a function which resides in the hands of non-technical administrators who alone are entitled to access to the supreme authority represented by the Minister; in the second place, it is most exceptional for the professional or scientific officer, however gifted administratively, to enter the charmed circle of the administrators; and in the third place, there is a complete failure to perceive the fundamental unity which underlies the employment of technical experts by the State, a type of recognition which in other walks of life—even on the administrative side of the Civil Service—has done much to promote esprit de corps, the pre-requisite of administrative efficiency.

There can be no doubt that, in the interests of efficiency, the technical hierarchies should be accorded a status equal to that of the administrative hierarchies, and that, in particular, the chief technical officer in a department should rank on terms of practical equality with the administrative head of the department. When policy is in course of formation or when larger decisions are being taken, the chief technical adviser should be permitted to play as prominent a part as the chief administrative adviser of the Minister, and the board system in one form or another seems peculiarly suitable for securing this result. Under the present system it frequently happens that the technical staff prepare a report and guide the hands of the administrators up to a certain point and then hear no more about the Minister's views until perhaps there is a public pronouncement on the platform or in parliament.

The Commissioners state that they heard no evidence to justify the view that at the present time specialists are disregarded. This statement is apparently based upon the fact that a long series of permanent secretaries expressed complacent satisfaction with the present system. If the Commissioners had heard first-hand information on the point, from professional and scientific heads of departments, we have little doubt that they would then have been satisfied that there is a case for a reform of the present system. They have been misinformed when they assert that "there is no real danger that their (specialist) advice would not be placed before the Minister or official on whom falls the responsibility for the final decision on the issue under consideration".

Nevertheless, the Commissioners are constrained to admit that there may still exist among specialists a feeling that their advice is not always sought and considered, and the pious remedy proposed is that

> "those in positions of administrative responsibility should take special precautions to ensure not merely that specialists are properly consulted and that full consideration is given to their views, but that they are given no ground for feeling that their value is not appreciated. It is important

> that specialists as well as other officers whose duty it is to give advice should be made aware of the decision taken by the responsible authority."

It is precisely because these things do not happen as a matter of course under the present system that there is an urgent need for according the technical advisers a more assured status and a more definite right to assert their points of view in the presence of those who have to take the ultimate decision.

Accepting without qualification the official Treasury evidence, the Commissioners state that they have received no evidence indicating that, when an appointment to the permanent headship of a department is under consideration, regard is not and will not be had to the claims of officers other than those serving in an administrative capacity, and in support of this statement they mention that two of the present permanent heads of departments began their careers on the specialist side of the Service. The Commissioners' findings on this important point are rather discounted by a passage in the chapter of the Report devoted to the Post Office, in which, when discussing the position and remuneration of the engineer-in-chief, they state that they would

> "have expected that over a period of years some technical officers would have been found to possess qualities rendering desirable their transfer to the administrative side. We were told, however, that no officer from the technical side had ever been promoted to an administrative post in the department."

We may remark in passing that entry into the administrative class may be obtained by those whose specialisation at the universities has not been in literary subjects, through the medium of the open competition for posts in the administrative class. This fact is apparently not generally known, and we propose to return to the subject in a subsequent issue. However, we would urge that the very fact that the administrative faculty in its highest sense is rare, renders it essential that the field from which administrators are drawn should be as wide as possible, and just as it is now repugnant that qualified persons should be denied public appointments on political, social, or religious grounds, so it should be equally accepted that no man should be virtually debarred from administrative preferment merely because he possesses precise and ordered knowledge of a particular branch of science.

Finally, there was the possibility of approach to the problem of raising the status of the technical expert by simplifying the extraordinarily heterogeneous collection of grades and salaries which obtains in the professional and technical services. As we have indicated, the Carpenter Committee made important recommendations, which are endorsed by the Commissioners, to secure greater uniformity in the scientific departments. According to the evidence submitted by the Institution of Professional Civil Servants, there are actually more than five hundred separate grades in the professional and technical services, revealing minute salary differences one from another, ostensibly based upon a fine weighing up by the 'establishment' experts (all of whom are administrators) of the relative values of the services performed by these officers. One would have thought that a *prima facie* case for rationalisation would have been afforded by the history of the non-technical services, which in the past revealed the same multiplicity of grading, most of which has disappeared as a result of a process of 'reorganisation'. A similar problem has confronted the Canadian technical service, and the recent report of the Canadian Royal Commission has recommended the replacement of 203 separate grades by seven simplified hierarchies.

This issue of simplification is something more than a desire for symmetry, for the acceptance of the principle that the grading and remuneration of professional and technical officers in different occupations should be unified would pave the way to that public recognition of the technical services of the State, which is a necessary precursor to the granting to the staff concerned of a higher status in the official hierarchy. The Commissioners state that it was not possible for them to review in detail the organisation of the various specialist classes outside the terms of reference of the Carpenter Committee, nor, as we understand, did the Commissioners make any detailed investigation of the actual working of the professional and technical departments. The fact that they were without any real first-hand acquaintance with the specialist services did not prevent the Commissioners from pronouncing quite definitely against the various proposals to which we have referred for enhancing the status of the expert or from stating that there is no justification for an improvement in remuneration except in the case of some of the highest technical posts.

The constructive proposals put to the Commission were rejected out of hand, with the qualification that the Commission admitted the extraordinary anomaly of paying between £1600 and £1700 a year to the engineer-in-chief at the Post Office, responsible for the technical side of the conduct of the State's telegraph and telephone enterprises, and for the control of an army of workmen and of professional and technical officers, whereas the secretary of the Post Office receives £3000 a year. The Commission recommends that the engineer-in-chief should receive £2500. This, coupled with a suggestion that the secretary of the Department of Scientific and Industrial Research, who now receives £2200, should receive £2500, and that in the highest professional posts adjustment of salaries is required, represents substantially the whole of the Commissioners' reactions to the suggestion that the employment of specialist officers by the State presents a special problem that requires reconsideration in the light of modern conditions.

When confronted by the problem of the Post Office, the Commissioners not unnaturally quailed, and took refuge in a suggestion that the importance of the issues raised by a State trading enterprise pointed to the need for a special committee or commission to inquire into Post Office organisation. It does not appear to have occurred to the Commissioners that *a fortiori* there was an overwhelming case for a special committee or commission to inquire into the even more difficult problem of the professional, scientific, and technical services, to which they admit they gave no detailed consideration.

While we have no hesitation in describing the Report as a disaster from the point of view of the welfare of the community, it would not be just to place the whole of the blame upon the Commissioners, many of whom, in view of their public position, must be regarded as being in close touch with informed public opinion. The failure to appreciate the significance of the expert in public administration is but a symptom of the more widespread failure to realise that the ills which now beset civilised communities can only be solved by scientific method and the utilisation of scientific discovery. Our task must continue to be the creation of an informed public opinion which will instinctively exhibit indignation when important public questions involving scientific considerations are discussed without the assistance of experts, and will insist that on all public inquiries there should be a due representation of experts familiar with the subject-matter of such inquiries.

Magical Belief and Practice.

(1) *Amulets and Superstitions: the Original Texts with Translations and Descriptions of a Long Series of Egyptian, Sumerian, Assyrian, Hebrew, Christian, Gnostic, and Muslim Amulets and Talismans and Magical Figures, with Chapters on the Evil Eye, the Origin of the Amulet, the Pentagon, the Swăstika, the Cross (Pagan and Christian), the Properties of Stones, Rings, Divination, Numbers, the Kabbâlâh, Ancient Astrology, etc.* By Sir E. A. Wallis Budge. Pp. xxxix + 543 + 22 plates. (London: Oxford University Press, 1930.) 30*s.* net.

(2) *Le livre de recettes d'un dabtara abyssin.* Par Marcel Griaule. (Université de Paris: Travaux et mémoires de l'Institut d'Ethnologie, tome 12.) Pp. xi + 180. (Paris: Institut d'Ethnologie, 1930.) 70 francs.

(1) BELIEF in the power of the amulet is one of the most interesting phenomena in the history of religious belief. In close alliance with 'magic' it appears as one of the earliest forms of man's belief in the forces which he believes to lie behind the perceptions of his senses: as the mascot it serves to testify to the last act of faith of a disintegrated religion. How closely the extremes of the scale approach one another appears in some instructions on the choice of amulets published a few years ago, in which the writer argued the possibility that there might be something in it on the analogy of wireless telegraphy. No anthropologist in search of *mana* in religious belief could desire a more illuminating example; but after saying this we hesitate to suggest that Sir Wallis Budge himself is not guiltless of flirting with the idea that "there may be something in it".

In his study of the amulet and allied beliefs, Sir Wallis Budge has confined himself to ancient Egypt and Babylonia, the later Kabbalists, the Gnostics, pagan and Christian, and the astrologers. Virtually his field is the ancient Mediterranean area. Within these limits he has covered the ground with no little thoroughness. In fact there is scarcely any aspect of magical belief and practice on which he has not touched. In addition, he has added to the evidence from his experience among makers of horoscopes, casters of nativities, diviners, crystal-gazers, palmists, and fortune-tellers of all kinds whom he has met while engaged on official missions in Egypt, the Sudan, and Mesopotamia—a fruitful field as all will agree who know the superstitious reverence and profound belief with which such classes are regarded by the populace in these countries.

"The use of amulets", says the author, "dates from the time when animism or magic satisfied the spiritual needs of man"; but on a previous page, to some extent following the lead of that distinguished authority, the late Dr. Seligmann, he tells us "the use of amulets is the result of the belief in the powers of the Evil Eye in man and beast". These two statements appear to need some qualification, or at least, reconciliation. In the Mediterranean area, without doubt, the amulet is predominantly used against the evil eye; but among the peoples of simpler culture the amulet is primarily a potent protector against any spiritual influence, vaguely conceived, rather than concerned with the specific concept of a human embodiment of malevolence operating through the eye. In fact, it is difficult not to feel that the author in his account of primitive spiritual beliefs has allowed his views to be too strongly coloured by early Mesopotamian demonology.

Again, the author says: "He [primitive man] required amulets to enable him to beget children, to give him strength, to overcome his enemies, visible and invisible, and above all the evil eye, and to protect his women and children and house and cattle; and his descendants throughout the world have always done the same". But taking the first part of this statement of the objects for which an amulet is employed, the character of primitive beliefs relating to the amulet all the world over would seem to suggest rather that it is not so much to enable man to do these things as to ward off influences that would prevent him from doing them that the aid of the amulet is invoked. Even in the case of the modern mascot of civilisation worn as a 'luck-bringer', so far as the belief is capable of analysis it is just as much a 'bad luck averter' as a 'luck-bringer'. Why is the mascot carried on the bonnet of a motor car? Why were mascots so much in vogue during the War?

The question is of something more than formal import as it implicates a quite definite change in attitude towards the supernatural. The primitive attitude of mind is one of fear; and the 'luck-bringer' implies some form of influence or control. Fear, if not entirely eliminated, has at least been deposed from its dominant position. The transition no doubt may be sought in the spell or incantation, the 'word of power'. If this does not warrant a certain looseness of terminology and definition in the author's more general statements, it may, perhaps, be regarded as justifying him when he comes to deal with matters of detail in his admirable accounts of the various types of spell to be found among Assyrians, Hebrews, Samaritans, and other peoples ancient and modern.

A wider view, in a geographical sense, would have added considerably to the value of the account of the swastika. It is here suggested that the swastika of the terramaricoli was really a cross. America is not mentioned; but it would have been interesting to know what the author thinks of the types and distribution of the swastika on that continent. The waved form in a circle of America also occurs in eastern Asia. Is this significant, or do other considerations outweigh the coincidence?

The contents of this book justify the author's contention that he should have used the term "magic" in the title instead of "superstition". The mere recital of the sub-title would support a claim that it might serve as a text-book of the magic art. Should the reader wish to know what forms of divination were current among the ancients, what rings they wore and why, how they used the waxen image of witchcraft, what were the various theories of numbers, or what virtues they assigned to precious stones, all this and more is here under his hand. Sir Wallis tells us that this book is an answer to the questions he was asked by the public in his department at the British Museum. Truly the curiosity of man about the things that are hidden is insatiable.

(2) Vol. 12 of the *Memoirs* published by the Institute of Ethnology in Paris is a collection of charms and medical receipts which very appropriately may serve to supplement and illustrate Sir Wallis Budge on charms and incantations. The collection is taken from a book purchased by M. Marcel Cohen in Abyssinia in 1910–11—a duplicate copy belonging to one of the priestly class, from which he was apparently prepared to part in the belief that it would not be understood. It consists of charms against magical powers and particularly the evil eye, while a second part is concerned with specific diseases, and ills of various parts of the body. It affords a considerable amount of information as to plants in medicinal use. Numerous taboos have to be observed, and much stress is laid on orientation, both in gathering and in using the plants. The value of the text is much enhanced by the editor's notes and appendices on the various types of spirits and magical beliefs current among the people. These are partly based on information obtained from Abyssinians who were fellow-students with him in Paris.

The Formation of Atolls.

Coral Reefs and Atolls: being a Course of Lectures delivered at the Lowell Institute at Boston, February 1930. By J. Stanley Gardiner. Pp. xiii + 181 (15 plates). (London: Macmillan and Co., Ltd., 1931.) 10*s.* 6*d.* net.

ALL interested in the many fascinating problems of the formation and maintenance of coral reefs, be they marine biologists, geographers, or geologists, have reason to be grateful to the president of the Lowell Institute of Boston. It was as a result of his invitation that Prof. J. Stanley Gardiner delivered a course of lectures at Boston in 1930, and that now we have a volume embodying these lectures, which represent the fruits of thirty-five years' interest in coral reef problems and five years of personal observation on the reefs of the Indian and Pacific Oceans.

While probably many people are aware of the difference between fringing and barrier reefs and atolls, few who have never visited coral reefs have any clear picture in their minds of what a reef is really like. A study of Saville Kent's magnificent pictures of the Great Barrier Reef gives a totally wrong impression. The exposed face of a reef is a buttress of immense strength but certainly not a forest of beauty. In his introductory chapter, Prof. Stanley Gardiner gives an admirably lucid and well-balanced account of the various kinds of reefs, which should correct the previous mental impressions of many of his readers. He also disposes of the too arbitrary distinction which has been made between fringing and barrier reefs, pointing out that an island may possess a fringing reef off one coast and a barrier reef off the other, the two merging into one another, and being usually dependent on the presence of a gently sloping or a precipitous coast respectively.

While the skeletons of corals are the bricks with which reefs are built, the equally important cement which binds together these bricks and covers every exposed, dead surface is provided by the coralline algæ, the nullipores, of which *Lithothamnion* is the best known of the five important genera. On and in the reefs dwell a varied collection of animals and plants (the latter, however, strangely sparse to the eyes of a marine biologist accustomed to temperate seas) which, with the corals and the nullipores, form that characteristic marine community of tropical seas which to a biologist is a coral reef. All these living constituents of reefs, with the parts they play, constructive, passive, or destructive, in the maintenance of that mass of limestone which, to the geologist and geographer, is a coral reef, are passed in brief, yet adequate, review by Prof. Stanley Gardiner.

Of the great, probably vital, significance of the unicellular zooxanthellæ which are invariably present in reef-building corals and all other cœlenterates on reefs, there can be no question. Prof. Gardiner stresses the importance of the oxygen produced by the zooxanthellæ, and suggests also that carbohydrate may be passed from them to the coral. Here it is impossible entirely to agree with him (for reasons which the reviewer has given elsewhere), while the resemblance between the conditions in corals and in *Convoluta* is more apparent than real. The illustration, in Fig. 14, of the gametes of the zoochlorellæ from *Convoluta* suggests, moreover, that the zooxanthellæ possess similar gametes, whereas they are apparently so degenerate as to have lost the power of sexual reproduction.

There can be nothing but praise for Prof. Gardiner's handling of the problem of the origin and formation of atolls. Much of the book is occupied with this matter, and rightly so, for it is the crux of the coral reef problem. How did these limestone rings, their vegetated summits barely rising above the surface of the sea, come to be dotted over the surface of the tropical oceans, surrounded as they frequently are by water thousands of fathoms in depth? The subsidence theory of Darwin and Dana, which has been recently so strongly defended by Prof. W. M. Davis, is here rejected as the explanation of the origin of atolls, and for good reasons. If the atoll has not been formed from a barrier reef by the submergence of the central land mass, then it must have arisen from beneath the sea, and this necessitates the presence of innumerable submerged banks not more than fifty fathoms from the surface. How have these been formed? In the Indian Ocean, which is here regarded as the site of an ancient continent, and in the western area of the Pacific, such platforms may have been formed by the erosion of islands, the process being possibly completed during the last glacial epoch as postulated by Daly in his well-known glacial control theory. But the atolls of the central Pacific, many of them situated on the summit of an isolated peak, cannot have had such an origin.

The only reasonable explanation is surely that supported by Prof. Gardiner, that these atolls are built up on the summits of extinct submarine volcanoes. Falcon Island, which has three times appeared above the surface since 1883, provides positive support for this view, while Admiral Wharton long ago suggested that the ash thrown up by such a submarine eruption would quickly be cut down to the level of wind-wave and current action, about 30-50 fathoms in the open ocean. The growth of corals and nullipores around the submerged slopes of Falcon Island prior to its last eruption in 1927, indicates how quickly corals can establish themselves on a bank of this nature.

The shape of the atoll remains to be accounted for. This was easily explained by the subsidence theory, but it is more difficult when an atoll is regarded as something arising from, and not sinking into, the sea. Here Prof. Gardiner follows Murray; he considers that lagoons have been formed by solution and erosion. While it is difficult to believe that solution plays an important part—coral seas are always saturated with calcium carbonate, and Mayor failed to find any dissolution of calcite by sea-water—yet there can be no gainsaying the great destructive action of the innumerable borers, of which molluscs are the most conspicuous but plants (blue-green algæ) the most ubiquitous. Corals do not flourish within lagoons; whereas outside their powers of growth are at least as great as the powers of destruction, within the lagoons this is not so. Conclusive evidence is given of the enlargement of many lagoons and of the carrying out of suspended coral mud by the ebbing tide. It is suggested that corals in lagoons may be killed by the deposition of amorphous calcium carbonate, produced by the removal of carbon dioxide from calcium bicarbonate by the zooxanthellæ. This, however, needs experimental verification. Moreover, the trade winds possibly have a considerable influence on the moulding of atolls.

All too little is known about coral reefs; there is unanimity about nothing. "Coral Reefs and Atolls" is a concise, admirably illustrated survey of the subject, and represents a definite advance in the elucidation of the coral reef problem.

C. M. Y.

Spherical Astronomy.

Text-Book on Spherical Astronomy. By Prof. W. M. Smart. Pp. xi + 414. (Cambridge: At the University Press, 1931.) 21*s.* net.

A NEW textbook supplying a real need is always welcome. The book now under review is based on lectures given in the University of Cambridge and is essentially designed for the use of students, but will be found to be of great service to astronomers also. Modern developments in astronomy have rendered the older textbooks incomplete, so in addition to the discussion of the usual problems of spherical astronomy, the book contains much new matter, including the essential discussion of such subjects as heliocentric co-ordinates, proper motions, the orbits of binary stars, and the use of photography in precise astronomical measurements, information on which is only to be found in scattered scientific papers.

Much care has been given to methodical arrangement and to the diagrams, which are generally excellent; while, so far as possible, the simplest mathematical tools have been employed, the formulæ being carefully developed, so that no difficulty should be experienced in following the argument to its logical conclusion. Thus, the first chapter is devoted to the proofs and applications of the formulæ of spherical trigonometry, which form the mathematical foundation of the subsequent chapters.

The traditional portion is generally very well done and calls for no special comment beyond the fact that it is reasoned with great lucidity and that great care has been taken with the diagrams.

Not much space is given to practical astronomy, the meridian circle being the only instrument described, presumably because it is the fundamental instrument by which the precise positions of the heavenly bodies are determined that form the foundation on which our knowledge of proper motions, solar motion, etc., is built.

Amongst the newer features is a paragraph on heliographic co-ordinates by which the positions of sunspots and other markings on the sun's surface are defined. In view of the well-established, but imperfectly understood, connexion between sunspots and terrestrial magnetic activity, this branch of astronomy deserves attention. The subject of the proper motions of the stars is adequately treated, and the derivation of the solar motion and also statistical parallaxes of stars are explained.

Photography now plays a most important part in nearly all branches of astronomy, and in positional astronomy the astro-photographic telescope is second in importance only to the meridian circle, to which it has become a natural auxiliary.

The catalogues of the Astronomische Gesellschaft were the product of a very great expenditure of money, time, and energy; they are now being reobserved, not with meridian circles but with photographic lenses, and the work will be completed for a small fraction of the original effort, and, in addition, the positions derived from the photographs will be of much higher accuracy than those in the original catalogues. The chapter on astronomical photography is, therefore, of special interest. Here the errors affecting a stellar photograph, its measurements, and the reduction of the measures are fully and carefully explained, and it is shown how, using rectangular co-ordinates, all errors of the first order are corrected by means of six constants.

It should be observed that though terms of the second order may generally be neglected for small areas, with lenses covering large fields of 5° or more—such as are in use for the re-observation of the A.G. Catalogues—this is no longer the case.

Reverting to the meridian circle, the description of the method of determining the collimation error seems rather laboured, and simpler diagrams would have sufficed. The circle of collimation is a purely instrumental condition, and in no way connected with the azimuthal adjustment, so why introduce the azimuth into the argument ?

The paragraph on planetary aberration does not appear to be quite correct. It is easily shown that the apparent position of a planet at time t is the true position at time $t-\tau$, τ being the aberration time. The usual practice is to antedate the time of observation by the aberration time, thus correcting both planetary and annual aberrations simultaneously.

The diagram illustrating the photographic refractor in paragraph 158 is not very elegant, though this is unimportant; but in the determination of stellar parallaxes, no mention is made of the method of dependences, the very neat modification of the method of least squares invented by Schlesinger and used by all parallax observers.

These points are mentioned in constructive criticism that they may be considered in a second edition, not in detraction of a very excellent work, on which the author is heartily to be congratulated.

Short Reviews.

The Wissahickon Hills : Memories of Leisure Hours out of doors in an Old Countryside. By Prof. Cornelius Weygandt. Pp. xiv + 366 + 10 plates. (Philadelphia : University of Pennsylvania Press ; London : Oxford University Press, 1930.) 17*s*. net.

I LOOKED up the Wissahickon Hills in my large atlas and did not find them ; I discovered Pennsylvania to be an immense State, and that the Alleghany and Blue Mountains tail off in its central parts into a welter of hills and streams. I saw that the author is a professor of English literature, and I thought that this is no book for NATURE. I took the book to bed and I read " The Fox Sparrow ". I had never heard of him, but I was charmed with the " big bouncing fellows " with their " high spirits that come from good shelter and full craws, sunlight and the urge of spring ". " In Praise of Wild Cherry " attracted me next, and this was followed by " The Kentucky Warbler ". I am still a yokel at heart, and I dreamt of my own hills and my father's farm-yard. " The Famous Darking Fowl " came next day, and I have never been able to leave this book alone since.

I do not know the country, but the hills, the streams, the birds, all belong to me and I know their ways. " The Old Stock " gives me my people, unaltered and unchanged for centuries. " We have a good deal of local pride. . . . We are rather sure of ourselves. . . . We are workers and few of us are fond of parade and show. . . . We are still stout walkers. We are fond of out-of-doors. We are unafraid of sweat. . . . We own to an interest in natural science more gladly than to an interest in art ", which " we are not sure that we ought to admit ". " Our Village " might be here, while near by Gilbert White and Richard Jefferies might dwell. They loved to potter and note the little wonders by the way. So does the author, and he is not trying to teach me anything. Emphatically this is a book for NATURE, not, perhaps, to be recommended to professional biologists, but to men who agree with Frost that " The best thing that we're put here for's to see ". Emphatically a book likely to become a classic of Pennsylvania and to attain a permanent place in Anglo-Saxon literature.

J. S. G.

Recent Advances in Analytical Chemistry. Vol. 1 : *Organic Chemistry.* Editor : Dr. C. Ainsworth Mitchell. Contributors : C. L. Hinton, E. J. Parry, D. Jordan Lloyd, H. Chick, D. W. Kent-Jones, G. D. Elsdon, W. Dickson, J. G. King, R. A. Acton-Taylor, H. R. Ambler. Pp. x + 420 + 6 plates. (London : J. and A. Churchill, 1930.) 12*s*. 6*d*.

WITH the enormous output of original literature in science, it is practically impossible for the scientific worker to keep in touch with more than a very limited field of inquiry. In this book a successful attempt has been made to collect and arrange in accessible form the latest reliable information on various sections of organic chemistry applied to analysis. As indicated by the editor, the aim has been to give a brief critical summary of the literature up to a decade ago. Although this volume is called " Organic Chemistry ", a considerable amount of important information on physical chemistry is included; for example, a very thorough review is given on the applications of the polarimeter in sugar analyses, on purification by electrodialysis, on condensation of gases, etc. From that period onwards, progress has been dealt with more fully, and concise working details of new methods are given.

Each chapter is prefaced by a short synopsis and ends with a bibliography. Throughout the text exhaustive references are recorded. The work is critical, and indications are given as to the direction on which further advance is likely. Although the book is restricted to some four hundred pages, a great number of subjects of industrial importance have been reviewed. These include sugar, oils and fats, essential oils, proteins, tannins and cereals, milk products, paper, petroleum, coal and gas. Each section is written by an expert in his own field, and the whole work is thoroughly co-ordinated and ably edited. It is an easily readable book, well printed, and with a good index. It is comparatively cheap as modern prices stand. The reviewer suggests that it is a book that should be in the hands of every analytical chemist. J. REILLY.

Sea-Angling Fishes of the Cape (South Africa): a Natural History of some of the Principal Fishes caught by Sea Anglers and Professional Fishermen in Cape Waters. By C. Leo. Biden. Pp. xii + 304 + 48 plates. (London: Oxford University Press, 1930.) 18*s*. net.

CAPE COLONY extends from the Atlantic to the Indian Ocean. Whereas on the west side there are almost constant conditions owing to the southern current, the waters of the Indian Ocean lave the southern peninsula, during the summer months. This means migration of fish from the north, while many stationary fish must have well-defined seasons of abundance and scarcity of food, although perhaps feeding is a matter of the psychology of the fish themselves, induced by temperature and other physical and chemical changes in the sea. There are also regular breeding seasons and movements induced by these. The author is clear on these matters in the eighteen chapters, on a like number of fish, which he presents to the angler. Eight are strong swimming pelagic fish, and his account of their local names suggests that seven must belong to genera common to the whole southern ocean, the eighth being the North Atlantic tunny, which is a rare visitor.

We are at once attracted by the much varied heads and teeth of the bottom feeders; these are correlated with equally different habits and food. Clearly, the Cape is a locality where colour fluctuations could be conveniently studied, as affected by environment, temperature, etc. Octopi, mussels, and tunicates are important articles of food. Commercial fisheries are not discussed; but the angler is generally a man of intelligence, and he is presented with a most readable and admirably illustrated account of his fish. Scientific details may occasionally be wrong; but the author is to be congratulated on a most useful book.

Leçons sur les conduites. Par Prof. Charles Camichel. (Chaire de mécanique des fluides et applications.) Pp. vii + 101. (Paris: Gauthier-Villars et Cie, 1930.) 30 francs.

THIS monograph gives an account of both experimental and theoretical researches carried out during the last twenty years on pipelines, mainly forming portions of hydraulic installations in south and central France. These researches chiefly concern the waves of pressure propagated along the pipelines, in consequence of the elasticity of their walls and the compressibility of water, when the flow of water is changed more or less suddenly, and also the resonance phenomena associated with these waves. The first chapter treats of pipelines of uniform cross-section and wall thickness, and the second with those of variable section and thickness. The third chapter deals with the effect of reservoirs of air connected with the pipelines, especially in damping down the waves. These three theoretical chapters comprise four-fifths of the book, the remaining portion being devoted to a very brief summary of the design and construction of pipelines subject to high pressures and of the accidents to which they are liable. The book is clearly written and should prove of great interest to hydraulic engineers, as well as to mathematicians interested in the practical applications of hydrodynamics.

Systematic Inorganic Chemistry: from the Standpoint of the Periodic Law. By Prof. R. M. Caven and Dr. G. D. Lander. New edition. Pp. xviii + 510. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1930.) 9*s*. net.

CAVEN and Lander's textbook has been known to teachers and students for some years as a carefully written statement of inorganic chemistry based on the periodic system, and it could well supplement any other book in use. It is particularly suited to the needs of the more advanced student who wishes to revise and systematise his knowledge of the subject, and a new edition of the work may be welcomed. The authors have added sections on the modern atomic theory and its bearings on the subject at the end of the book. In view of the rapid changes which are taking place in this part of the subject, it is undoubtedly wise to adopt this plan, the permanent structure of the science being dealt with in the body of the work. The additional sections fit in very well with the general plan of the book. One or two newer discoveries probably came too late for inclusion; for example, the preparation of nitryl chloride, the reactions given not leading to the formation of this substance. The new edition of this excellent textbook may be recommended to teachers and students.

Siam: Nature and Industry. Pp. vii + 324 + 60 plates. (Bangkok: Ministry of Commerce and Communications, 1930.) n.p.

IT is seldom that a book of this nature, issued by a State, presumably for propaganda purposes, can be recommended as having any scientific value. This volume, however, is an exception. It avoids the usual guide-book information and self-congratulatory statements, and contains a number of serious chapters on the scientific aspects of the country. Most of these are written by competent authorities under their own names. Thus the book is a valuable compendium on the geology, fauna, flora, ethnology, agriculture, mining, and other aspects of Siam. It is particularly useful, since accurate information on many matters relating to Siam is not easy to find. Several of the chapters were issued as separate pamphlets in 1926. They are now revised and collected in this volume, with additions, which was prepared for the congress of the Far Eastern Association of Tropical Medicine, held at Bangkok in December 1930. There are several maps and illustrations.

The Architecture of the Solid State.*

By Prof. W. L. BRAGG, F.R.S.

A SOLID body is a mechanical system in equilibrium, an example of atomic engineering, with balance of stresses in the component parts. Analysis by X-ray methods, and more recently by those of electron diffraction, has given us a scale plan of its component parts. To what extent can we explain the way in which the atoms are arranged, and the properties of the body as a whole, by considering the forces which act between the atoms?

A broad generalisation divides solids into three classes—metallic, organic, and inorganic. Though it is easy to cite cases of solids which are intermediate in character, this division into classes is clearly marked, and corresponds to a very fundamental difference in the nature of the bonds which hold the atoms together. Metals are associations of electropositive atoms with each other, organic compounds are associations of electronegative atoms, and inorganic compounds associations of electropositive with electronegative atoms. The fundamental distinction between the laws which govern these associations has been implicitly recognised by assigning to each its own branch of chemistry, metallurgical, organic, and inorganic. The law of combination in inorganic compounds was first foreshadowed by Berzelius, those for organic compounds were founded by Kekulé, and confusion arose in the past from the attempt to bring both classes into a common scheme. The laws of atomic association in intermetallic compounds are again different, and are only now being understood through a study of alloy structures.

The success which has as yet been attained in explaining physical properties by atomic structure is different in these three classes. The structures of the metals are very simple, and were amongst the first to be discovered by X-ray analysis; many alloy structures have also been determined. The difficulty of correlating structures and properties is not due to any lack of knowledge about atomic arrangement, but arises partly because the theory of the metallic state is very complex and as yet incomplete, and partly because the mechanical properties of the metals, which are so important to us, depend rather on the destruction of the perfect crystal than on its behaviour as an ideal crystal. Knowledge in this field is mainly descriptive. On the other hand, those organic substances the physical properties of which as solids are most interesting are very complex forms, such as cellulose or rubber. The difficulty here of giving even a descriptive account of the dependence of properties on structure is mainly that of discovering the atomic arrangement. This is one of the obvious fields in which to concentrate all the resources of X-ray technique in future. Such successes as those which Mark has had with cellulose and Astbury with the wool fibre show its interest and possibilities, but in all cases the structures can as yet be only guessed.

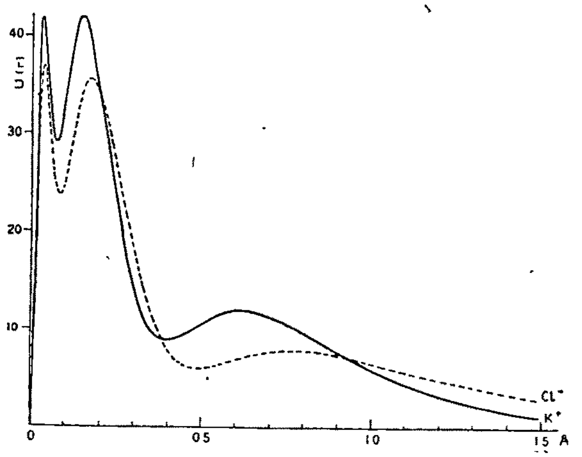

FIG. 1.—The radial distribution of electrons in the ions K and Cl⁻. The peaks in each curve of distribution represent the *K*, *L*, *M* electron groups, containing two, eight, and eight electrons respectively (Hartree).

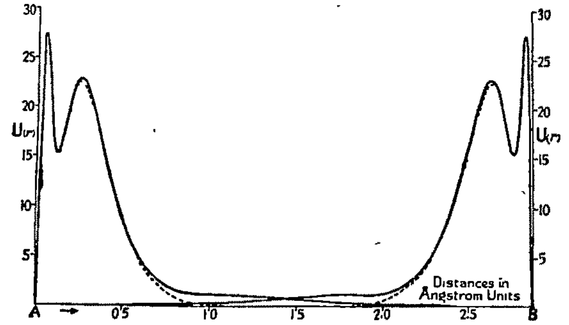

FIG. 2.—The ions Al^3 are shown by the dotted curves, at a distance apart of 2·86 A. as in the crystal of aluminium metal (James, Brindley and Wood). The distribution representing the remaining electrons is almost entirely confined to the space between the ions (metallic bond).

In comparison, the inorganic solids are not of such great technical importance, but I propose to discuss their properties because a more complete story can be told. Not only are the structures well known, but also the interatomic forces can to a large extent be treated quantitatively. The landmark in this field is, of course, Born's great work on the dynamics of the crystal lattice, and it is to the inorganic compounds that his ideas have been mainly applied.

The reason for the success in treating the inorganic crystal is that it can be regarded to a large extent as a problem in electrostatics. The typical crystal is built of component parts which are charged positively and negatively. These parts may be simple charged atoms or 'ions', or they may be charged groups of atoms. Further, the forces of repulsion which keep the ions apart and prevent their structures intermingling can be simply expressed, and their strength quantitatively estimated. So a theory of the physical properties of the solid can be built up, a few aspects of which I wish to discuss.

What is the justification for supposing that electrostatic forces bulk so largely in these compounds? It lies in the fact that when two ions approach each other, the force of repulsion which prevents further approach sets in when the structures have scarcely penetrated at all into each other.

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* Kelvin Lecture delivered before the Institution of Electrical Engineers on April 30.

The nucleus of an atom is surrounded by an atmosphere of electrons, a kind of space-charge which exactly (neutral atom) or nearly (ion) neutralises the positive charge on the nucleus. The former idea of a series of electron orbits has been replaced by a wave-mechanical distribution which cannot be visualised. It can be represented in a way which is a very good approximation for many purposes by supposing each electron to move in the field of the nucleus and the other electrons, representing it by the 'smeared out' continuous distribution which the solution of the wave equation gives, and then taking the electron atmosphere to be the sum of these distributions. These atmospheres have been worked out for many atoms, the most accurate results being those of Hartree. Instead of definite electron orbits, we get a continuous distribution with spherical symmetry which may be thought of as the density of the electron atmosphere, or probability of finding an electron in unit volume at different distances from the nucleus. A convenient way of showing the electron distribution is to plot U_r against the distance from the nucleus r, where $(U_r)dr$ is the number of electrons between r and $r+dr$. Such a curve for chlorine, which has a charge of $17e$ on its nucleus, and is surrounded by eighteen electrons, is shown in Fig. 1. The distribution has peaks which correspond to the K, L, M electron groups of atomic theory.

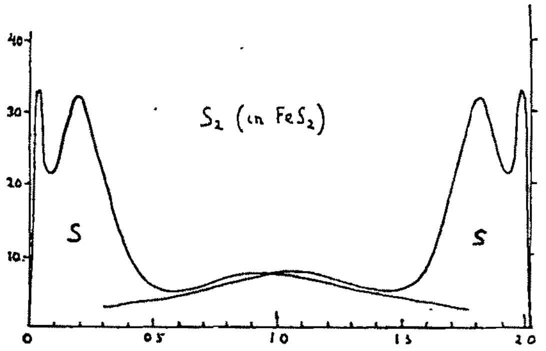

FIG. 3.—The group S_2 in FeS_2, iron pyrites. The distance between the atoms (2·05 A.) is so small that the M shells overlap (non-polar bond).

A striking feature is the rapid rate at which the electron atmosphere thins out as the distance from the nucleus increases. For example, the electron density in various parts of the chlorine ion is as follows, the figures representing the number of electrons per cubic angstrom unit $(10^{-24}$ cm.$^3)$.

K shell	3250
L shell	111
M shell	1·00
At r = 1·84 A.	0·04

The last distance of 1·8 A. is called the 'ionic radius' of chlorine. This theoretically indefensible, but extremely useful, conception of ionic radii expresses the fact that ions in crystals appear to take up a certain amount of space. For example, sodium has an ionic radius of 1 A., chlorine of 1·8 A., and the two ions are 2·8 A. apart in sodium chloride. We may take it here as representing the point where the overlapping of one ion by another takes place. We can see, therefore, that the repulsive force sets in when an extremely tenuous part of each electron atmosphere is involved, in the case of chlorine only 10^{-5} of that in the K shell.

The difference between the three types of interatomic bond is shown in a striking way if we take these atomic models, set them distances apart, such as are found in actual crystalline structures, and see to what extent the electron atmospheres overlap. Fig. 2 shows the state of affairs in an aluminium crystal. The aluminium ions Al^{3+}, shown as dotted lines, are separated by a wide gap. This interspace is occupied by the valency electrons, and metallic properties suggest that these electrons are not bound each to its own atom but are shared by all.

Fig. 3 shows the group S_2 in iron pyrites, FeS_2. The bond between the sulphur atoms is of the non-polar type, such as characterises organic compounds, and the two atoms are so close that there is a merging of their M shells. The two structures combine to form a twin structure like a larger atom with two nuclei. Contrast with these the series of polar crystals shown in Fig. 4 (taken from a paper by Brindley). The structures are of the sodium chloride type in which there is a simple alternation of positive and negative ions, and it is seen that the ions scarcely overlap at all. The diagram exaggerates the extent of overlapping, because the curve measures the distribution of electrons in complete spherical shells all round each nucleus, whereas the ions come in contact at one point only.

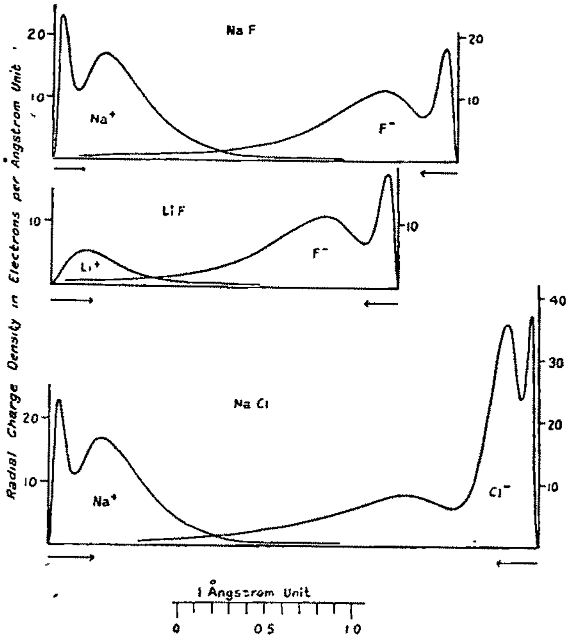

FIG. 4.—The electron distribution in compounds of the sodium chloride type (Brindley). The ionic structures overlap at points where the electron density is extremely small (polar bond).

The first success of Born's theory lay in explaining the heat of formation of these compounds. Suppose the sodium and chlorine ions to remain in regular array, but to be widely separated, and then allow the whole structure to collapse uniformly, ending in the sodium chloride crystal. The energy of the electrostatic field between the ions is reduced in the process, just as when the plates of a condenser come together. This energy can be calculated, and a correction due to the work done against the repulsive forces can be worked out. The latter is small because it only comes into play at the very end of the process. Born showed that the calculated loss of energy was in accord with the heat of formation of the crystal.

(*To be continued.*)

Determination of Position in High Latitudes, with Particular Reference to Aircraft Observation.

By C. J. STEWART, O.B.E.

THE determination of position from land or air observations in high latitudes is rendered difficult, apart from conditions of temperature, by the unreliability of the magnetic compass and gyroscopic compass. On aircraft the latter is not yet a practicable instrument. Hence, astronomical methods must be utilised. In the consideration of any method of air navigation to the poles it must first be made clear that, even with assumed perfectly accurate instruments and accurate observations with them, astronomical observations from an aeroplane can give an exact position in two cases only: (1) by the observation of two stars; (2) by choosing the time of flight so as to render possible simultaneous observations of both sun and moon. The first case implies that the flight takes place at the season of perpetual night, and need not therefore be considered. The limitations of the second case are increased by the known inaccuracy of any form of sextant used in the air. Broadly, while sextant observations on the ground may be relied upon to give position within, say, one to three miles, aerial observations can only be relied upon to give position within about ten miles, and it is usually necessary to take the mean of a number of readings to secure this result. The use of automatically stabilised aircraft may render a somewhat more accurate location possible, but the utility of such aircraft under polar conditions can scarcely be regarded as established.

In view of such limitations, reliance has to be placed upon other means of navigation. Radio direction-finding is unlikely at the present stage of development to be of use, since its accuracy at a range of, say, four hundred miles would not, under favourable conditions, give position in line to within twelve miles. Radio signalling is, however, of value for providing exact time signals. The navigator is therefore compelled to rely upon the use of the most accurate instruments for—

(1) indicating direction, and
(2) indicating ground speed in magnitude and direction.

This, of course, is virtually the oldest method of navigating, namely, dead reckoning.[1] The instrument used for indicating direction must be some form of sun compass or a gyro azimuth. Of these alternatives, where the sun is available, the sun compass is likely to be the more accurate, since an instrument measuring the sun's position, in conjunction with an accurate chronometer, would be simpler and less liable to variation than any form of gyro azimuth at present known. The feasibility of using gyroscopic devices will be referred to later, but since the sun compass formed an essential part of the equipment of both Amundsen and Byrd in their polar expeditions, a description of such an instrument is necessary.

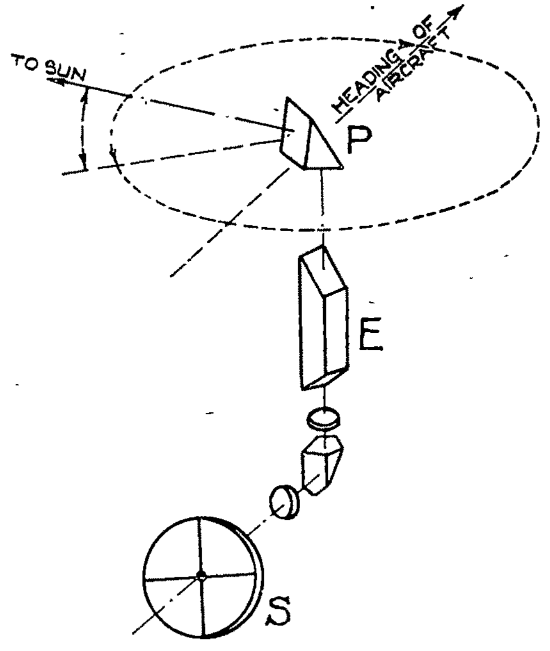

FIG. 1.—Optical arrangement of the Goerz sun compass.

Instruments for measuring ground speed and direction are quite well known[2] and, in their use under polar conditions of temperature, present no great difficulty.

Since the sun is above the horizon during the exploring season, and since it is always at a low altitude, the sun compass forms a very suitable instrument for determining directions. The Goerz sun compass was constructed specially for the Amundsen expedition in 1925 and, according to reports, gave very satisfactory results.[3]

This instrument comprises an optical arrangement which throws an image of the sun on a screen S (Fig. 1), when the aircraft is on the desired course. The reflecting prism P may be rotated about a horizontal axis and set according to the declination of the sun. It may also be rotated about a vertical axis and set according to the time of day and the desired course. When the settings have been made, a clock mechanism keeps the prism in the correct orientation. After reflection, the light passes through the erecting prism *E*, which is rotated at one-half the speed of the prism *P*. The light then passes through a lens system to the screen. A vertical line on the screen serves as a lubber line. The compass must be installed with the horizontal part of the optical axis parallel to the longitudinal axis of the aircraft.

Such an instrument will give, of course, a space direction and not an earth direction. Thus, if it is set to give some definite meridian at any given position of the aeroplane, the track of the latter will not be in the direction of the pole unless the position is chosen to lie on that meridian.

By the use, then, of the sun compass and ground speed indicator (incorporating, of course, a drift indicator) the navigator to the pole must attain his object by careful course plotting based on dead reckoning.

Since the determination of ground speed is a vital matter in such dead reckoning, considerable judgment and care is needed in the method of securing a reading. One method is to time the passage of a ground object past two wires on a sight which is so set as to incorporate the height of the aeroplane above the ground, the method itself being based on similar triangles.

This method is liable to error, of course, where the height of the ground is not known exactly. In such a case, the wind speed is determined by flying the aeroplane on different courses and plotting the track or course made good. From two such readings the wind speed and direction may be determined, and thus from a knowledge of the air speed the ground speed on any given course may be obtained.

As an illustration of the difference between ground and air technique for position-finding in high latitudes, the method used by Peary in his journey to the north pole in 1919 may be compared with the method used by Byrd in his flight to the north pole in 1926. Peary followed closely a meridian from the base camp, using dead reckoning for direction and distance, occasionally using a sight on the sun for correcting his distance. When his dead reckoning calculations indicated that he had reached the pole, a meridian sight on the sun showed him that he had covered a distance which would have taken him exactly to the pole had his direction been correct. This sight by itself, however, did not suffice to locate his position on the earth, but a sight on the sun from the same position eighteen hours later in a direction at right angles to the first observation gave his location as five miles from the pole. Byrd in his flight to the north pole in 1926 flew from a known base in a direction indicated by the sun compass and at a ground speed calculated from drift and airspeed observations. At satisfactory intervals of time, observations of the elevation of the sun were taken, which gave him position lines cutting his plotted course at varying angles, some at suitable angles for checking his latitude and distance, others at angles for checking his longitude, and thus his direction.

It will be at once apparent that such aerial observations taken with instruments which, under the best conditions of usage, are subject to error, are less exact than those taken on the ground from the same position at suitable time intervals.

Byrd and his companions in the south polar flight in November 1929 used the dead reckoning method with two sextant readings of the elevation of the sun. Byrd does not claim any considerable accuracy for these sextant observations. His method, which appears as a fine example of dead reckoning navigation, deserves comment. His navigational equipment, comprising a sun compass, drift and ground speed indicator, and airspeed indicator, were all thoroughly tested at the base before the flight to the pole, and were, of course, used with the greatest skill. Any errors due to the use of this equipment can therefore be regarded as being as small as human effort could make them.

The flight may be divided into three parts—

(*a*) From the base camp to the trail camp of the geological party close to the mountains;
(*b*) from the trail camp to the south pole and the return to the supply depot at the foot of the mountains;
(*c*) from that depot to the base camp.

The base camp and the trail camp had been located by ground observations, and these positions may be regarded as accurate to within one or two miles. The geographical position of the trail camp had been determined by Dr. Laurence M. Gould, the geologist of the expedition, who had also determined the position of the east portal of the Liv glacier, which was a short distance nearer the pole than the camp.

The parts (*a*) and (*c*) of the flight need be discussed only briefly, since the territory had been well explored, both from the air and on the ground, and the navigation of it served mainly as a check upon the accuracy of the instruments. The start was made from the base camp at 3 h. 30 m. Nov. 29, 1929, Greenwich Civil Time. At 8 h. 16 m. G.C.T. the plane reached the trail camp, 327 nautical * miles nearer the pole and 361 miles from the south pole. On leaving the trail camp the same course was maintained for 16 miles, when it was changed 30° to the right towards Liv glacier, where a check was obtained from a predetermined position—the east portal of the glacier. Here, owing to difficulty in obtaining sufficient height, the course was changed and continued for 50 miles up and over the glacier. Reaching the plateau, the course was made along the 171st meridian for the flight south to the pole. The position of the aeroplane relative to Mount Nansen and Mount Ruth Gade checked the dead reckoning position from the trail camp. At 10 h. 20 m. the plane was placed on the 171st meridian at parallel 86° 13′, and the sun compass set along that meridian to the pole 227 miles away.

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* All the distances referred to are in nautical miles.

Here, then, one may pause to consider the accuracy with which this actual position was attained in view of the difficulties experienced in reaching the position and the deviation from the course laid down. Subsequent instrumental observations appear to indicate that no considerable error was introduced by the manœuvre. Heading south, and holding the plane as closely as possible to the 171st meridian by the aid of the sun compass and the drift and speed indicator, it was estimated that the pole was reached at 13 h. 14 m. Greenwich Civil Time. In this flight it was noted that at local midnight at that meridian, when the sun was beyond the pole and in line with the meridian, the nose of the plane was pointing directly at the sun and a corresponding indication was given by the sun compass, so indicating that the sun compass was showing the direction of the 171st meridian. There was no outside check on how closely the aeroplane was holding to this meridian except the landfall made on the return journey. Two rough checks on the dead reckoning determination of the distance flown were made at 12 h. 38 m. and 13 h. 6 m., when sextant elevations of the sun were obtained. These gave positions from the pole of 56 and 2 nautical miles respectively. The corresponding dead reckoning positions were 50 and 11 nautical miles. Byrd discounts the accuracy of the sextant observations owing to the errors introduced by the motion of the aeroplane, and experienced aerial navigators will agree with his judgment. These checks, nevertheless, serve a very useful purpose since they were the only independent evidence available, and the distances are of the same order as those given by the dead reckoning calculations.

At 13 h. 14 m. it was reckoned that the pole had been reached, but deviations of the plane to the right and left of the course for a distance of three miles, and covering a further directional distance of about five miles, decreased any error in the actual location of the pole so far as the flight was concerned. The aeroplane was headed back over the pole and flown down the 168th meridian at 13 h. 25 m., which should have made the course for the Axel Heiberg glacier. At 15 h. 30 m. the glacier was sighted.

It will be seen, therefore, that, by the skilled use of the drift and ground speed indicators and the sun compass, the navigation had been sufficiently precise to locate the close vicinity of the pole, the sextant observations serving as the check on the dead reckoning determination given by the speed indicator and compass.

It will be noted that a journey of some seven hundred miles was made in a period of about ten hours. In a land exploration a normal distance in such a time would be about ten miles, during which time observations of the position can be made as necessary, although the difficulty of making these relatively exact determinations is far greater than that of obtaining data in an aircraft.

Although gyroscopic methods of position finding in high latitudes suggest themselves as theoretically feasible, it is not profitable in the present state of the art of using aerial or other gyroscopes to discuss such means for position finding. Not only would such gyroscopes have to be far more exact in functioning than any so far produced for aerial work, but also the conditions of temperature would inevitably introduce such troubles in running that prolonged and arduous research would be necessary to devise the apparatus. The dangers of relying solely upon such means in an aerial polar expedition are so numerous as to render any such scheme impracticable.

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[1] "Aircraft Instruments" C. J. Stewart. (Chapman and Hall.)

[2] "Aircraft Instruments" C. J. Stewart

[3] "Aircraft Instruments" Eaton. The Ronald Press Co., New York. Amundsens Nordpolflug 1925. *Illustrierte Flug-Woche*, July 23, 1925. "Der Sonnen-Compass" Von C. P Goerz. *Ibid.*

Obituary.

PROF. F. W. CLARKE.

FRANK WIGGLESWORTH CLARKE, born on Mar. 19, 1847, at Boston, Massachusetts, was well known among inorganic chemists, mineralogists, and geologists in Great Britain. For mineralogists and geologists his "Data of Geochemistry" was a handbook full of invaluable information, not in other ways readily accessible, especially at the time of its first publication in 1908. In addition to his work directly related to geology and mineralogy, he did important work on atomic weights and thermochemical constants. He was chairman of the International Committee on Atomic Weights in 1900; president of the American Chemical Society in 1901, of the Washington Academy of Arts and Sciences in 1911, and of the Washington Philosophical Society in 1896. He was a foreign member of the Geological Society of London; an honorary member of the Chemical Society, of the Mineralogical Society, and of the Manchester Literary and Philosophical Society; and a corresponding member of the British Association and of the Geological Society of Edinburgh. He was given the honorary degree of D.Sc. by Victoria University, Manchester, and LL.D. by the University of Aberdeen.

Clarke graduated at Harvard in 1867. His first teaching post was in the Department of Chemistry at Cornell University, Ithaca, New York, in 1869. He became professor of chemistry in Cincinnati University, Ohio, in 1874. His first paper, in 1868, was "On a New Process of Mineral Analysis". At Cornell he turned his attention to the determination of atomic volumes of solids and liquids as well as to inorganic analytical methods, and during his professorship at Cincinnati he published, in the *Smithsonian Miscellaneous Collections*, a series of articles on "The Constants of Nature", concluding, in 1883, with the recalculation of atomic weights, of which a new edition was published in 1898.

In 1883 Clarke joined the U.S. Geological Survey and became chief chemist, a post which he held until 1925. He was also professor of mineral-chemistry in the George Washington University at Washington, of which University he was made a doctor of science in 1899. It was during his service with the Geological Survey that Clarke produced the bulk of his work. In the Royal Society's catalogue for 1884–1900 there appear 39 titles under his own name alone and 17 with other authors. His work in this period included important papers on the constitution of silicates, and especially on the micas and chlorites, and in 1889 a paper, destined to be of great interest in later years, on a platiniferous nickel ore from Sudbury, Ontario. The "Data of Geochemistry" did not appear until 1908: it is now in its fifth edition.

The War period seems to have diverted Clarke's attention from minerals, and he produced a series of papers on the inorganic constituents of marine invertebrates, mostly written in collaboration with G. Steiger or W. C. Wheeler, and now summarised in one volume, of which a second edition was required in 1922. In this year he published a paper on the average composition of igneous rocks in conjunction with H. S. Washington, and this was followed by one on the composition of the earth's crust in 1924. This and the fifth edition of the "Data of Geochemistry" were his last publications. He was then seventy-seven, but still enjoying excellent health, when he paid a visit to England, renewing his acquaintance with many friends.

WE regret to announce the following deaths:

Prof. Arthur Starr Eakle, professor of mineralogy at the University of California, aged sixty-seven years.

Prof. A. Forel, formerly professor of psychiatry in the University of Zurich, pioneer of neurology and brain anatomy, and author of the "Social World of Ants", aged eighty-three years.

News and Views.

No one will deny that Great Britain, and indeed the whole world, is passing through a phase of acute economic and industrial depression. We have referred to this repeatedly in our columns and urged the importance of research in providing new outlets for trade, new methods and new materials. Research in all departments of life must at all costs go on, and we had hoped that the days were gone when the so-called unproductive research department was the first to go when economy was called for. Yet 'research' and 'education' are prominent among the recommendations submitted by the Committee on National Expenditure (Cmd. 3920. London: H.M. Stationery Office. 4s. net). Apparently research is still regarded as an expensive luxury. The report emphasises the point raised in our leading article that public opinion is not yet educated to the value of the scientific worker and of scientific method to the community. The Committee on National Expenditure consisted of Sir George Ernest May (chairman), Mr. P. Ashley Cooper, Sir Mark Webster Jenkinson, Mr. Charles Latham, Lord Plender, Mr. Arthur Pugh, and Sir Thomas Royden—the omission of any person of scientific eminence will be noted—and in its terms of reference it was charged to make recommendations for "effecting forthwith all possible reductions in the national expenditure on Supply Services". Among the recommendations are the abolition of the Empire Marketing Board, abandonment of the new programme of research in civil aircraft, reduction by 12½ per cent of expenditure on research and technical development for defence, wholesale reduction at the Ministry of Agriculture and Fisheries, including 50 per cent reduction of grants for agricultural education and limitation of grants for research, and a quarter of a million reduction in the grant to universities. We would urge the Cabinet committee which is to examine these proposals to consider very gravely the proposed restriction of research which, in the long view, can only impede the return of prosperity.

JOHN DRYDEN, the poet, was born three hundred years ago, and in the month of August, though chroniclers do not record anything more exact than that it was on or about Aug. 9, 1631. Dryden was interested enough (as were other literary men of his time, for example, Edmund Waller and William Hammond) to subscribe the foolscap obligation or resolution, dated Dec. 5, 1660, approving the formation of an organised society for the purpose of prosecuting 'Experimental Philosophy'. This was the germ of the Royal Society of London, incorporated a little later, and of which Dryden became an original fellow. He had signed the resolution, it may be mentioned, as "Driden". Born at Aldwinkle, Northamptonshire, Dryden was the eldest of fourteen children. He entered Westminster School as a King's scholar, proceeding afterwards to Trinity College, Cambridge. In Dryden's poem "Annus Mirabilis", written before his return to London at the close of the year 1666, he apostrophised the newly founded Royal Society. Clearly he regarded it as embodying an intellectual awakening of high intent. Dryden lived in Gerrard Street, Soho, and he died there on May 1, 1700, and was buried in Westminster Abbey.

ON July 28 a memorial tablet to Thomas Earnshaw, the horologist, was unveiled outside the Church of St. Giles-in-the-Fields, Bloomsbury, by the Astronomer Royal, Sir Frank Dyson. The tablet has been erected by the Clockmakers' Company and the British Horological Institute. Like his predecessors, Graham and Harrison, and his contemporaries, Mudge and Arnold, Earnshaw came from the country, having been born at Ashton-under-Lyne, Lancashire, on Feb. 4, 1749, but for many years he had a business at 119 High Holborn. To him is ascribed the merit of devising the chronometer escapement and compensation balance precisely as they are now used, while it was he and Arnold who first produced chronometers in large numbers and at moderate cost, thus rendering service of the utmost value to navigation and commerce. His improvements were recognised by the Commissioners of Longitude, and he was awarded £3000 by the Government. His death took place in Chenies Street, Bedford Square, on Mar. 1, 1829, and he was buried in St. Giles-in-the-Fields, where it was his custom to worship. He had published a pamphlet in 1806 entitled "Explanation of Timekeepers constructed by the Author and the late Mr. John Arnold", and another in 1808 stating his own claims to the invention of improvements in timekeepers.

IMPORTANT changes in the archæological service in India are foreshadowed in a dispatch from the *Times* correspondent at Simla, which appears in the issue of July 31. He states that the Government of India proposes to submit to the autumn session of the legislature a bill which will place all archæological investigation under the Government of India instead of under the provincial governments as heretofore. It will empower the Government of India to make rules governing work by private investigators and regulating the disposal of the finds. Further, provision will be made to facilitate the co-operation of non-official scientific organisations, Indian and overseas, in archæological exploration. The need for such cooperation has been felt in India for some time. This may have been accentuated by the discovery near Ambala, some two years ago, of remains of the Indus Valley civilisation. An appeal for such co-operation, made not long after the discoveries at Mohenjodaro and Harappa, produced offers of expert assistance; but the obstacle to extended investigation has been a lack of funds. In view of these later finds, it is expected with confidence that further exploration will produce evidence to show an eastward extension of this early civilisation, possibly into the Ganges basin; but systematic investigation with this objective is precluded unless assistance, financial and other, is attracted by the possibility from sources other than official.

THE Indian Research Council of the Royal Anthropological Institute is already in touch with archæological, as well as other branches of anthropological, research in India; but unfortunately it has, at the moment, no funds to enable it to carry on active research in India on the lines on which the Institute is already conducting investigations in another archæological field. It may not be out of place, however, in this connexion to mention another activity of the Royal Anthropological Institute with reference to India which should be of considerable utility at the present juncture in making the public more intimately aware of conditions in that country—conditions which, as has been pointed out time and again, have a vital bearing upon problems now under discussion, but upon which the general public is but ill-informed. The Institute's Indian Research Committee, acting under the direction of the Council, has arranged for a series of public lectures to be delivered in the coming autumn which will deal with the races and cultures of India. The session will be opened by the Marquess of Zetland on Oct. 12 with a lecture on "India, Past and Present". The lectures to follow will be: Oct. 19, Prof. F. W. Thomas—"Kings and Emperors of Ancient India"; Oct. 26, K. de B. Codrington—"Indian Sculpture"; Nov. 2, Col. T. C. Hodson—"Hillmen and Headhunters of Northern India"; Nov. 9, F. J. Richards—"Caste and Creed in Southern India"; Nov. 16, J. V. S. Wilkinson—"Mughal Court Painting". The lectures will be delivered at University College, London.

THOUGH many obituary notices have been written of the late Sir Charles Parsons, it is probable that some time will elapse before a biography worthy of him is available. In the meantime, however, it is to be hoped that some of those who knew him best will not fail to place on record their recollections, for the value of such records will increase with the passing of time. Among the fullest obituary notices we have seen is that by Sir Alfred Ewing contributed to the *Proceedings of the Royal Society*. All too brief as this is, it yet contains much of interest not to be found elsewhere. Born a year after Parsons, Sir Alfred was the first to make an independent trial of a condensing steam turbine; it was on his advice that the radial flow turbine now preserved in the Science Museum was installed at Cambridge, and later on he conducted the trials of the historic *Turbinia*. For forty years Sir Alfred Ewing enjoyed the friendship of Parsons, a friendship which "continued without a break or cloud". Another friend of Parsons was Mr. J. Golder, who from March to June contributed a series of articles on the great engineer to the *New Age*. Towards the end of his life Parsons appeared to Mr. Golder as a 'retired admiral': "Blue reefer suit. Fresh ruddy complexion. Dreamy blue eyes. He was quite unconscious of what he had done. His service, like the navies he transformed, was the service of the silent."

THE habit from which they take their name makes flying-fish so conspicuous and invites observation so much that it is curious to find there is still difference of opinion as to whether they really fly or only use their pectorals as parachutes. In the July-August number of the *Scottish Naturalist* (p. 121), Mr. W. L. Calderwood gives some notes on these fish, as observed in calm weather in the Arabian Sea. His observations were made carefully with prism glasses, and led him to the conclusion that the pace, which was very uniform, was maintained by the use of the pectorals at short intervals. Although it could not be seen, at a long distance from the ship, whether these fins were vibrating or not, it seemed to him that a flight extending sometimes even to 150 yards, and performed at only about a foot above the surface, could not have been kept up except by renewed impulses from the fins. This was exactly the impression formed by the writer of this note after repeated naked-eye study of these fish on a first voyage into the same part of the world. They were seen at times to vibrate their fins when clear of the water, as well as when touching it with the tail, as is generally admitted and very carefully described by Mr. Calderwood in the paper alluded to. The impression their flights left was that of the starting flutter and patter of the moorhen, continuing as the glide and whirr of the partridge, with the difference that in the fish the end of the first glide was generally also that of the flight.

THE Medical Research Council announces that it has appointed a Therapeutic Trials Committee, as follows, to advise and assist in arranging for properly controlled clinical tests of new products that seem likely, on experimental grounds, to have value in the treatment of disease: Prof. T. R. Elliott, physician to University College Hospital, London (*chairman*); Sir E. Farquhar Buzzard, regius professor of physic, University of Oxford; Dr. H. H. Dale, director, National Institute for Medical Research; the Right Hon. Lord Dawson of Penn, president, Royal College of Physicians, London; Prof. A. W. M. Ellis, physician to the London Hospital; Prof. F. R. Fraser, physician to St. Bartholomew's Hospital, London; Sir John Parsons, ophthalmic surgeon to University College Hospital, London; Dr. J. A. Ryle, physician to Guy's Hospital, London; Sir John W. Thomson-Walker, consultant urologist to King's College Hospital, London; Mr. Wilfred Trotter, surgeon to University College Hospital, London; Prof. D. P. D. Wilkie, surgeon to the Royal Infirmary, Edinburgh; and Dr. F. H. K. Green (*secretary*). Conditions have been the subject of discussion and agreement between the Medical Research Council and the Association of British Chemical Manufacturers, under which the Therapeutic Trials Committee will be prepared to consider applications by commercial firms for the examination of new products, submitted with the available experimental evidence of their value, and will arrange appropriate clinical trials in suitable cases. The Committee will work in close touch also with the existing Chemotherapy Committee, which is engaged for the Medical Research Council in promoting researches aimed at the discovery and production of new remedies.

THE first regular world-wide broadcasting service from the southern hemisphere has now been inaugurated by Amalgamated Wireless (Australasia), Ltd. The programmes are transmitted daily from Sydney, 2ME, and from Melbourne, 3ME, on the wave-length of 31·28 metres. Those who possess short-wave sets should listen in and help the undertaking by sending reports to Amalgamated Wireless at Australia House, Strand, London, W.C.2. The time-table (G.M.T.) of the transmissions from Sydney is as follows: 05·00 to 07·00 for American countries bordering the Pacific; 09·30 to 11·30 for islands of the Pacific and eastern Australia; 11·30 to 12·30 for Japan, China, and India; 19·00 to 21·00 for Great Britain, western Europe, and South Africa. All programmes will have included in them the laugh of the Kookaburra. The transmissions take place on Sundays at the same times. Melbourne, 3ME, transmits on the same wave-length from 10·00 to 11·30 every Wednesday and Saturday.

THE International Union of Geodesy and Geophysics, at its meeting at Prague in 1927, invited the Argentine Republic to co-operate in the International Time Service. In a recent circular letter (in English) the General Director of the Military Geographic Institute announces that the Provisional Government of the Argentine, by a decree dated Feb. 3, 1931, charged the Institute with the transmission of rhythmic time signals, by short wave, twice daily. The service commenced on June 1, 1931, transmission taking place from the powerful station of the International Transradio Company at Monte Grande. The signals are transmitted (*a*) from $11^h\ 45^m$ to $11^h\ 50^m$ G.M.T. through the transmitter *L.S.F.* in 19,600 kc./s. (15·30 m.), using 14 kilowatts, directed by a reflector towards Europe; and (*b*) from $23^h\ 45^m$ to $23^h\ 50^m$ G.M.T. through the transmitter *L.S.D.* in 8830 kc./s. (33·97 m.), using 16 kilowatts, directed towards Europe and North America by the aid of a bi-directional antenna without reflector. The time-station is at the Institute at Belgrano, $3^h\ 53^m\ 44{\cdot}964^s$ west of Greenwich, according to the Potsdam-Buenos Aires longitude determination made by the Institute in 1927–28. The Institute offers to send monthly, to anyone interested, a list in Greenwich sidereal time of the times of reception of the signals in Belgrano itself; and the co-operation of other institutions and observers is invited in the reception of these signals, of which details are given in the circular.

THE recent broadcasts of the song of the nightingale made by the B.B.C. this year, which have been such a popular item, especially abroad, have led to various rumours in the press. We have been told that many of the listeners have distinctly heard the scratch of the needle which accompanies gramophone records, and have suggested that records have been made of the singing so that listeners need never be disappointed. Another and more serious accusation is that birds have been caught, put into cages, and forced to sing into the microphone by gentle persuasion or otherwise. The extraneous noises heard, such as the striking of village clocks, distant motor horns, etc., could easily have been added to mislead the listeners. In the *Wireless World* for July 29 there is a letter from the owner of the house at which the broadcasts were made, and at which he was present, saying that they were genuine transmissions of the bird's singing, and that there was no necessity to have resort to other methods.

THE Convention of the International Commission on Illumination, of which Mr. C. C. Paterson is president, will be held in London in September next. The meeting will be made notable by the flood-lighting of several historical buildings in London in the evenings. Recently Londoners had an opportunity of witnessing experimental flood-lighting of Westminster Abbey and other notable buildings. One of the most successful examples of flood-lighting is Dover Castle, a description of which appears in the Osram G.E.C. *Bulletin* for July. The flood-lighting has proved so successful that it has been decided to make it permanent. Twelve powerful projector lamps are used, each taking a thousand watts. Situated as it is on the top of a hill, it is visible for miles around and everyone is pleased with the effect produced. Ships passing many miles out in the English Channel can see it plainly, and in clear weather it is a picturesque sight from the French coast. It is one of the best examples of flood-lighting yet carried out in Great Britain.

THREE new automatic wireless beacon stations are to be erected on the Uruguayan coast by the Marconi Company on behalf of the Hydrographic Department of the Government of Uruguay. The stations, which are expected to be placed in commission in the summer of 1932, are to be of the fixed omnidirectional type. Two of the transmitters will be installed in lighthouses —at Lobos Island and Cape Polonio; and the third in the English Bank Light Vessel. The transmitters are designed to operate on two definite wave-lengths, one of 600 metres and one between 950 and 1050 metres. In addition, the Marconi beacon in the English Bank Light Vessel will operate in conjunction with a submarine sound signalling device, so that navigators can estimate their distance as well as their direction from the light vessel. It is understood that the beacon station at Lobos Island will transmit on a wave-length of 1000 metres. The beacon station at Cape Polonio will transmit on the wave-length of 1050 metres. The allotment of a distinctive signal for the English Bank lightship has not yet been finally decided, in view of the special arrangements for the transmission of a series of dots in conjunction with the submarine signal device.

AN excellent example of the importance of research in industry is the invention of 'paragutta', a material with which the new telephone cable provided to supplement the growing traffic between the United States and Cuba, is insulated. For the past seventy-five years, the standard materials for insulating deep-sea cables have been gutta-percha and balata. Paragutta is a mixture of about fifty per cent gutta-percha, forty per cent rubber, and ten per cent hydrocarbon wax. Its mechanical qualities are fully equal to those of gutta-percha, its electrical stability in water is the same, but it has much better specific electrical properties. In the *Bell Laboratories Record* for May, a full description of the new material is given by A. R. Kemp. It is pointed out how the mixture can be extruded on to the conductor in a continuous sheath of multiple layers free from mechanical defects. The insulated conductor has then only to be drawn through cold water, when it quickly sets into a firm covering sufficiently tough and flexible to resist rough handling in factory or cable ship. The specific conductance of paragutta is only one-thirtieth of that of ordinary cable gutta-percha and its dielectric constant is twenty per cent smaller. It follows that if paragutta had been available to insulate the permalloy-loaded telegraph cable laid five years ago its speed would have been thirty per cent greater. Its revenue-earning capacity would thus have been increased thirty per cent. This is of great importance from the commercial point of view. The expense of failure in a submarine cable is unusually great. Minute defects in its insulation can do far-reaching damage. Very prolonged and elaborate tests were therefore necessary before the cable users and manufacturers were convinced that it was suitable for practical use.

MR. HUTCHINSON'S visit to Africa in 1930, in the company of General Smuts and with the generous assistance of the botanists and forest officers of the districts visited, must have been one of great interest, and especially as Mr. Hutchinson had previously visited some of the same parts in 1928, at a rather different season. The account given in the *Kew Bulletin*, No. 5, 1931, makes good reading from the botanical point of view, and also has the human touches bringing out the joy of seeing new plants and new country, and such difficulties as the drying of paper to keep pace with the press when collecting in an area so little known and with so rich a flora, the problems of motoring on African roads, and camping in lion-inhabited areas. Mr. Hutchinson's two visits should do much to make the flora of South Africa, and especially Rhodesia, better known; certainly the number of new species (five in the genus *Monotes* alone) and the new data bearing on phyto-geographical distribution, which have been collected on this comparatively short trip, point to the scope for such work. Although of very general interest, Mr. Hutchinson's account should be of especial interest to those who have been to any of the parts visited, and from this point of view, members of the British Association who toured through Matopos, Victoria Falls, Zimbabwe, etc., in 1929, will find mentioned many of the plants with which they became acquainted. The publication of further notes on the species collected and of the further volumes of the "Flora of West Tropical Africa" will be anticipated with added interest.

WE have received from the British Drug Houses, Ltd., London, N.1, leaflets describing the preparation, biological standardisation, and uses of certain of their products. Pituitary (posterior lobe) extract is tested, in accordance with the regulations made under the Therapeutic Substances Act, for its oxytocic activity, the strength being expressed in terms of the international unit. In addition, the pressor activity of each batch is determined. The extract finds its chief uses in obstetrics and in the treatment of diabetes insipidus. Radiostol is prepared by irradiation of ergosterol under controlled conditions. Its potency is expressed in terms of the Coward antirachitic unit; as soon as the tests are completed, its activity will be expressed in terms of the unit recently described by the Medical Research Council. Radiostol is a specific in the prevention and treatment of rickets and allied diseases and dental caries. Radio-Malt is a preparation containing Radiostol in combination with a highly active concentrate of vitamin A together with malt extract. It provides vitamins A, B, and D in a palatable form. The tests for vitamin potency are all carried out on rats, the growth response being the criterion for vitamins A and B, and the deposition of calcium at the ends of the long bones of rachitic animals that for vitamin D. The leaflets are illustrated with reproductions of actual tests, and with diagrams of the growth of rats on vitamin-free diets supplemented with Radio-Malt.

The Ministry of Agriculture and Fisheries has published a new *Bulletin*, entitled "Some Diseases of Rabbits". In short clear paragraphs accounts are given of the symptoms of twenty-two diseases to which domestic rabbits are liable, and suggestions are made for treatment. Published by H.M. Stationery Office at the price of *3d.*, this pamphlet should be a useful guide to the many breeders of rabbits for commercial purposes. It should be noted that the Ministry itself carries out at its veterinary laboratory post-mortem examinations and bacteriological work in connexion with rabbits. For a fee of *3s.* a carcass, it is open to rabbit-keepers whose rabbits are dying, or who have other evidence of disease in their stock, to avail themselves of this opportunity for reliable diagnoses. The make-up of the pamphlet is so far in advance of the older publications of H.M. Stationery Office that we dislike pointing to its unbusinesslike publication, but the inefficiency is glaring. In the first place, a note in italics prominently printed upon the 'contents' page states that "The Ministry does not accept responsibility for statements made in the advertisement pages of this publication"—and the only advertisement in the whole pamphlet is one of the Ministry's own publications. In the second place, the most valuable advertising spaces in the pamphlet, the back cover and the inside front cover, are vacant, while there is no indication of the subjects of the thirteen *Bulletins* which have preceded this one. Surely a list of the series cries for one of the vacant pages.

The Report of the National Research Council of the United States for the year ending June 30, 1930, which appeared in the Report of the National Academy of Sciences for the same period, has now been published as a separate pamphlet of 120 pages by the Government Printing Office, Washington. The expenditure of the Council for the year was about £190,000, which was provided mainly by the Rockefeller Foundation, the Carnegie Corporation and Fund, and the Education Board. The issue of comprehensive reports on current knowledge in particular fields has been continued, and several have had to be reprinted—and in general where this has been necessary the opportunity has been taken to revise them, so that they are thoroughly up to date. The research fellowships maintained during the year numbered: in mathematics, physics, and chemistry 63, in biological sciences 41, and in medical sciences 20. The research work of these fellows is supervised by boards which consist of some of the most renowned workers in each particular field. From the total sum expended on fellowships during the year, the average value of a fellowship appears to be £450 per annum, and they are only awarded to candidates of Ph.D standing who have shown marked ability in research.

The Report of the Librarian of Congress, Washington, D.C., for the year ending June 30, 1930, is a volume of more than 400 pages, dealing with the general administration of the Library and with the numerous additions made during the preceding twelve months. The total number of printed books and pamphlets up to June 30 was 4,103,936, of maps and views 1,161,478, and of music (volumes and pieces) 1,062,194. "The most substantial addition to our resources by donation effective during the year", says the report, "was the grant from the Guggenheim fund for the promotion of aeronautics." A part of the fund, 75,000 dollars, was for the endowment of a chair of aeronautics, to which Prof. A. F. Zahm was appointed, while another part was available for the purchase of aeronautical literature. By April 1930 the aeronautical collections comprised no fewer than 9327 volumes and pamphlets, and included the Gaston Tissandier collection, the Samuel Pierpont Langley collection, and other notable collections. "There are, of course," says Prof. Zahm, "many American institutions equipped to furnish ready information in practically the whole range of aeronautics. . . . But for comprehensive, thoroughgoing, systematic research, requiring the greatest range of reference literature, the national Library is, and naturally should be, pre-eminent." Moreover, "Any person, from any place, may examine, within its walls, any book in its possession, and may do this without introduction or credentials".

In vol. 25, part 3, of the *Transactions of the Mining and Geological Institute of India*, December 1930, there is a paper by Mr. C. H. McCale, headed "Suggestions Concerning the Utilisation and Conservation of Indian Coal". The two points especially stressed are the use of coal dust firing and low temperature carbonisation. It was, however, pointed out in the discussion that experience in other countries does not necessarily apply to India, where the conditions are very different from what they are in Europe. In the first place, the demand for power is limited, and therefore the amount of coal dust that can be consumed for the firing of boilers is also relatively small. Furthermore, distances in India are very great; and the transportation of powdered fuel over many thousands of miles is a doubtful proposition unless the fuel is of the highest possible grade, and this is scarcely likely to be the case in India. As regards low temperature carbonisation, although there is a number of companies working processes for this purpose in England, they are not yet commercial propositions, and in India there is the serious additional difficulty of the inability to dispose of the by-products, which are expected to contribute very largely to the commercial success of the undertaking in other countries.

A new aspect of Russian interest in her considerable Arctic territories is expressed in the publication of the periodical entitled *Bulletin of the Arctic Institute of the U.S.S.R.*, of which No. 5 has just appeared. The scope of this bulletin covers all polar regions, north and south, besides giving a more particular account of Russian activities. It also gives a useful bibliography from time to time. The greater part of the *Bulletin* is printed in Russian, but some of the matter is in English. During the present summer, various projects are on foot in Russian Arctic regions, including visits to the meteorological stations in Franz Josef Land and the Kamenev Islands, oceanographical work in the Barents and Kara seas, and geological work in the Chukchee peninsula of north-eastern Siberia.

DR. A. F. JOSEPH has resigned from the deputy directorship of the Imperial Bureau of Soil Science, a post which he has held since the inception of the Bureau in May 1929. He brought to his task a full knowledge of soil problems in different parts of the Empire and a ripe experience in dealing with them; further, his personality helped greatly in smoothing over many of the difficulties of establishment and organisation. The purpose of the Bureau is to supply information to agricultural departments and soil investigators in different parts of the Empire, and the work is complicated by the widely varying problems which have to be attacked. Dr. Joseph has been eminently successful not only in sending out information of the kind that was wanted, but also in putting different workers in touch with one another and so economising time and effort.

THE Proceedings of the first Imperial Horticultural Conference have already been referred in NATURE (Sept. 6, 1930, p. 384). In a foreword to the published account of these proceedings now being issued by the Imperial Bureau of Fruit Production, East Malling, Kent, Sir Robert Greig, chairman of the Executive Council of the Imperial Agricultural Bureaux, remarks that many of the papers presented at this conference proved to be of exceptional technical interest. For this reason it has been decided to print the papers fully; they are being issued in three sections: (1) (issued December 1930) papers on the economic and administrative side of horticulture; (2) (issued February 1931) papers on the application of science to horticulture, (3) papers on the storage of fruit. Part 1 is issued at 1*s*., Part 2 at 2*s*. In Part 2 the papers are grouped under three headings: (1) field experiments, (2) the application of pure science to horticulture, (3) soil and climate as affecting horticulture.

THE Report of the Haffkine Institute for the year 1929 has recently been issued by the acting director, Major L. A. P. Anderson. Plague work necessarily occupies a considerable part of the Institute's activities and of the Report. The demand for Haffkine's plague prophylactic vaccine has been well up to the average, some million and a half doses having been dispatched, and several problems relating to this vaccine have been investigated. A study of the immunising and curative power of various anti-plague serums suggests that a serum prepared in the sheep or ox has greater potency than one prepared in the horse. Inquiries have been made on maternal morbidity and mortality and on stillbirths in Bombay, and on tuberculosis by Dr. Soparkar in this Presidency. In this part of India it would seem that the bovine type of tubercle bacillus plays a negligible part in the causation of this form of tuberculosis. In the Anti-Rabic Department, 685 cases were treated with only 5 deaths, a mortality of 0·73 per cent.

THE Medical Research Council announces that it has awarded Dorothy Temple Cross Fellowships for 1931–32, under the terms of the benefaction in that name for research fellowships in tuberculosis, to Dr. C. A. Birch, senior medical registrar and tutor in the Royal Infirmary, Liverpool, and to Dr. R. L. Vollum, demonstrator in pathology in the University of Oxford. Dr. Birch will study problems of tuberculosis at industrial centres in the United States; and Dr. Vollum will investigate recent developments in methods for the investigation of tuberculosis, in Germany and Austria. The fellowship awarded last year to Lieut. S. M. Burrows, formerly clinical assistant in the Tuberculosis Department, St. Thomas's Hospital, has been renewed for a further year.

THE Ministry of Agriculture and Fisheries announces that the fee charged for the blood test of bacillary white diarrhœa in poultry has been reduced from 3*d*. to 2*d*. This disease is of considerable importance to poultry keepers, and the blood agglutination test is the most practicable means of identifying the carrier hens which transmit the disease through their eggs to the chicks.

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just circulated a 'clearance list' of about a thousand second-hand books dealing with zoology, mathematics, chemistry, geology, etc. Most of the prices asked are very low.

IN view of the approaching centenary celebration of Clerk Maxwell, the Cambridge University Press announces a book of essays written to commemorate the event by Sir J. J. Thomson, Dr. A. Einstein, Dr. Max Planck, Sir Joseph Larmor, Sir James Jeans, Sir Ambrose Fleming, Dr. W. Garnett, Sir Richard Glazebrook, and Sir Oliver Lodge. The same publishers will also issue shortly a new work by Mr. T. Whittaker entitled "Prolegomena to a New Metaphysic".

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant pathologist at Ancoats Hospital, Manchester—The Gen. Supt. and Secretary, Ancoats Hospital, Manchester (Aug. 12). A graduate assistant in electrical engineering at the Dartford Technical College—The Principal, Technical College, Dartford (Aug. 14). A "Wander" scholar for diseases of children at Westminster Hospital—The Secretary, Westminster Hospital, S.W.1 (Aug. 14). An assistant resident medical officer and resident clinical pathologist at the Manchester Royal Infirmary—The Chairman of the Medical Board, Royal Infirmary, Manchester (Aug. 19). A full-time teacher for mining courses under the Education Department of the County Council of the West Riding of Yorkshire—The Education Officer, County Hall, Wakefield (Sept. 1). A demonstrator in agricultural botany and a demonstrator in agricultural bacteriology in the University of Leeds—The Registrar, University, Leeds (Sept. 1). A full-time assistant master to teach practical metal and woodwork, and engineering subjects at the Victoria Institute Science and Technical School, Worcester—The Secretary for Education, Tudor House, Worcester. A civil engineering assistant for general drawing office and field work at H.M. Dockyard, Portsmouth—The Civil Engineer-in-Chief, Admiralty, S.W.1.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Acromegaly among the old Northmen.

I HAVE read with great interest the description of the Gardarene skull given by Sir Arthur Keith in his "New Discoveries relating to the Antiquity of Man". No pathologist will, I think, doubt that the skull is acromegalic, and this raises the interesting question: Was there anything in the terribly hard life of the Icelandic and Greenland colonists that led to pituitary disorder and so to acromegaly?

There has recently been published a good English translation by Mr. E. R. Eddison of the Egil Saga, and this I think suggests that Egil himself suffered from pituitary disease culminating in definite acromegaly. First as to Egil's personality and appearance. Egil Skallagrimson, the hero of the Saga, lived about a thousand years ago; his activities were not limited to the northlands—Norway and Iceland—for he fought in the battle of Winaheath under Athelstane against Olaf, the half Danish king of Scotland. It is after the victory, as he sat in Athelstane's hall, that the following account of his appearance is given:

"He sat upright, but his head was much bent. Egil was great of face, broad of forehead, with great eye-brows; the nose not long, but marvellous thick; that place wide and long where the moustachios grow: the chin wonderfully broad, and so all about the jaw: thick-necked and great-shouldered beyond the measure of other men: hard-looking and grim-like whensoever he was wroth. He was of goodly growth and taller than any man else: his hair wolf-grey and close of growth, and become early bald" (p. 111).

Here, even in Egil's prime, there is the suggestion of some overgrowth of parts of the face, and the bent neck may be significant. In his old age, that is, between seventy and eighty, he became dull of hearing and blind. There is an episode in which, being sightless, he lies about in front of the fire in the way of the kitchen wenches; later he is warned not to put his feet too near the fire. He was, however, still sufficiently vigorous to kill with his own hands two thralls who had helped him conceal the treasure that Athelstane had given him. After his death, there was an expectation or legend that his bones were particularly long and strong, for later—that is after his bones had been moved—in the church-yard "were found men's bones. They were much greater than other men's bones: men think they know from sayings of old men that they would have been the bones of Egil. There was then Skapti Thorarinson the mass-priest, a wise man. He took up the skull of Egil and set it in the church-yard. The skull was wonderfully great; yet that seemed more beyond all likelihood, how heavy it was. The skull was all wavy-marked on the outside, like a harp-shell. Then would Skapti find out about the thickness of the skull. Took he then a hand-axe, great enough, and swung it with one hand at his hardest and smote with the hammer on the skull and would break it; but there where the blow came it whitened, but dented not nor split. And one may mark from such things, that that skull would be nought easy-scathed before the hewings of small men, while skin and flesh followed it" (p. 222).

Here then we have the skeleton of Egil with especially thick, strong bones and heavy skull with irregular growth of bone on the surface. Two conditions immediately come to mind—acromegaly and osteitis deformans (Paget's disease). Taken alone, the description of the skull might well suggest the latter, but we may be sure that some mention would have been made of the crippling deformity of this disease had Egil suffered from it; moreover, he could scarcely have overcome his two thralls. There remains acromegaly, and here the blindness, and thickness of the skull, seem almost conclusive; indeed, as already indicated, it seems likely that even in his prime Egil had been to a slight degree acromegalic.

At this stage of my hypothesis, I went to the Royal College of Surgeons and, in Sir Arthur Keith's absence, was shown a number of acromegalic skulls by Dr. Beadles. It then appeared that acromegalic skulls could be either thick or thin, and might even be thick in some parts and not especially thick in others. No. 36.1 of the general pathological series is an acromegalic skull with a capacity of 1650 c.c., suggesting some degree of giantism; it is not specially thick, but there is little diploe and the bone is hard. In skull 3861.1 of the special pathological series, that of a modern Roman with no history and with a normal capacity (1500 c.c.), the skull is 2 cm. thick in places; and in another skull, that of a woman (3862.1), the frontal is much thickened. Allowing for a little exaggeration, the Roman skull might, I think, well give something approaching the result obtained on Egil's skull with the hand-axe.

Now, Sir Arthur Keith quotes Prof. Hansen to the effect that several skulls from the same cemetery presented traits resembling those found in the Gardarene skull, "of a similar kind but in a lesser degree" (p. 488). There is, then, evidence of a considerable amount of pituitary disorder among a group of men living a particularly hard life, exposed on their voyages to extremes of cold, to hunger, thirst, and malnutrition, enduring hardships such as only the fittest can have survived, and I would reiterate the question with which I began this letter, but in a more definite form: Was acromegaly—a somewhat rare disease among ourselves—relatively common among the Icelandic colonists and their descendants? If so (and here I would particularly invoke the help of our Scandinavian colleagues), do the circumstances of its occurrence among these adventurous Northlanders offer any hint as to the underlying causes producing alterations in the pituitary gland? C. G. SELIGMAN.

Court Leys, Toot Baldon,
Oxford, July 16.

New Isotopes of Strontium and Barium.

APPLICATION of high resolution to accelerated anode rays has now provided improved mass-spectra of these two elements. Strontium shows a third isotope 87 in addition to those already observed. Results with barium were only obtained with great difficulty. In addition to the main line 138, they indicate the presence of no less than three of the lighter isotopes expected from the chemical atomic weight 137·36. The positions and intensities of these new lines explain the failure to observe them with the older apparatus, for with inadequate resolution their general effect would be indistinguishable from the ordinary penumbra of the strong line 138. Quantitative estimates of relative abundance will be published later. The following are the mass numbers in order of intensity:

Sr	88	86	87	
Ba	138	137	136	135

It will be noticed that Sr^{87} and Ba^{136} form isobaric pairs with rubidium and xenon respectively.

F. W. ASTON.

Cavendish Laboratory, Cambridge, July 21.

Age of Certain Gravels in the New Forest Area.

ALTHOUGH the researches of Dr. Longstaff, Mr. H. Bury, Mr. R. A. Smith, and others have thrown much light on Quaternary problems in the New Forest area, a good deal still remains obscure. For sometime past a former pupil of mine, Mr. J. Preston, has been examining the gravel exposures which lie to the east of the Hampshire Avon, and recently we studied together these sites and the various stone tools which have been found. Especially interesting is a pit near Hordle. It lies about 100 ft. above sea-level and opens on the side of a small valley, debouching on the Solent a short distance away. The section in the pit is as follows:

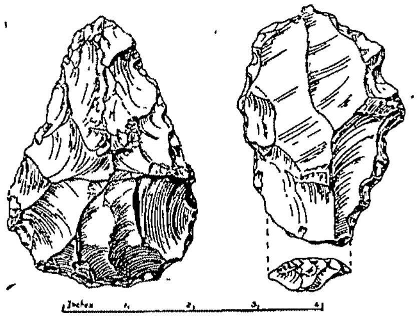

FIG. 1.

(*a*) Surface soil and sub-soil.

(*b*) Thick deposit of coarse gravel, certainly never laid down by river action, and recalling in many ways the main plateau gravel spread which is found all over the New Forest area. This has yielded what appear to be rolled late Chellean and lower Acheulean tools at Stoney Cross and at a site near Picket Post. At the Hordle pit an unrolled *coup de poing* of latish Acheulean type and a but slightly rolled Levallois II flake have been found (Fig. 1).

(*c*) Sand, similar in every way to that found to-day on the beach at Barton.

(*d*) Evenly-bedded gravel, certainly laid down by river action. A slightly rolled example of a late Chellean *coup de poing* has been found, as well as a more rolled specimen of earlier date (Fig. 2).

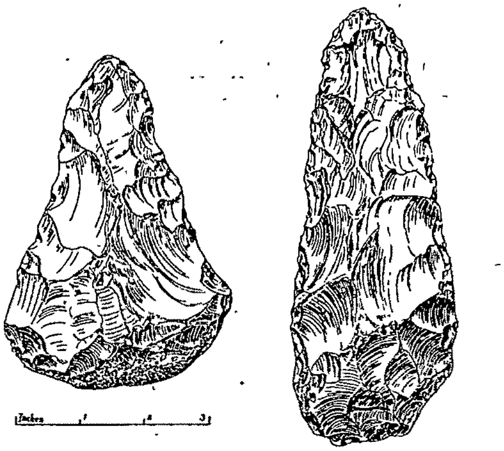

FIG. 2.

Deposit (*c*), taken in conjunction with the general height of the pit above sea-level, suggests that we are dealing with the effects of the same earth movement which formed the 100 ft. raised beach at Brighton, lately discussed before the Geological Society of London by the Rev. J. Fowler. Is it too rash to suggest that the following may have been the sequence of events in this part of Hampshire?

I. Chellean tools were incorporated in fluviatile gravels along the margins of rivers close to the coast-line. The date, judging by the slightly rolled specimen cited in (*d*), must have been towards the end of Chellean times.

II. Submergence of the land to a depth of at least 100 ft.

III. Incorporation of middle Acheulean *coups de poing* and Levallois II flakes in a gravel spread which crept over the whole area, reaching down from what to-day is a height of some 350 ft. at Stoney Cross to nearly sea-level at the Solent. This gravel is to all appearance an outwash gravel, being probably due to glacial conditions beginning to occur to the north of the district. Its age would seem, judging from the archæological data available, to have been late Acheulean. At no very different date, uplift took place and the formation of the existing valleys by the denuding action of the rivers Avon, Stour, and Blackwater. That these valleys, though probably shallower, existed previously is shown by the fact that the gravel spread, mentioned in III, sags a little way down the sides of the modern valleys—clearly, at anyrate in the case of the Avon above Fordingbridge, forming a sort of pseudo-terrace, though always at a high level. At the beginning of the uplift the sea may have helped in the excavation of these deep valleys, and it should always be remembered that the underlying ground is composed of soft Barton Sands.

IV. Formation of low-terrace gravels along the bottoms of the modern valleys. In these a local archæologist (Mr. J. B. Calkin) has found one or two Mousterian tools; mammoth bones have also been found. The age of these gravels is probably Würm. The archæological evidence, therefore, suggests that the uplift just postulated, with the probably simultaneous valley cutting, cannot have occupied any great length of time.

It is obvious that much further work is needed in this interesting area. We can only hope that Preston and other investigators in the district will continue to find further important and interesting material.

M. C. BURKITT.

Merton House, Grantchester,
Cambridge.

Condition of Sparingly Soluble Substances in Gelatine.

IN a recent letter to NATURE,[1] Mr. Nabar and Dr. Desai write: "It is considered that the results obtained from a study of the precipitation of sparingly soluble substances, such as silver chloride, which do not form Liesegang rings in gelatine, should not be applied to explain the condition of sparingly soluble substances, such as silver chromate, which do form Liesegang rings in gelatine. There is a difference in the function of the gelatine in the two cases."

The writers appear to have overlooked some experiments of Bolam and Mackenzie,[2] in which Liesegang rings of silver chloride in gelatin were actually obtained. Moreover, while the observations of Nabar and Desai on the behaviour of the silver electrode in gelatin-silver chromate systems appear to be in agreement with those of Bolam and Mackenzie,[3] their statement with regard to gelatin-silver chloride systems, that "whatever fall in the contact potential is to take place occurs as soon as silver nitrate in gelatine and potassium chloride in gelatine are mixed", is not in accord with the results of Langdon.[4]

The conclusion that the gelatin functions differently in the two cases does not appear to be justified.

T. R. Bolam.

Chemistry Department, The University,
King's Buildings, Edinburgh,
May 5.

[1] Nature, April 25, 1931, **127**, 628.
[2] *Trans. Far. Soc.*, **22**, 159 ; 1926.
[3] *Trans. Far. Soc.*, **22**, 166, 167 ; 1926.
[4] *Trans. Far. Soc.*, **19**, 285 ; 1923.

With reference to the letter by Mr. G. M. Nabar and Dr. B. N. Desai in Nature of April 25, p. 628, I should like to direct attention to the theory of banded precipitates that I published in various journals as the result of a series of experiments from 1916 to 1922, and summarised in a paper on " Adsorptive Stratification in Gels, V ".[1] In these papers the rôle of the ionic product and the metastable limit is fully discussed.

The authors also appear to be under the impression that silver chloride does not form Liesegang rings in gelatin ; but this is not quite correct. The phenomenon is the same whatever the medium in which the precipitate is formed ; and as I have stated, " No serious attempt to obtain a sufficiently insoluble precipitate in the stratified form has failed. . . . There appears to be no evidence to show that stratification will not occur, provided a precipitate can be obtained in a suitable state of subdivision from solutions of sufficient dilution." Actually the formation of bands of silver chloride in dilute solution in gelatin is recorded by W. M. Fischer,[2] bands of this substance in water in capillary tubes were obtained by Brodersen,[3] and I obtained good bands in U-tubes in agar agar.[4] The formation of banded precipitates of silver chloride, as with any other insoluble substance, for example, silver chromate in agar agar, depends primarily on adjusting the supersaturation produced so that a suitably finely divided precipitate will be obtained.

S. C. Bradford.

Science Museum, South Kensington,
London, S.W.7.

[1] *J. Soc. Chem. Ind.*, **7**, 78 ; 1929.
[2] *Z. Anorg. u. Allg. Chem.*, **145**, 311 ; 1925.
[3] *Kolloid Z.*, **35**, 21 ; 1924.
[4] *Biochem. J.*, **10**, 170 ; 1916.

By the courtesy of the Editor of Nature, I am able to give the following reply to the comments of Drs. Bolam and Bradford on our letter on " Condition of Silver Chromate in Gelatine Hydrolysed and Electro-Dialysed to Different Extents ", published in Nature of April 25, 1931, p. 628.

Drs. Bolam and Mackenzie[1] have not given any experiments in which silver chloride rings in gelatine were obtained in the absence of silver chromate. In our experiments, the contact potential of the silver electrode reached its final value as soon as the solutions of silver nitrate in gelatine and potassium chloride in gelatine were mixed, a result which does not agree with the observations of Langdon.[2] Using the same sample of gelatine, it was, however, found that with silver chromate the fall in the contact potential of the silver electrode was gradual. The contact potential measurements show that, in our experiments, silver chloride in gelatine was not in ionic condition, but that silver chromate was. We hold that, in the first case, gelatine acts as a protective colloid, and in the second case, as an inhibiting agent ; and that it is the inhibitive power of gelatine which is responsible for the formation of Liesegang rings.

We agree with Dr. Bradford that serious attempts to obtain a sufficiently insoluble precipitate in the stratified form will prove successful. We also believe that just as bands of silver chloride in gelatine can be obtained by taking the former substance in sufficient dilution, the bands of the same substance in gelatine can be obtained even in slightly stronger solutions, provided the *p*H of gelatine is decreased sufficiently. We have found experimentally that the inhibitive power of gelatine towards silver chromate can be altered considerably even by slight changes in its *p*H value. We are at present studying the effect of changing *p*H of gelatine on its efficiency in giving banded precipitates (rings) of different sparingly soluble substances.

All the points raised in the communications of Drs. Bolam and Bradford are dealt with in detail in a paper which will be sent shortly for publication.

B. N. Desai.

Physical Chemistry Laboratory,
Wilson College, Bombay, 7, July 3.

[1] *Trans. Far. Soc.*, **22**, 159 ; 1926.
[2] *Trans. Far. Soc.*, **19**, 285 ; 1923.

Oxidation Reduction Potential of Complex Iron Compounds in Yeast.

When an alkaline extract of yeast is saturated with ammonium sulphate there is precipitated, with the protein, cytochrome ' C ' and a complex iron compound giving no visible spectrum. The latter can be separated from the proteins slowly by ultra-filtration. It remains in solution when the protein, with the cytochrome ' C ', is precipitated by trichloracetic acid.

This iron compound is of interest because its oxidation potential (E_0, referred to the normal hydrogen electrode, = +0·02 at *p*H 7·1) lies very close to that at which the spectrum of cytochrome ' C ' appears and disappears—a potential near which a variety of aerobic organisms appear to function. In quite low concentration it prevents the hydrogen electrode from giving correct values in buffered solutions—a property which makes it seem likely that it can act as a catalyst.

That the iron is complexly bound and not in the form of simple ferrous or ferric ions is shown by the fact that even in a large excess of such a buffer as a concentrated borate–tartrate mixture, the oxidation reduction potential of this compound lies about 0·25 volt above that of ferric chloride added to the buffer. The iron of the compound does not react with sulphocyanide when oxidised, but does react slowly with *aà* dipyrridyl when reduced.

An attempt to isolate the compound is now in progress. Because its oxidation potential is close to that of cytochrome ' C ', and because it is apt to accompany the latter in attempts to obtain the pure pigment, there is some danger of confusing the effects and properties of the two substances.

Thomas B. Coolidge.

Converse Chemical Laboratory,
Cambridge, Mass., U.S.A., July 7.

Measurement of Ultra-Violet Radiation.

We are interested in the photographic method of recording the ultra-violet light of the sky, which has been described by Dr. J. R. Ashworth.[1]

With reference to the criticisms of Dr. Cunliffe[2] the objection to the step-wedge does not appear to be important ; it is probable that the logarithmic ' law ' is approximately correct and in any case the wedge can be calibrated. It is, of course, well known that the photographic effect of an exposure is not a simple function of the time integral of the intensity and that an intermittent exposure does not give the same effect as a continuous exposure for the same total time. It is pertinent, however, to point out that the physiological response to radiation is somewhat analogous and that a photographic measurement may, therefore, be particularly valuable.

A further point for consideration appears to be the quality of the radiation recorded. It is generally agreed that little benefit is derived by man from ultra-violet radiation of wave-length greater than about 3200 A. and we note that Dr. Ashworth's filter transmits radiation between 3400 and 3700 A. Possibly the thin silver film transmitting radiation of wave-length 3130 A., described two years ago by Mr. Lamplough in a paper to the Royal Society of Arts, could advantageously be substituted.

The methylene blue method developed by Messrs. Webster, Hill and Eidinow shares with Dr. Ashworth's method the disadvantage of response to the longer wave-lengths; in addition, the sensitivity appears to be affected by temperature changes.

A. F. DUFTON.
H. E. BECKETT.

Building Research Station,
Garston, Herts, July 6.

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[1] NATURE, June 13, p. 893.
[2] NATURE, July 4, p. 35.

The Forbidden Lines in the High Frequency Discharge of Mercury, Cadmium, and Zinc.

IN addition to the observed results of the intensity modification of spectra in the high frequency discharge in mercury, we have found the forbidden lines $1S - 2p_1$ of mercury and $1S - 2p_1$ and $1S - 2p_3$ of cadmium with moderate intensities. The quartz tube was 15 cm. long and 2 cm. in diameter, and the pressure of vapours was kept at about 0·001 mm. mercury. The spectra were excited with external electrodes by a 10-metre oscillator, and observed in it, end on. Heating the tube caused the discharge to become brighter, and a remarkable intensity modification was observed in mercury, as is seen from the reproduction of the microphotometric records of the spectra at 70° C. and at room temperature (Fig. 1). It can be seen that the effects of a slight rise of temperature are: (1) the vapour emits only the series lines, while spark lines appear at room temperature; (2) the intensities of the series lines decrease quite regularly with the increase of the number of the members; (3) the forbidden line $1S - 2p_1$ enhances more than the neighbouring triplet lines $2p_2 - 12d$ and $2p_2 - 13d$.

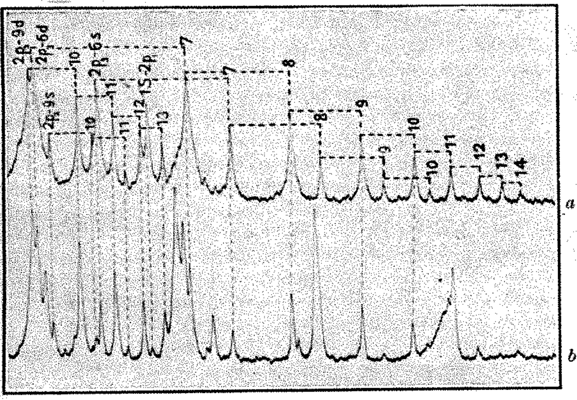

FIG. 1.—Photometric curves of the spectra of mercury, (a) at 70° C., (b) at room temperature.

In cadmium, in consequence of the strong concentration of atoms excited in D-levels, it was possible to observe 12 members in the singlet diffuse series and 8 members in the p-D intercombination lines. Intercombination lines which begin on the triplet levels are less affected, and the pp'-combinations which are emitted strongly in the arc are lacking in this discharge. In zinc, the singlet sharp series are strengthened and it was possible to observe 10 members, and the triplet series was slightly affected. It is to be regretted that we could not find the forbidden line in this vapour.

According to W. Hanle's work on the excitation function (*Anregungsfunktion*) of the spectral lines of helium, neon, and mercury, the maximum of the excitation function of the triplet levels is sharp in form and lies at about 10 volts, while that of the singlet levels is flat and at about 30 or more volts higher than the former. If it is assumed that electrons which have velocities of about 20 volts predominated in our exciting condition more than that of lower volts, the strengthening and weakening of the lines will be explained with reference to the observation of W. Hanle. As the pressure of vapours is very low, the interatomic field due to ionised or excited atoms will certainly be very weak, and this will also be a favourable condition for the emission of the forbidden lines. In the case of mercury, a slight rise of temperature favours the condition, probably in consequence of the increase of the frequencies of the collisions between atoms and electrons, the number of slower electrons becoming greater.

A full account of these experimental results will shortly be published elsewhere.

J. OKUBO.
E. MATUYAMA.

Physical Laboratory,
University, Sendai, June 10.

Part-Absorption in X-Rays.

IN connexion with the experiments of one of us (B. R.) on the part-absorption in X-rays,[1] the results of other workers on the same subject are conflicting. While Cork,[2] Lindsay,[3] and Van der Tuuk[4] report negative results, Bhargava and Mukherjee[5] confirm our results so far as the part-absorption lines are concerned. It seems to us that the conflicting results obtained by different authors are simply due to the thickness of the absorption screens used by them in their experiments.

In the first experiment, described in NATURE of May 17, 1930, the copper $K\alpha$-radiation was allowed to pass through carbon powder lightly pressed in a slit of about half a millimetre thickness. The modified line appeared to be very feeble. Later on, the carbon powder was replaced by goldbeater's skin, which contains nitrogen and oxygen in addition to carbon. By trial, it was found that five pieces of goldbeater's skin when pressed on the slit of the spectrograph produce modified lines beautifully on the photographic plates.[6] We have further found that the increase in thickness of the absorption screen does not necessarily increase the intensity of the modified lines; or rather, on the contrary, if the absorption screen is too thick, the modified lines disappear completely.

Further investigation on the variation of intensity with the different thickness of the absorption screen is still in progress. It appears that the negative results of Cork, Lindsay, and Van der Tuuk may be due to the large thickness of the absorption screens used by them. In this connexion it may be mentioned that Bhargava and Mukherjee obtained the modified line of carbon by passing the copper $K\alpha$-radiation through only four pieces of ordinary black paper used for wrapping the photographic plate. Later on they obtained a line of type $\mathrm{Ag}K\alpha - \mathrm{Ni}K_{\mathrm{abs.}}$ (Prof. M. N. Saha, in a private communication, has written to us that Messrs. Bhargava and Mukherjee have also found a line of the type $\mathrm{Ag}K\alpha - \mathrm{Cu}K_{\mathrm{abs.}}$)

Cork (l.c.) reports a line $\mathrm{Cu}K\alpha - \mathrm{Be}K\alpha$ by passing copper $K\alpha$-radiation through Lindeman glass, which contains beryllium (0·9 per cent) among other constituents. As we have found in our experiments in carbon screen, Cork also finds that the intensity of this line does not increase by placing a beryllium screen in the path of the incident radiation. Further, non-appearance of any line modified by boron (which is another constituent of the Lindeman glass) might be due to the higher percentage of boron in the glass.

Lindsay (l.c.) has suggested that sometimes false bands appear on the photographic plate, due to the imperfection of the crystals. In our experiments the modified lines were obtained with both fixed and rotating crystals on a large number of plates. Generally, the crystal was rotated by hand about 2° on each side of the expected line. The rate of rotation of the crystal was 0·1° in every five minutes. In some plates this rate was varied. The modified line appeared as usual in every case, and thus the question of rotation of the plate does not affect our results so far as the modified lines are concerned.

The intensity estimate[7] is wrong, owing to an unfortunate mistake in comparing the blackness with a wrong plate. We have re-estimated the intensity of the modified lines and it appears to be of the order of 1 in 1000 (or even less) in comparison with the parent line. Agfa-Röntgen film is found to be more suitable for this type of investigation than ordinary plates.

B. B. RAY.
B. B. DATTA.

University College of Science,
92 Upper Circular Road, Calcutta,
May 1.

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[1] NATURE, May 17, June 7, Sept. 13, 1930.
[2] *Comptes rendus*, Jan. 1931.
[3] NATURE, Feb. 28, 1931.
[4] *Naturwissen.*, April 3, 1931.
[5] NATURE, Feb. 21, Feb. 28, 1931.
[6] NATURE, June 7, 1930; *Zeit. f. Phys.*, Bd. 66.
[7] *Zeit. f. Phys.*, Bd. 66.

Fine Structure of Raman Lines in Liquids.

I HAVE investigated the Raman spectra of several liquids with a spectrograph of high dispersion specially built for this purpose. The spectrograph was placed in a thermostat in order to allow very long exposures without losing anything in definition, owing to variation in the refractive index of the glass prisms.

With this apparatus I have observed, for the first time, so far as I know, the isotope effect in Raman spectra. I have succeeded in measuring the isotope effect in carbon tetrachloride and in stannic chloride, among other substances. The observation confirms the analysis of the infra-red absorption spectra of this substance proposed by Cl. Schaefer.[1] The work will appear in detail in the *Zeitschrift für Physik*.

I have also obtained beautiful Raman spectra of a number of different liquids. The plates show that the Raman lines have a characteristic structure, resembling unresolved vibration-rotation bands. This confirms the suggestion recently proposed by A. Kastler[2] that the rotations of the molecules in liquids are quantised.

Concentrated ammonia liquor gives a strong Raman band which is due to the NH_3-molecule. This band shows a distinct rotation structure. It is composed of a strong, unresolved Q-branch, surrounded on both sides by a succession of lines, of which the strongest have a spacing corresponding to the formula

$$\nu = 3317{\cdot}4 \pm 19{\cdot}87 \times J.$$

Further, there is a number of weaker lines with an average spacing of 9·7 cm.$^{-1}$. The rotation structure of the band consists obviously of a strong Q-branch and two positive branches, a strong R- and a weaker S-branch. Of the negative branches, the P-branch is rather strong, while the O-branch seems to be very weak. The intensity of the lines has a maximum at $J = 4$–5, as in the infra-red absorption spectrum.

The Raman band of water has a very complicated structure which, on addition of an electrolyte, becomes more distinct. In collaboration with Mr. Hugo Fredholm, I am extending systematic work in this direction.

I might finally mention a result which implies the possibility of a partial rotation of a molecule, as suggested by Bonino and Cella[3] in the case of pinene. Toluene, $C_6H_5 . CH_3$, gives a number of Raman lines of which two, commonly ascribed to the vibration C – H, show rotation structure. The Raman band $\nu_0 = 3056{\cdot}3$ cm.$^{-1}$, has the simplest structure. It is composed of a strong, unresolved Q-branch, a strong negative and a weaker positive branch, corresponding to the formula

$$\nu = 3056{\cdot}3 \pm 7{\cdot}0 \times J.$$

If these branches are interpreted as P- and R-branches, the spacing leads to a value for the moment of inertia, $I = 7{\cdot}9 \times 10^{-40}$ gm. cm.^{2}, which is in excellent agreement with the value to be expected for a rotating methyl group. Further details will be given elsewhere.

A. LANGSETH.

Chemical Laboratory of the University,
Copenhagen, July 14.

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[1] *Zeit. f. Phys.*, **60**, 586; 1930.
[2] *Compt. rend.*, **192**, 1032; 1931.
[3] NATURE, **126**, 915; 1930.

Occurrence of *Lithothamnion* in the South Indian Cretaceous.

WHILE examining some micro-sections of rocks from the Trichinopoly Cretaceous (South India), I have recognised the presence of *Lithothamnion* in several of the sections. This form has not been reported before from this area; and except for a passing reference by Hayden[1] to the occurrence of *Lithothamnion* in certain Cretaceous (?) beds of the Kampa system in Tibet, I believe the present find is the first of its kind to be reported from the Cretaceous of any part of India.

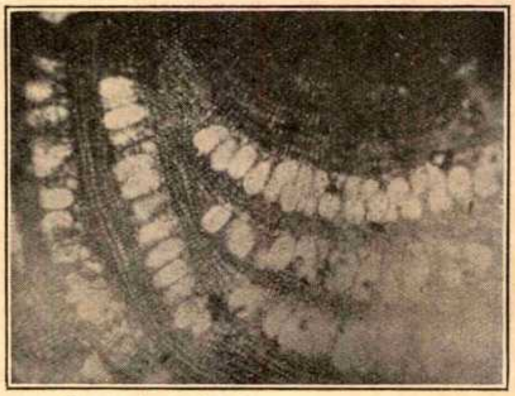

FIG. 1.—Archæolithothamnion sp ? × about 25.

In view of the great interest attached to this discovery, some of the sections were sent to Dr. Julius Pia, of the Natural History Museum, Vienna, and he has identified the form as *Archæolithothamnion* (Fig. 1), and some of the sections appear to be identical with *A. torulosum*, which he has figured in his chapter on Algæ in Hirmer's "Handbuch der Paläobotanik". The form has been recognised in quite a large number of sections, and it is certain that a detailed study of these will reveal not only more than one species of *Lithothamnion* but also the presence of several other types of Algæ. As regards the age and locality of these rocks now under study, they all belong to the Niniyur stage, which is the youngest subdivision of the Trichinopoly Cretaceous and corresponds to the Danian of the European stratigraphical scale.

L. Rama Rao.

Department of Geology,
Central College,
Bangalore, South India.

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[1] *Mem. Geo. Sur. Ind.*, vol. 36, pt. 2, p. 45.

The Energy of Horizontal Atmospheric Motion.

With reference to my note on atmospheric structure in Nature of June 27, it should be remarked that for any part of a horizontal field of isobars at which the velocity of the air is in geostrophic accord with the gradient the energy of a layer of air of uniform thickness contained within a square lying between a pair of consecutive isobars is the same for any part of the field, due allowance being made for variation of density and latitude. Hence the energy of the field can be estimated by counting the number of squares which are accommodated in the field.

The proof of this assertion is as follows:

Let the isobars be drawn for intervals of b millibars; let the distance between a pair of consecutive isobars be l, and let h be the thickness of the layer for which the geostrophic equation holds.

Let V be the velocity of the air, ρ its density, ϕ its latitude, ω the earth's angular velocity.

Then the mass of the layer of air within the square of which the side is l is $\rho l^2 h$, and the velocity V is $\frac{b}{2l\omega\rho}\operatorname{cosec}\phi$.

Hence the energy is $\frac{1}{8}\frac{hb^2}{\rho\omega^2}\operatorname{cosec}^2\phi$.

It is consequently the same for every square, whatever its size may be, which lies between isobars with the same pressure interval. If we take as our unit of energy $\frac{1}{8}\frac{hb^2}{\omega^2}$ and denote it by N, the energy for any square within the layer is $\frac{\operatorname{cosec}^2\phi}{\rho}N$. If any portion of the field be made up of such squares and their number n counted, the energy of that portion of the layer, expressed in terms of the unit N, is $n\operatorname{cosec}^2\phi/\rho$.

The value of the unit N for a layer 100 m. thick with a pressure interval of 2 mb. is about 26,000 kilowatt-hours, worth £100 at a penny per B.T.U.; or with ρ 1000 gm./m.^{3} (nearly normal at 2 km. height) the energy is 35 million kw.-hr. in latitude 60°, 104 million kw.-hr. in latitude 30°.

The number n can be obtained by inscribing successive circles tangent to the pair of isobars and to each other and counting their centres.

When isobars are curved, computation is still possible, but the formula requires modification.

This reasoning enables us to compute the energy of the horizontal motion of a 100-metre layer, shown on the maps of isobars at various levels in the troposphere. The energy between 30° N. and 60° N. clearly increases with height up to 8000 metres at least.

Napier Shaw.

July 4.

Jubilee Celebrations of the Society of Chemical Industry.

Please allow me to amend that portion of the account of the jubilee celebrations of the Society of Chemical Industry, published in Nature for July 25 (p. 157), which refers to the development of the chemical autoclave as illustrated by "a series of drawings and exhibits by the National Physical Laboratory". The actual origin of these illustrations and specimens is entirely otherwise. The drawings were made by Mr. H. Tongue, principal technical assistant of the Chemical Research Laboratory, Teddington. The collection of autoclaves included representative examples of various types constructed at my suggestion over a period of fifteen years, first at the Finsbury Technical College, then in the University of Birmingham, and recently in the Chemical Research Laboratory, the cost of production having been met in all cases by the Department of Scientific and Industrial Research.

The account also refers to "reduction products of fluorine compounds"; the substances exhibited were reduction products derived from the hydrocarbon, fluorene.

Full particulars regarding the exhibits from the Chemical Research Laboratory are given in a very serviceable handbook to the Exhibition, published by the Chemical Engineering group of the Society of Chemical Industry.

About forty members and guests of the Society of Chemical Industry visited both the Chemical Research Laboratory and also the Departments of Metallurgy and Metrology in the National Physical Laboratory, this being the first occasion on which the former institution has been inspected by a large party of visitors.

G. T. Morgan.

Chemical Research Laboratory,
Teddington, Middlesex.

Control of Prickly Pear by the Cochineal Insect.

As a result of a long series of tests carried out in Australia under the Commonwealth Prickly Pear Board, it was ascertained that the cochineal insect, *Dactylopius tomentosus*, could only live on certain species of *Opuntia*, among which was *O. dillenii*. As this species was reported to be a pest in India and Ceylon, I was authorised to offer strains of this cochineal bred in the laboratory free from parasites to the Government entomologists of those countries. The offer was accepted by Ceylon, and the insects were successfully established there in 1924 or 1925. In India, the offer was considered at a conference of the entomologists of the various provinces, and it was decided not to accept it, on the ground that prickly pear was largely used for hedges, and that, where it threatened to become a pest, it could easily be eradicated, as abundant cheap labour was available.

It appears from his letter in Nature of July 18, p. 117, that Mr. C. T. Jacob has introduced the insect from Ceylon to South India "to destroy clumps of *O. dillenii* in which dangerous snakes were harbouring around business premises".

The last sentence of the leading article in the same issue of Nature, p. 86, "that more may be involved in the thoughtless importation of strange animals than the importer can possibly conceive", seems appropriate to this instance.

W. B. Alexander
(Officer in charge of Prickly Pear
Investigations in Australia, 1923–25).

University Museum, Oxford,
July 21.

Research Items.

Age of the Giant Tortoises of Galapagos.—In 1928 a number of giant tortoises, all belonging to the species *Testudo vicina*, were brought from the Galapagos Islands by the New York Zoological Society and deposited at different stations where their development might be watched. At the stations the rate of growth differed, the three individuals in Arizona showing only a 66 per cent increase, while in Florida and Texas more than 200 per cent increases were attained (C. H. Townsend, *Zoologica*, vol. 9, p. 459; June 1931). The author states that the differences are traceable chiefly to climate and treatment, but it is obvious that size is also an important factor, smaller specimens on the whole showing the larger growth percentage. The age of the giant tortoises while comparatively young seems to be traceable in the striations of the horny plates of the carapace. Where age is definitely known up to twelve or even twenty years, the striations agree in number with the years, but in larger and older individuals the ridges tend to flatten out and become illegible. The author states that the common notion that large Galapagos tortoises must be of extremely old age is unwarranted, though he adds that the real length of life is unknown. Under favourable conditions they reach a large size in a few years, when the rate of growth becomes slow. Nevertheless, there are records of giant tortoises from both Galapagos and Aldabra which lived under observation in tropical climates for more than 150 years, dying upon their removal to cold climates.

Hairs and Wools.—Begun as a study in the significance of human and other hair in the detection of crime, Dr. John Glaister's researches have led him to make a comparative investigation of the hairs of a vast number of mammals. The results appear as an imposing quarto volume of 187 pp. and 145 plates, "A Study of Hairs and Wools", published by the Faculty of Medicine of the Egyptian University, where the author is professor of forensic medicine. The author concludes that a critical examination of hair will always reveal the mammalian order or suborder to which it belongs, in a very large number of instances will betray the family, and in many cases the species. If it be a human hair, in an appreciable number of cases it is distinctive of sex, in most cases it can be allocated to its site on the body, and in "a very approximate manner" may decide the age of the possessor, as very young, adolescent, adult, or aged, provided a number of hairs are available. Such identifications can only be made by an expert, however, and that after a laborious comparison with a large series of authentically identified human and animal hairs. It is a pity that in the reproduction by half-tone process the finer markings of the hair surfaces are often lost, for obviously the blocks have been made from a very fine series of photographs; but we are thankful to have this handsome and costly work, the publication of which was made possible by the generosity of the Egyptian Government.

Echinostomes from Rats.—Rats trapped in the city of Manila for routine bubonic plague inspection, are also examined for intestinal and other parasites. A. Tubangui (*Philippine Jour. Sci.*, 44, March 1931) reports that, of 109 rats, one brown rat harboured in its small intestine twenty-one specimens of an echinostome fluke that is believed to be identical with the human intestinal fluke *Euparyphium ilocanum*, and another brown rat yielded more than a hundred specimens of an apparently new species of the same genus. *E. ilocanum* was first recovered by Garrison (1908) from the stools of Filipino (Ilocano) prisoners in Manila, and was afterwards recorded from natives of the neighbouring province of Zambales. Its presence in a Manila rat may mean that this human parasite has a wider field of distribution than has formerly been supposed, and that rats are a factor in its dissemination. Descriptions and figures of the two flukes are given. The number of species of flukes now recorded from the brown rat is fourteen.

Polymorphic Characters in Rotifers influenced by Feeding.—Polymorphic characters expressed in the number of lateral spines occur in the rotifer *Brachionus pala*, which has four anterior and two posterior spines, while the variety *amphiceros* has two lateral spines in addition, which vary in size in different individuals. The effects of temperature and feeding upon the two forms has been tested by Kenzo Kikuchi (*Jour. Fac. Sci., Imp. Univ. Tokyo*, Sect. 4, vol. 2, p. 163; 1931). It was found that change of temperature had scarcely any effect upon the spines of *Brachionus pala*, but when it was fed with the green alga *Scenedesmus*, lateral spines characteristic of the variety *amphiceros* were produced. The progeny of the variety fed on *Polytoma*, however, had no lateral spines. So also when examples of *B. amphiceros* were fed upon *Polytoma* they lost their lateral spines, but when the progeny of this deficient form were fed with *Scenedesmus* they grew spines and became *amphiceros*.

Tetraploid and Triploid Petunias.—A tetraploid *Petunia* with twenty-eight chromosomes has been described by Dr. Kostoff. It was larger and more succulent, with larger flowers and broader leaves; it also developed faster than the diploid, but was self-sterile. The offspring from pollinating this plant with the diploid is now described by D. Kostoff and James Kendall (*Jour. of Genetics*, vol. 24, No. 2). Sixteen tetraploid plants (with twenty-eight chromosomes) were produced, as well as two hypotetraploids with twenty-seven chromosomes, one triploid (twenty-one chromosomes) and one hypotriploid with twenty chromosomes. The meiotic chromosomes of the tetraploid hybrids were usually found associated in rings or chains of four during diakinesis. Their reduction processes were almost regular and there were only 2 per cent of abortive pollen grains, the plants setting good seed when selfed. In the original tetraploid mother-plant, however, there were many meiotic irregularities and only half the pollen was good. The tetraploid hybrids are believed to have arisen either from both male nuclei uniting with the diploid egg, or from the union of the latter with a diploid male nucleus from a pollen dyad. The triploids and hypotriploids showed many meiotic irregularities and were self-sterile, but could be pollinated successfully by the tetraploids.

Building of the Northern Appalachians.—From Alabama to New York the Palæozoic formations of the Appalachian geosyncline were folded into mountains shortly after the beginning of the Permian, and it has been commonly assumed that this orogeny continued from New Jersey to Newfoundland, notwithstanding the clear demonstration by the pioneer geologists of Canada that the northern section of the Appalachians was folded in the main during the Devonian, with minor deformations in the late Ordovician and late Carboniferous. Prof. C. Schuchert has discussed the facts afresh in the *Bull. Geol. Soc.*

Amer., 41, pp. 701-724, 1930. He finds evidence for a four-fold deformation, progressing from the interior oceanward: (*a*) an arch-making movement at the close of the Cambrian which separated the St. Lawrence geosyncline into two seaways; (*b*) the Taconic isoclinal folding and overthrusting, with nappes, towards the end of the Ordovician; (*c*) the Acadian disturbance of Devonian time accompanied by the initiation of the Gulf of St. Lawrence; and (*d*) the Appalachian revolution of the Permian, which elevated the Maritime Provinces and refolded the Acadian geosyncline. Schuchert considers the crossing of earlier by later folds to begin in Nova Scotia, whereas Bailey placed the beginning of the crossing in south-east Maine.

Deep-Focus Earthquakes.—The occurrence of earthquakes of abnormal focal depth is a question on which opinion is not in complete agreement. The late Prof. H. H. Turner had put forward this hypothesis, but there is evidence both for and against it. The problem has been reinvestigated by F. J. Scrase, in a paper in the July number of the *Proceedings of the Royal Society*, from the point of view of reflection of the waves. In general, a number of supplementary reflected waves should occur, and if the focus is sufficiently deep, they should produce definite separate phases on the records; from an examination of a considerable body of data, it is found that these can be recognised and that the times of transit are in reasonable agreement with the calculated times. A corresponding feebleness of the surface waves which has been observed in many earthquakes also lends support to the deep-focus hypothesis. The results of the investigation favour the idea that the initial phase of an earthquake is a direct compressional wave and is not generated by reflection of a distortional wave (see also NATURE, 127, p. 486, Mar. 28, 1931).

Collision between Organic Molecules and Surfaces.—It is now possible with modern vacuum technique to allow beams of molecules to impinge on a surface, and to collect the molecules leaving the surface, under conditions such that no interaction occurs between individual molecules in either the incident or the reflected beam. The July number of the *Proceedings of the Royal Society* contains an account of an investigation of this type by F. O. Rice and H. T. Byck, in which the molecular beams contained acetone or dimethyl mercury. These were allowed to impinge upon targets of platinum, tantalum, and tungsten, which could be heated, and an analysis was made of the products leaving the surfaces. The results of most significance were obtained with platinum. No decomposition whatever of the compounds could be detected as a result of their collisions with the metal, although the temperature of the metals was well above that required for decomposition under ordinary conditions, and it is concluded that the molecules must have left the surface very soon after reaching it: that is, that both adsorption and trapping in irregularities on the surface was of no importance. With tungsten and tantalum, some decomposition into hydrogen and carbon monoxide, and possibly other products, was detected, above 1085° for the former metal and 1400° for the latter, but in these cases surface reactions occurred with the formation of carbides.

Nuclear Moments.—A review of the work which has been done upon the rotation of the nuclei of atoms has been published by R. de L. Kronig and S. Frisch in the issue of the *Physikalische Zeitschrift* for June 15. In line spectra this manifests itself by the appearance of a hyperfine structure, which requires special sources and instruments of high resolving power for its study. It can be described formally by the introduction of a new quantum number, and has its origin physically in the various modes of quantised magnetic coupling which can occur between the nucleus and the valence electrons. The nuclei of isotopes may differ in their spin properties, and so introduce a fresh complication into the hyperfine structure. With molecular spectra the nuclear spin may control the intensities of alternate lines in certain bands, in some cases alternate lines being absent. The magnitude of the nuclear spin can be deduced from the intensity data. Although hyperfine structure was discovered by Michelson, it is only in recent years that any systematic study of it has been made, and Prof. Kronig's list of elements for which the nuclear spins have been investigated includes only thirty-one.

Wave-Mechanical Models of Atoms.—Some pictorial representations of hydrogen-like atoms which are published by H. E. White in the first June number of the *Physical Review* are of interest as giving probably as definite an idea as is possible of atomic structure on modern theory. They were obtained by utilising the fact that the Schrodinger equation for a hydrogen atom can be separated into three equations, the solution of one of which leads to an expression for the probability that the electron will be at various distances from the nucleus, and of another to the probability for various inclinations of the line joining the electron and nucleus to an external magnetic axis. A spindle was turned to the shape of the radial 'probability-density', and was photographed whilst rotating about the 'magnetic' axis, the angle between the axis of the spindle and the magnetic axis being changed at a variable rate to represent the corresponding part of the solution of the wave-equation. The resulting photographs are a set of symmetrical patterns, one for each atomic state, and are shown in the paper in white on a black ground. To obtain the closed *s*-states a slightly different procedure was followed. The pictures show clearly the approximate agreement between the wave-mechanical representation and the region swept out by a precessing orbit on the Bohr theory, and equally well, the existence of lobes in some of the wave-mechanical models which are not called for at all in the early quantum theory.

The Arc Spectrum of Zirconium.—An analysis of the arc spectrum of zirconium, the outcome of some ten years of work upon this element, is described by Dr. and Mrs. Kiess in the United States Bureau of Standards *Journal of Research* for April. The lines and terms of this spectrum are numerous, but more than twelve hundred of the sixteen hundred lines which have been measured have been classified and the terms of the spectrum assigned to definite configurations of the atom by the aid of Hund's theory. The spectrum has many features of interest. Several pairs of related states of the atom have almost the same energy, with the result that pronounced perturbations of the individual pairs occur, and cause both abnormalities in the intensities of lines which arise from transitions from these terms and Zeeman patterns for them which depart from their simple theoretical values. Lines of this spectrum also appear in the Fraunhofer solar spectrum, but, as has been found with the spectrum of singly ionised zirconium, certain of these have to be ascribed to transitions in the atom which are theoretically possible, and of which the magnitude can be predicted from other lines, but they are of small intensity or even absent with laboratory sources. The resonance lines and *raies ultimes* have been identified, and the ionisation potential of the neutral atom shown to be 6·92 volts.

Anti-Neuritic Vitamin.—Previous methods for the isolation of anti-neuritic vitamin have yielded only very small quantities of material which is probably still far from chemically pure. In the June number of the *Journal of the American Chemical Society*, Seidell and Birckner, of the National Institute of Health, Washington, describe experiments on the isolation of the vitamin from yeast, the process involving four stages. An 'activated solid' is first prepared by adsorption on fuller's earth of the filtered yeast extract made at 80°. Extraction of the solid is now made by agitating it violently for five minutes in 0·4–0·5 *n*NaOH and centrifuging. The clear liquid is rapidly acidified to *p*H 3·0 with sulphuric acid. On evaporation under reduced pressure to one-tenth, a brown solid separates, which has been shown to be very rich in the thermostable growth factor (B_2 or G) required as a supplement to anti-neuritic vitamin for normal growth. The clear liquid is cooled for deposition of sodium sulphate, and inorganic salts, impurities, etc., are precipitated with alcohol to approximately 50 per cent alcohol in the solution. This alcoholic solution contains the anti-neuritic (B_1) vitamin, but only about 15 to 20 per cent of that originally present in the yeast. The solution is distilled down to small volume, centrifuged, and benzoylated with sodium carbonate and benzoyl chloride, extracted with chloroform, and the aqueous layer poured slowly into 10–15 vols. of acetone. The precipitate is extracted with a mixture of propyl alcohol and concentrated hydrochloric acid, distilled down and poured into acetone. The precipitated solid is dissolved in methyl alcohol and added dropwise to a large volume of acetone. The white voluminous flaky precipitate is washed with acetone and dried in a vacuum. It is curative in 0·03 mgm. doses by the Smith rat method, or about one-fourth greater than the crystals obtained by Jansen and Donath in 1927.

Aceto-acetic Ester Condensation.—Since the discovery by Geuther in 1863 that aceto-acetic ester, $CH_3COCH_2COOC_2H_5$, is formed by the action of sodium on ethyl acetate there has been much discussion as to whether the metal itself is responsible for the condensation (Michael's theory), or whether the active agent is sodium ethoxide formed from traces of alcohol in the ester or from other side reactions (Claisen's theory). It was found by Michael that ethyl acetate from which all traces of alcohol have been removed reacts with sodium as readily as the ordinary ester, but it is possible, of course, that some alcohol might be produced by a side reaction. It has also been shown by Snell and McElvain that acetic and propionic esters are unique in not giving the corresponding acyloins when treated with sodium in presence of excess of ester, and a study of the reaction mechanism should therefore be confined to them. In the June number of the *Journal of the American Chemical Society*, these authors state that they have made a careful study of the reaction between sodium and ethyl acetate in which the amounts of aceto-acetic ester, alcohol and hydrogen produced have been determined. Similar determinations were made with sodium ethoxide as condensing agent, and the results obtained appear to constitute strong evidence in favour of Claisen's theory. The amount of alcohol found in the mixture when sodium is used is approximately the sum of that produced by the aceto-acetic ester condensation and that resulting from the reduction of the ester by the sodium used in the reaction. The action of the sodium thus appears to be the generation, by reduction of the ester, of sodium ethoxide, which is the real condensing agent. In contradiction to earlier investigators, but in agreement with the recent experiments of Kutz and Adkins, it was found that sodium ethoxide produces practically the same amount of condensation, and just as readily as metallic sodium does.

Astronomical Topics.

Nagata's Comet, 1931 *b*.—This proves to be the brightest comet observed for several years. The following orbit and ephemeris have been circulated from the U.A.I. Bureau at Copenhagen. They are by Mr. Berman:

T	1931 June 15·140 U.T.	
ω	324° 58′	1931·0
Ω	191 8	
i	41 24	
$\log q$	0·03342	

EPHEMERIS FOR 0^h U.T.

	R.A.	N. Decl.
Aug. 7	12^h 0^m 24^s	10° 16′
11	12 14 56	10 9
15	12 28 56	9 58

The light on July 26 and Aug. 7 is 0·9 and 0·6 of that at discovery. The comet should be looked for in the evening twilight.

The two following positions of Nagata's comet are from photographs by Nicholson and Moore at Mt. Wilson:

U.T.	R.A. 1931·0.	N. Decl.
July 18·1792	10^h 40^m $44{\cdot}7^s$	9° 51′ 3″
19·1861	10 45 6·0	9 54 47

The comet had a tail 4° long (*Harvard Card*, No. 161).

Changes of the Corona in the Sunspot Cycle.—It has for a long time been recognised that the type of the corona varies with the sunspot cycle, having polar streamers at spot-maximum and equatorial extensions with delicate 'polar plumes' at minimum. Dr. W. J. S. Lockyer reopens the subject and extends his study up to 1930, in *Mon. Not. Roy. Ast. Soc.* for May. He introduces statistics of prominences, and his discussion indicates that the correlation between prominences and the corona is much closer than between spots and the corona; and further, that the latitudes of prominences and of the coronal streamers are very closely associated. Prominences attain much higher latitudes than spots, and even reach the poles of the sun at the times of spot-maximum. Dr. Lockyer notes that the corona of the 1926 eclipse was of maximum type, although it was nearly two years before spot-maximum; but the prominences had already reached high solar latitudes. He refers to the corona of 1908, which, when the photographs were first published, appeared to have little connexion with the prominences; but it was afterwards found that the orientation marked on the photographs was wrong.

The research also indicates that the latitudes of prominences and coronal streamers are somewhat higher during increasing than during decreasing sunspot activity; in other words, maximum prominence latitude precedes maximum sunspot activity. Reference is also made to the 'coronal arches' that appear above prominences in many eclipse photographs. They afford further evidence of the close connexion between prominences and corona.

Dr. Lockyer anticipates that the 1932 corona will be nearly of minimum type; the sunspot minimum is expected to be about 1934.

Centenary Meeting of the British Association.

PROGRAMMES OF SECTIONS.

SECTION A (MATHEMATICAL AND PHYSICAL SCIENCES).

A CENTENARY meeting in London necessarily envisages a programme which differs in many details from the programme of a provincial meeting. The occasion is one for a certain amount of stocktaking, and nothing could more clearly demonstrate the remarkable progress of the physical sciences during the period that has elapsed since the jubilee meeting than a comparison of the topics that interest the Section to-day with those of half a century ago. The Section anticipates a specially large gathering of guests from foreign lands and from the overseas dominions, and the programme naturally reflects in some measure the interests of a number of these distinguished visitors.

The president of the Section, Sir J. J. Thomson, proposes to discuss the increase in the facilities for education and for research in physics that the last fifty years have seen.

A large number of discussions has been arranged, and perhaps that of widest general interest is a discussion which bears the not unambitious title of "Evolution of the Universe". This discussion will be held in the Great Hall of the University of London, and will be opened by Sir James Jeans. General Smuts (president of the Association), Prof. E. A. Milne, Sir Arthur Eddington, Prof. W. de Sitter, Sir Oliver Lodge, Prof. R. A. Millikan, and the Bishop of Birmingham will contribute. Of more immediate technical interest are the discussions on geophysical prospecting, with special reference to instruments, to be opened by Prof. A. S. Eve, and on the unit of atomic weight, when Dr. F. W. Aston, in opening the discussion, will review critically some of the more suitable suggestions for such a unit, for example, those of the proton, the neutral hydrogen atom, one quarter of the α-particle, one quarter of the neutral helium atom, one sixteenth of the neutral oxygen atom. He will advance arguments in favour of (*a*) retaining the present chemical scale, (*b*) adopting one sixteenth of the neutral oxygen atom as standard.

Sir Napier Shaw will present a communication on meteorology through the century, and papers will be read before the main section by Profs. R. W. Wood, G. P. Thomson, J. C. McLennan, P. Zeeman, and others.

The mathematical subsection presents a comprehensive and technical programme. Titles such as "Asymptotic Partition Formulæ" and "Tesseral Matrices" are *φωνᾶντα συνετοῖσιν*, but even those whose interest in such subjects is passing small may find attractive Prof. J. B. S. Haldane's paper on some "Mathematical Problems of the Biologist".

The subsection of cosmical physics is organising a discussion on magnetic storms, which will be opened by Prof. S. Chapman. A programme of very wide interest has been prepared, which includes papers ranging over such diverse subjects as lightning, Nova Pictoris, stratified clouds, deep focus earthquakes, and radio research in the empire.

Sectional excursions have been arranged, through the kindness of the directors of these institutions, to Greenwich Observatory, to the National Physical Laboratory, to the G.E.C. Research Laboratories, to a Nelson Line steamship, and to Kew and Slough.

SECTION B (CHEMISTRY).

The coincidence of the Faraday Centenary celebration with that of the British Association is particularly happy so far as the Chemistry Section is concerned. Faraday's discoveries in many branches of chemistry and physics were so numerous and so fundamental that it is difficult to determine which is the most important from all points of view, and his eminence as the pioneer in physical chemistry will probably be emphasised in Sir Harold Hartley's presidential address, "Michael Faraday and the Theory of Electrolytic Conduction". The remainder of the programme will take the form of four discussions, and the first of these will immediately follow the presidential address. Profs. P. Debye (Leipzig), N. J. Bjerrum and J. N. Brønsted (Copenhagen), K. Fajans (Munich), J. C. Philip, S. R. Milner, and Sir Harold Hartley have promised to speak on "The Influence of the Medium on the Properties of Electrolytes".

The morning and afternoon of Friday, Sept. 25, will be devoted to the chemistry of the vitamins and related substances, which was also discussed at a recent meeting of the Royal Society. Those taking part in the discussion on the chemistry of vitamin A and the carotinoids include Profs. P. Karrer (Zurich), H. von Euler (Stockholm), R. Kuhn (Heidelberg), J. C. Drummond and I. M. Heilbron, and Drs. R. A. Morton and T. Moore. In connexion with the chemistry of vitamin B and related problems, the speakers are Profs. B. C. P. Jansen (Amsterdam) and R. A. Peters, while the chemistry of vitamin D and related sterols will be discussed by Profs. A. Windaus (Gottingen) and I. M. Heilbron, and Drs. R. Bourdillon and O. Rosenheim. Sir F. Gowland Hopkins will introduce the discussion, which will be summed up by Prof. R. Robinson.

On Sept. 28, the Section will hold a symposium on the British fuel problem, and on the following day the final discussion will be on the structure of simple molecules. This will be introduced by Prof. P. Debye, who will also quote the evidence from X-ray measurements. The other speakers will be—Prof. J. E. Lennard-Jones on evidence from molecular spectra, Mr. R. H. Fowler on the quantum mechanical theory of valency, Prof. V. Henri (Marseilles) on predissociation and the structure of some special molecules, Prof. F. G. Donnan and Mr. C. N. Hinshelwood.

Special exhibits will be on view during the meeting; those already arranged are by Dr. R. C. Menzies (illustrating the chemistry of thallium), Prof. C. S. Gibson (illustrating some recent investigations of the chemistry of gold), and Prof. H. V. A. Briscoe (illustrating the chemistry of rhenium).

SECTION C (GEOLOGY).

The proceedings of Section C (Geology) will open with the address of the president, Prof. J. W. Gregory, in which he will review to some extent the last hundred years of geology. This will be followed by an account of the geology of the London district by Mr. H. Dewey, of the Geological Survey, and Dr. S. W. Wooldridge, and two papers concerned with that area.

The principal business of the Section will be the discussion of certain phases of the science that are of interest at the present time. The first, on "The Evidence of Palæontology with Regard to Evolution", will be opened by Sir Arthur Keith; other speakers will include Dr. R. Broom, of South Africa, Dr. W. D. Lang, Profs. Hawkins, Swinnerton, Trueman, and D. M. S. Watson. The pronouncements of the opener have been so provocative of late that this discussion may be of the greatest interest.

Prof. O. T. Jones will introduce a subject of more importance perhaps to the practising geologist, "On

Earth Movements in Relation to Stratigraphy". In this discussion Prof. E. B. Bailey and Mr. J. Weir, will consider "Submarine Faults as Boundaries of Facies". Prof. H. A. Brouwer, of Holland, and Dr. E. O. Ulrich, of the United States, will carry the discussion far beyond the limits of the British Isles.

The other subjects are of greater economic interest and will show how the purely scientific and the practical are connected. As the Section meets in the Royal School of Mines, it is very appropriate that Prof. G. C. Cullis should introduce there the subject of "The Genesis of Ores in Relation to Petrographic Processes", and here it is probable that its economic importance will be stressed. Prof. P. Niggli, of Zurich, and other petrologists can be expected, however, to explore thoroughly its relation to petrogenesis.

The place that oil and oil products have in the world to-day should make the fourth and last discussion, on "The Genesis of Oil Pools in the Sedimentary Cycle", of the widest interest. The first speaker will be Prof. V. C. Illing, and representatives of the great producing companies have promised to contribute.

As these discussions will necessarily occupy most of the time available, other papers will be given before appropriate sub-sections. Of these, one by Dr. C. A. Matley should be of great historic interest, for in his account of the Harlech Dome the author will deal fully with Lapworth's work on that area. Dr. Matley has also arranged to have an exhibit illustrative of Lapworth's maps and papers in the Imperial College of Science.

A full programme of excursions has been arranged for the week of the meeting, and during the week preceding a party will visit East Anglia under the guidance of Profs. Boswell and Kendall.

Section D (Zoology).

The programme this year of Section D (Zoology) is on quite novel lines, as there are no papers upon individual topics. Each of the six mornings is being devoted to special subjects, and is occupied by a discussion, a symposium, or a mixture of the two. Prof. E. B. Poulton's presidential address, "A Hundred Years of Evolution", opens the sectional meetings, and the rest of that morning will be filled by a series of short papers on particular aspects of the evolution question, followed by a short general discussion. The authors of the short papers are Prof. Julian Huxley, Prof. H. Fairfield Osborn, Dr. F. A. Dixey, and Mr. E. B. Ford.

On the following day the topic is vertebrate embryology. Prof. E. W. MacBride is opening this discussion and Dr. J. H. Woodger and Mr. C. H. Waddington are to follow him, so we may look forward with certainty to a lively general discussion of the subject. The Saturday morning is to be devoted to the population problem. The names of Profs. Carr-Saunders, Crew, J. B. S. Haldane, Hogben, Huxley, and MacBride, Dr. R. A. Fisher, and Mr. J. R. Baker, are a guarantee of a stimulating three hours' discussion.

Monday is the systematists' day, but the subject, "Classification with Reference to Phylogeny and Convergence", upon which Dr. Tate Regan (opener) and Drs. F. A. Bather, W. D. Lang, Hugh Scott, and John Stephenson have promised to speak, should provoke a ready response from other members of the Section in the open discussion towards the end of the morning. The Tuesday programme concerns variation and genetics, the particular subjects to be dealt with being induced mutations, local races, study of lineages, and the mathematical side of evolution, by Prof. J. W. Heslop Harrison, Drs. W. R. Thompson, W. H. Thorpe, and O. W. Richards, Prof. D. M. S. Watson, and Prof. J. B. S. Haldane respectively. Finally, on Wednesday the applied side of zoology is to the fore. Prof. W. Garstang and Drs. A. Bowman and E. S. Russell are discussing the various aspects of the 'over-fishing problem'; and then Drs. A. D. Imms, Ll. Lloyd, C. B. Williams, J. C. F. Fryer, and P. A. Buxton are contributing to a symposium on insects and human welfare.

In the afternoons, visits have been arranged to most, if not all, the places of special interest to zoologists within easy reach of South Kensington; and on the Sunday there is to be a whole-day excursion to Tring and Whipsnade.

Section E (Geography).

The programme arranged for this Section includes a series of topics representative of the field of geographical studies at the present day. In addition, it is fitting that on this occasion the evolution of the subject as indicated by successive British Association meetings should be traced, and very appropriately such a review is to be given by Dr. H. R. Mill, who has had such a long connexion with the Section.

A former president, Sir Halford Mackinder, will again preside over the Section, and his address will be on "The Human Habitat". The Section will also have the advantage of its president's leadership in the Saturday excursion which has been arranged to the south-east coast, an area rich in its illustrations of so many phases of our historical geography.

A subject of special interest at the present day, that of the establishment of national parks, will be considered by Dr. Vaughan Cornish, with particular reference to "The National Park of Northumberland, a Shrine for Hadrian's Wall". The London area will be dealt with in two papers, of which the first, by Dr. Wooldridge, will analyse the physical setting, while the second, by Mrs. Ormsby, will consider various aspects of the evolution of the Metropolis, with particular reference to the growth of its population.

Papers of imperial interest will form an important element at the centenary meeting, and the Section is fortunate in having guests from both Australia and South Africa. Dr. Fenner, of Adelaide, is to deal with some problems of South Australia, while Prof. J. H. Wellington, of Johannesburg, is to review the important question of land utilisation in South Africa. A paper which is certain to arouse considerable interest has also been promised by Prof. Griffith Taylor—whose name is inevitably associated with that of Australia—under the title of "The Geographer's Aid in Nation-Planning". Some recent agricultural developments in the Empire will be considered by Sir John Russell, while Lord Lugard will deal with the profoundly significant problems of tropical Africa in an address which he is to give on Africa in transition.

Among the foreign guests of Section E will be Prof. W. Werenskiold, of Oslo, who is to give a résumé of his researches into the variations of glaciers and of climate in Norway.

Finally, a day is to be devoted to a symposium on geographical problems of the earth's crust. The opening paper in this series will be by Mr. A. R. Hinks, and others who have promised to contribute include Prof. J. W. Gregory, Prof. A. Holmes, and Dr. G. C. Simpson.

Section F (Economic Science and Statistics).

A varied programme, in which the main feature is a number of papers dealing with important economic problems of current interest, has been arranged for Section F (Economic Science and

Statistics). The president of the Section is Prof. Edwin Cannan, and he has selected for his presidential address the subject of "Internationalism in Economic Theory". Mr. J. H. Morris will discuss the important but difficult problem of "The Rationalisation of the Cotton Industry". During the past few years, the difficulties of primary producers in all parts of the world have been very prominent, and in this connexion the papers of Mr. J. W. F. Rowe on "The Artificial Control of Raw Material Supplies" and of Mr. R. R. Enfield on "The World's Wheat Situation" are of special interest. Another interesting session should be that in which Mr. Maurice Dobb is to read a paper on "Some Economic Problems connected with the Five-Year Plan in Russia". Prof. J. H. Jones is to give a lecture on "Wages, Prices, and Employment", and this should lead to an important discussion of the much-debated question of the interrelation of these factors and of the causes of the present grave unemployment problem.

A new feature of the Section's activities is the formation of a group dealing with industrial co-operation. In connexion with other sections, a wide range of papers and discussions has been arranged to deal with these industrial problems, including means of co-operation between industry and educational institutions in promoting the training of managers; the physiology and psychology of work; the utility of trade barometers, and patents and the protection of scientific discovery.

Section H (Anthropology).

Section H (Anthropology) will profit very much from the centenary meeting, since it is attracting many field workers from overseas. Following upon the presidential address by Prof. A. Radcliffe-Brown, of Sydney, a session will be devoted to papers from field workers in Oceania. Field workers from South Africa, including Dr. R. Broom, will also speak.

Special interest is attached to a morning given up to reports of work in the Mediterranean region carried out by Misses Caton-Thompson and Gardner, Miss D. A. E. Garrod, and Mr. W. A. Heurtley. Problems of British archæology, including accounts of work at Avebury, of Upper Palæolithic finds in north Lincolnshire, and of Early Iron Age finds in Monmouthshire, will also be discussed. Among papers by distinguished foreign guests are the Huxley Memorial Lecture by Dr. Thilenius, suggestions for studies of ethnic pathology by Dr. Suk, of Brno, an account of Neanderthal man in Italy by Dr. Sergio Sergi, and a discussion of the possibilities of determining the geological age of fossil man by comparison with the teeth of contemporaneous Proboscidea, by Prof. Henry Fairfield Osborn. A lecture to which the public are invited will be given at 5.30 P.M. on Monday evening, Sept. 28, by Prof. Elliot Smith, on the now famous Peking man.

An almost untouched subject, the psychological origins of law, will be opened up by His Honour Judge Dowdall, and will, it is hoped, lead to further research into this important aspect of man's social activity. Social phenomena among various primitive peoples will be discussed by field workers, including agriculture and land ownership among the Hopi, the economic factor in primitive life, birth dances, the magical significance of tattoo designs, and a general paper on the social organisation of the Nilotes by Prof. C. G. and Mrs. Seligman. Prof. Seligman will also deal with heredity in modern human hybrids. The complex problem of the relation between Canaanites and Hyksos will be raised by the veteran field worker and archæologist, Sir Flinders Petrie, while Nineveh and its origins will be discussed by Dr. Campbell Thompson, who has carried out three seasons' work there.

An interesting feature will be exhibitions arranged by courtesy of the Director at the Wellcome Museum, including a collection of crania from South Africa brought over by Dr. Broom, and photographs of native South African life taken by Mr. Duggan-Cronin. The afternoons will be devoted to visiting the museums and private collections in which London is so rich, and the Section is deeply grateful for the special facilities which curators and keepers are arranging for its members.

Section I (Physiology).

The first morning's proceedings in Section I (Physiology) are to be devoted to a discussion on the "Physiological Basis of Sensation", which will be opened by Prof. E. D. Adrian, Foulerton professor of the Royal Society. He will be followed by (among others) Dr. C. S. Myers, Sir J. Herbert Parsons, and Prof. Frank Allen, of Winnipeg.

On Friday morning (Sept. 25), Prof. E. P. Cathcart, of Glasgow, is to speak on the relation of rations for children to those of the 'standard' adult man, Prof. A. V. Hill is describing the lost place of lactic acid in the study of muscular contraction, and Prof. Charles Heymans is speaking on the control of the circulation, to which his researches have contributed so much. At the end of the morning, Prof. J. Barcroft will discuss the physiological problems entailed by such an expedition as that of climbing various Himalayan summits. It will be interesting to hear the opinions of Mr. E. N. Odell, who was on the 1924 Everest expedition, and of Dr. Raymond Greene, of the 1931 Kamet climb, on Prof. Barcroft's opinion that climbing is dependent almost entirely on an appropriately designed apparatus for the supply of oxygen.

Dr. H. H. Dale is using his presidential address to open a discussion on the "Biological Nature of Filtrable Viruses", while the rest of Monday morning (Sept. 28) is to be devoted to a discussion on the same subject. Among those speaking are Dr. T. M. Rivers, of the Rockefeller Institute, New York, Dr. Alexander, of Onderstepoort, and Mr. J. E. Barnard.

The morning of Sept. 29, which is the last business meeting of the Section, is devoted to a discussion on "Methods and Problems of Resuscitation". The opening address will be given by Sir Edward Sharpey Schafer, and among those who will follow are Prof. Yandell Henderson, of Yale, Dr. J. S. Haldane, Dr. C. K. Drinker, of Harvard, Sir Bernard Spilsbury, and Sir Francis Shipway. This is probably one of the problems in which applied physiological methods have been of most interest and value in practical work.

The afternoon and evening arrangements of the Section include visits to the Royal College of Physicians and to the Wellcome Historical Museum.

Section J (Psychology).

Section J (Psychology) is fortunate in having as its president this year Dr. C. S. Myers, for he was largely responsible for its formation as a subsection of I (Physiology) in 1913 and as a separate section in 1921, and is one of the pioneers in the development of experimental psychology and its application to the problems of industry. The subject of his address will be "The Nature of Mind".

The programme for the Section is a strong and varied one; most of the past presidents of the Section—Profs. Bartlett, Brown, Drever, Pear, and Valentine—will figure in it. Among the distinguished foreign guests who will contribute papers are Prof. Kohler of Berlin, Prof. Piéron of Paris, and Dr. Frank Allen of Toronto. Prof. Köhler will speak on "Recognition and Reproduction", Prof. Piéron on "The

Theoretical and Practical Aspects of Intelligence", and Dr. Allen on "The Function of Induction in Colour Vision".

An intra-sectional discussion has been arranged on "Mental Defect", at which papers will be read by Dr. E. O. Lewis on "The Social Aspects of Mental Deficiency", by Prof. F. A. E. Crew on "The Genetic Background of Mental Defect", by Dr. R. G. Gordon and Dr. Norman on "Some Psychological Experiments of Different Types of Mental Defectives", and by Dr. F. C. Shrubsall on "The Classification of the Mentally Defective and the Relative Frequency of Different Types".

The organising committee of the Section decided to restrict the meetings to the morning sessions, hence, as the programme is very full, two sets of papers will run concurrently on two mornings. Visits have been arranged to the psychological laboratories of King's, University, and Bedford Colleges, to the Tudor Lodge Child Guidance Clinic, Islington, the Jewish Child Guidance Clinic, the Bethlem Royal Hospital, and the National Institute of Industrial Psychology.

SECTION L (EDUCATIONAL SCIENCE).

Sir Charles Grant Robertson has chosen for his presidential address to Section L (Educational Science) a subject in full accord with the special nature of the centenary meetings of the British Association, namely, "Educational Development: 1831 and 1931: A Centenary Retrospect and a Forecast". The address is to be delivered in the Great Hall of the University on the morning of Sept. 24. Dr. E. Deller will follow with a paper on "London as a Pioneer in University Education", and in the discussion afterwards, Sir Frank Heath, Sir Robert Blair, Sir Philip Hartog, Sir William Beveridge, Sir John Gilbert, and the Rev. Scott Lidgett will take part.

On the second morning two subjects, Imperial in nature, will be considered: "The Establishment of a Central Institute for Imperial Education" and "The Education of Backward Peoples". Lord Eustace Percy, Prof. F. Clarke, and Mr. F. H. C. Butler will give papers on the former, and Sir Michael Sadler, Dr. Maxwell Garnet, Sir Percy Nunn, and Major A. G. Church will speak in the discussion. Papers on the latter subject will be read by Mr. S. Rivers Smith, Major H. A. Harman, and Dr. A. R. Paterson, and in the discussion the Hon. Hugh A. Wyndham, Lord Raglan, Mr. A. Victor Murray, Mr. C. W. Hobley, and Miss M. F. Perham will speak.

The next session is to be devoted largely to problems connected with school clinics and child guidance. Three papers are to be given: Dr. G. A. Auden will deal with "The Maladjusted Child", Dr. W. Moodie will follow with "Environmental Factors in Maladjustment", and Dr. A. Macrae will give the third paper on "Psychological Examination as an Aid to Vocational Adjustment". Dr. C. W. Kimmins, Dr. Emanuel Miller, Dr. J. R. Rees, Dr. C. L. C. Burns, Dr. R. G. Gordon, and Mr. D. T. John will also state their views. The session will close with a paper and discussion on "Eugenics in Education". Prof. R. Ruggles Gates is reading the paper, and Prof. Julian S. Huxley, Prof. E. W. MacBride, and Sir Arthur Thomson will take part in the discussion.

At the final session "School Broadcasting" will be dealt with by Mr. Frank Roscoe and Lord Eustace Percy. There will be an appropriate demonstration, and Sir Walford Davies will open the discussion and Miss Mary Somerville will answer questions. A paper on "Adult Education Broadcasting", by Prof. Winifred Cullis, will follow, and Mr. C. A. Siepman will take part in the discussion and questioning.

The reports of three special committees will be presented during the meeting. Sir Percy Nunn and Mr. G. W. Olive will report on "General Science in Schools with special reference to Biology"; Sir John Russell and Mr. C. E. Browne will present a report on "Education for Life Overseas"; and Sir Richard Gregory and Mr. J. L. Holland will deal with the report of the Committee on Educational and Documentary Films.

SECTION M (AGRICULTURE).

Sir John Russell's presidential address to Section M (Agriculture) on "The Changing Outlook in Agriculture" gives the keynote for the whole sectional programme. Each session treats a single aspect of agriculture and selects representative products or problems to illustrate how the application of science has influenced the development of practice, how current problems are being attacked, and in what directions developments may be expected.

The first two sessions are devoted to crop production, the next three to animal production, animal health, and the utilisation of animal products, and the final session to the economic aspects of agriculture in Great Britain and the Empire.

The application of genetics to the improvements of varieties of cereals and to fodder plants will be considered by Dr. E. S. Beaven and Prof. R. G. Stapledon, who, whilst emphasising the importance of breeding from the material indigenous to any area, will direct attention to the danger that the present movement to pedigree strains may defeat its purpose by the development of an international trade in pedigree seed without reference to its merits for the particular purpose required. On the animal side, Prof. F. A. E. Crew will raise the question whether attempts at animal improvement in newer areas by the importation of specimens of improved European breeds possess any advantage over the less favoured one of selection towards a desired type amongst the animals already existing in any particular locality.

Dr. S. G. Barker will examine the scientific and economic aspects of methods of sheep breeding to produce wool suitable for specific manufacturing processes. On the veterinary side, Sir Arnold Thieler will carry his well-known work in South Africa a step further by his demonstrations that 'stiffsickness' may be identified with true rickets or osteomalacia, and that it is caused by a deficiency not of calcium but of phosphorus.

Dr. D. J. Hissink will give an account of the reclamation of the Zuider Zee, whereby the cultivated area of Holland will be increased by one-tenth; he will discuss especially the way in which the original infertile magnesium and sodium clay is converted into a fertile calcium clay by the removal of sodium salts by drainage. Industrial crops are represented by surveys of the present position of the production and research on rubber and cotton, and for the utilisation of animal products, milk and the cold storage of meat will be treated.

Probably the widest interest will be aroused by the discussion on the economic aspects of agriculture, which will begin with reviews of the present position and outlook for cereals by Sir A. Humphries, and for meat by Sir William Haldane. Possible changes in the organisation of farming will then be considered by Sir Daniel Hall, who will discuss the units for farming, and Mr. C. S. Orwin, who will put forward the claims for a higher degree of specialisation.

Excursions have been arranged to the Rothamsted Experimental Station, the laboratories and farm of Imperial Chemical Industries at Jealott's Hill, and the Dairy Research Institute at Reading.

Birthdays and Research Centres.

Aug. 13, 1872.—Prof. Richard Willstatter, For.Mem.R.S., professor of chemistry in the University of Munich.

In recent years I have been occupied chiefly with such different things as silicic acid, that is true monosilicic acid, and with the enzymes of leucocytes. With regard to these, I began with studying the protein-splitting enzymes, trypsin and kathepsin, their occurrence and behaviour in the colourless blood-cells of herbivores and carnivores. At the present time I am engaged in analysing the glycogen-splitting enzyme of leucocytes. Concerning the peculiarities of amylase, it is surprising how much information can be obtained from observations with blood-cells. In the muscle, where the metabolism of carbohydrates is being studied so thoroughly, things must be so much more intricate.

In connexion with my problem I should like to raise a question. Is it to be taken for granted that glands are producing enzymes, or are they disintegrating the blood-cells and selecting and storing the enzymes ?

Aug. 14, 1861.—Sir Richard Threlfall, G.B.E., F.R.S., chairman of the Fuel Research Board.

I regret that for the past year my health has not permitted me to live continuously in England, and consequently the amount of work I have been able to do has been but small. My main occupation has been the investigation of the decolorising power of charcoal which has been activated by partial combustion in sulphur vapour, and I am looking forward to continuing this work as soon as my health permits me to do so.

I have also had on hand for several years the study of a gravity balance (Threlfall and Pollock, *Phil. Trans.*, 1899), with the assistance of Mr. Dawson. This instrument gave very promising results in Australia so far back as 1898, but there are indications that, after more than thirty years, some slipping is beginning to take place at the joints where quartz is soldered to metal. There is, however, another possibility which I am now investigating, but in the meantime the behaviour of the instrument has become unsatisfactory.

I am also engaged in attempting to bring out a new edition of a small book on " Laboratory Arts " which I published during the 'nineties, and which now, of course, requires very copious revision. The proposed changes are mostly in MS., but I am unfortunately short of the kind of assistance required to enable me to get it through the press.

Aug. 15, 1871.—Prof. G. Elliot Smith, F.R.S., professor of anatomy in University College, London.

The results achieved by recent research in comparative neurology now for the first time open the way for a comprehensive synthesis of our knowledge of the brain, and suggest the possibility of new and fruitful methods of studying the factors which were responsible for the attainment of the growing powers of skill and understanding in vertebrates and the making of the mind in man. If this great scheme of research is to be realised, the most urgent need is the correlation of the information acquired by comparative anatomy and physiology, by clinical investigation and experimental psychology, as well as by palæontology and anthropology, with properly critical attention to considerations of phylogeny and chronology, so as to define the means whereby the drastic revolutions which occurred in the central nervous system—and, in fact, the whole organism—when each of the different classes of vertebrates came into being, made possible new modes of locomotion and new possibilities of behaviour, and how the refinement of sensory discrimination eventually made the acquisition of higher degrees of skill attainable.

My aim at the present time is the study of the means whereby these general biological principles found expression in the process of conferring upon man's ancestors the higher powers of understanding and skill which transformed them into men.

Societies and Academies.

Paris.

Academy of Sciences, June 15.—**Adolphe Lindenbaum** : Regulated ensembles.—**Francesco Severi** : Biharmonic functions and the theory of analytical functions of two complex variables.—**Gaston Julia** : Conformal representation of multiple associated areas.—**Gr. C. Moisil** : The use of generalised vector potentials in the integration of a class of partial differential equations.—**R. Gosse** : Equations $s=f(x, y, z, p, q)$ which admit of an invariant of the second order.—**G. Cerf** : The characters of systems in involution of partial differential equations.—**S. Mazurkiewicz** : The problem of Lusin.—**F. E. Myard** : Closed chains with five rotoid couples deformable at the first degree of freedom.—**E. Chausse** and **J. Baubiac** : The secondary vortices produced below an obstacle immersed in a liquid.—**Fernand Baldet** : The Raffety bands and the spectra of comets. The radiations from the nuclei of comets cannot be identified with the Raffety bands given by the flame of an oxyacetylene blowpipe.—**Ch. Racine** : Contribution to the study of the static problem in the theory of relativity.—**L. Goldstein** : The application of quantic mechanics to chemical kinetics. **Maurice Robert** : Application of the oxymetal rectifier to the measurements of the maximum potential difference.—**Stanislas Teszner** : Recording mobile waves with a modified Dufour cathode ray oscillograph.—**Louis Leprince-Ringuet** : Relation between the path of a rapid proton in air and the ionisation which it produces. Application to the study of the artificial disintegration of the elements.—**F. Margand** : The damping of the oscillations of polyphase synchronised machines in the theory of two reactions.—**Georges Fournier** : The translation of light intensities into sound intensities. By means of the apparatus described, by listening at a telephone a blind person can distinguish the position of a window or source of light, the surface occupied on a table by a sheet of white paper, and other phenomena of light.—**P. Waguet**, **A. Stampa**, and **J. Dourgnon** : The rôle of irregularities of the profile of reflectors for motor car projectors and their photographic control.—**Daniel Chalonge** : The variations of the energy distribution in the continuous spectrum of molecular hydrogen.—**Henri Grenat** : The identification of the Raffety spectrum.—**Marcel Laporte** : The chemical reactions of ionised gases. The synthesis of nitric acid.—**Cazaud** : The influence of the magnitude of the micrographic grain on the resistance to fatigue of mild steel. The effects of cold-hardening, of annealing, and of overheating.—**Marcel Godchot** and **Mlle. G. Cauquil** : The viscosities, surface tensions, and parachors of some cyclo-hydrocarbons.—**A. Portevin** and **A. Sanfourche** : The attack of the common metals by solutions of phosphoric acid. Twelve metals were submitted to the attack of solutions of phosphoric acid of different origin and of varying concentrations. The results are given in a diagram.—**L. Bert** : The action of 1, 3-dichloropropene on the sodium phenols.—**P. Carré** and **P. Mauclère** : The transformation of the polyatomic alcohols into mono- and polychlorhydrins by means of thionyl chloride.—**E. Calvet**: Velocities and heats of saponification of the amides. The heats of saponification of the amides of the fatty series vary but little from one term to the next, but the saponification velocities vary rapidly, especially for the first terms.—**Lespieau** and **Reginald L. Wakeman**: The preparation of the trimethylene hydrocarbons: 1-methyl-2-propylcyclopropane. Starting with β-brompropaldehyde, methylpropyltrimethylene has been prepared free from its ethylene isomer, as shown by its Raman spectrum.—**Raymond Paul**: Some derivatives of 1, 4, 5-pentane triol.—**Paul Gaubert**: The diffraction rings produced by spherolites with helicoidal structure.—**Robert Lami**: The saline heterogeneity of rock pools on the sea coast during rain.—**A. Guilliermond**: New researches on the microchemical characters and the mode of cytological formation of the anthocyanin pigments.—**Henri Coupin**: An unrecognised factor of the momentary variation of plants.—**A. Ch. Hollande** and **Mme. G. Hollande**: Cytological study of the different stages of the Eberth bacillus (*Bacterium typhi*).—**Charles Richet, Jr.**, and **Jean Dublineau**: The effects of the puncture of the fourth ventricle on the combustion of protein materials.—**Fernand Mercier** and **Léon J. Mercier**: A new sparteine salt, neutral sparteine valerianate.—**G. Champetier**: The formation of the alkali celluloses.—**P. Carneiro** and **W. Kopaczewski**: The nature and specificity of antigens. The experiments described lead to the conclusion that immunity appears to be an electrocapillary phenomenon.—**A. Trillat**: Experiment on infection by air. The case of chicken cholera. The practical conclusion from the results obtained by the author is that chicken cholera can be transmitted by the air, especially confined air: hence poultry houses should be well ventilated in order to free them from the moisture accompanying the gaseous products of respiration.—**C. Levaditi, P. Ravaut, P. Lépine**, and **Mlle. R. Schoen**: The affinity of a virus isolated from inguinal granulomatosis (Nicolas and Favre's disease) for the lymphatic system of the ape.

CRACOW.

Polish Academy of Science and Letters, March 20.—**G. Bouligand**: An application of the paratangent to a problem of superficial measurement.—**Mlle. M. Charpentier**: A topological problem arising out of the theory of the differential equations $\dot{y}=f(x, y)$.—**S. K. Zaremba**: The trend of the integrals of an ordinary differential equation of the first order in the neighbourhood of the singular integral supposed to exist.—**L. Infeld**: The constitution of the wave associated with free electrons.—**W. Kessel**: The complexity of the resonance spectrum of selenium vapour.—**M. Kamieński**: Researches concerning the movement of the periodic comet, Wolf I. Part 12. Disturbances of the path of the comet by Uranus from 1884 to 1919.—**M. Centnerszwer** and **J. Szper**: The electrolysis of fused alkaline nitrites. The products are nitrogen and alkaline oxide at the cathode, nitrate and a mixture of NO_2 and NO at the anode.—**K. Dziewoński** and **J. Moszew**: The synthesis of diethyl-α-α-acenaphthyl-diketone (αα-dipropionylacenaphthene).—**K. Dziewoński** and **J. Spirer**: Syntheses and transformations of two diketones: αα- and ββ-derivatives of acenaphthene.—**K. Konior**: The tectonic of the border of the Carpathians between Biala and Andrychów.—**St. Macko**: Two peat bogs in the neighbourhood of Zamość, studied by means of pollen analysis.—**St. Maziarski**: Genetic studies of the genus *Ægilops*. The morphology and cytology of interspecific hybrids.—**J. Jarocki**: The Mycetozoa of Czarna Hora (Polish Eastern Carpathians).—**J. Zaćwilichowski**: The innervation and the sensorial organs of the wings in insects (2).—**F. Górski**: The action of weak electric currents on chlorophyll assimilation in *Elodea canadensis*.—**M. Konopacki**: The micromorphology of the eggs and embryos of the frog (*Rana fusca*) submitted to centrifugation.

April 13.—**G. Bouligand**: The regular and positive solutions in the whole plane of the equation $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=u$.—**A. Rosenblatt**: The movements adjacent to plane radial movements of incompressible viscous fluids.—**G. Giraud**: Certain non-linear problems of Neumann and certain non-linear mixed problems.—**M. Centnerszwer** and **J. Szper**: The electrolysis of fused sodium metaphosphate.—**K. Dziewoński, Mlle. J. Krasowska**, and **Mlle. J. Schoenówna**: Researches on the acenaphthene sulphonic acids.—**R. Malachowski**: The equilibrium in aqueous solutions of aconitic acid.—**Cz. Kuźniar**: The origin of the mirabilite in the deposits of potassium salts at Holyń and at Siwka.—**L. Marchlewski** and **A. Boryniec**: The absorption of ultra-violet rays by certain organic substances.—**J. Wlodek, C. Strzemieński**, and **E. Ralski**: Researches on 'Czerwone Wierchy', Tatra and Bielsko soils in which mixed plant associations are developed.

GENEVA.

Society of Physics and Natural History, Mar. 19.—**P. Rossier**: The nature of Purkinje's phenomenon. In an earlier study, the author has shown that the intensity of the source and the acuteness of the maximum of the eye sensibility curve vary in the same sense. A more complete calculation enables the conclusion to be drawn that this variation of sensibility is insufficient to explain the observed phenomena: the known diminution of the wavelength of maximum sensibility with the intensity ought to be preserved.—**Ed. Paréjas**: Results of the Harvard University geological expedition in the Canadian Rockies (Jasper National Park), 1929. Note No. 3. The Trias of the Athabaska Valley. The Upper Trias (Norian to Pseudomonotis, cf. subcircularis) has been recognised in the valley of Vine Creek, a tributary of the Athabaska, to the north of Jasper. The underlying formations of Cold Sulphur Spring, Corral Creek, and Fiddle River, attributed to the Trias, are also marine. They have a pronounced detrital character marked by the abundance of the mica grit, the presence of conglomerates and of magnesian breccia of alpine type. The Trias of Jasper Park, about 200 metres in thickness, rests on the Rocky Mountain quartzite formation (Upper Palæozoic).—**E. Joukowsky**: The phreatic sheet of Soral (Canton of Geneva). A well showed the following in section, from top to bottom: post-glacial deposits, 5 m.; Würmian end moraine, 20 m.; fluvio-glacial gravel, 10 m.; stratified clays and sand, 14 m.; fluvio-glacial gravel, 17 m. The water table was at a depth of 58·5 m. The thickness of the water-bearing layer is at present 9·3 metres. The variations of level recorded with the limnigraph during a month, show a direct relation with the pressure recorded on the barograph. Between February 1930 and March 1931 the level has risen more than two metres.

April H. 23.—**Saini** and **J. Weiglé**: A possible transformation of maleic acid into fumaric acid. The authors tried to see if a magnetic field could convert maleic acid into fumaric acid. The results of experiments in a magnetic field of intensity between 5000 gauss and 8000 gauss show that this transformation does not occur.—**E. Briner, A. Demolis, H. Paillard**: The ozonation of aldehydes and the theory of active molecules. Studying this ozonation, the authors have proved an intense activating action exercised by the ozone on the molecules of oxygen. This action markedly increases the yield of oxidations carried out with ozone.—R. Wavre: From the human scale to the terrestrial scale. The author discusses a remark of Helmholtz which the Wegener hypothesis makes of current interest. He shows that the duration of certain phenomena of hydrodynamical order increases as the square of the dimensions. For example, the large but very slow currents in the midst of the terrestrial magma have quite well been able to last for millions of years, even although this magma were very viscous. Care is necessary in passing from the laboratory scale to the terrestrial scale.—G. Tiercy: Silvering telescope mirrors. The method of E. Schaer employed at the Geneva Observatory. The author describes the composition of the baths and gives the characteristics of the Schaer method adopted for silvering the Observatory mirrors.

Official Publications Received.

BRITISH.

Proceedings of the Malacological Society of London. Edited by R. Winckworth. Vol. 19, Part 5, July. Pp. 219-258+plates 26-29. (London: Dulau and Co., Ltd.) 10*s*. net.

Department of the Interior: North West Territories and Yukon Branch. Report of the Director of the North West Territories and Yukon Branch 1929–30. (Fiscal Year ended 31st March 1930) Pp. 28. (Ottawa: F. A. Acland.)

Proceedings of the Society for Psychical Research. Part 121, Vol. 40, July. Pp. 59-104. (London.) 4*s*.

Memoirs of the Indian Meteorological Department. Vol. 25, Part 7: An Analysis of the Base Line Values of Autographic Instruments. By Dr. Sudhansu Kumar Banerji. Pp. 247-278. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2*s*.

India: Meteorological Department. Scientific Notes, Vol. 3, No. 25: Heights of Base of Clouds in India as determined from Pilot Balloon Ascents. By the late M. V. Narayanan and M. P. Manna. Pp. 77-82 (Calcutta: Government of India Central Publication Branch.) 5 annas; 6*d*.

Proceedings of the Edinburgh Mathematical Society. Series 2, Vol. 2, Part 4, June. Edited by Prof. H. W. Turnbull and Dr. E. T. Copson Pp. 181-283. (London: G. Bell and Sons, Ltd.)

Harper Adams Agricultural College, Newport, Shropshire. Report of the Advisory Department, 1930–1931. (Advisory Report No. 6.) Pp. 31. The Work of the Harper Adams Pig Feeding Experimental Station during 1930. By Dr. Charles Crowther. Pp. 7. (Newport.)

Technical College, Bradford. Diploma and Special Day Courses, Session 1931–32. Pp. 232+19 plates (Bradford.)

The North of Scotland College of Agriculture. Guide to Experiments and Demonstration Plots at Craibstone, 1931. Pp. 58. Bulletin No. 37: A Disease-resisting Turnip. By Wm. M. Findlay. Pp. 12. (Edinburgh.)

Indian Journal of Physics, Vol. 6, Part 1, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 20, Part 1. Conducted by Sir C. V. Raman. Pp. 80. (Calcutta) 1.8 rupees; 2*s*.

Geological Survey Department: Tanganyika Territory. Short Paper No. 8: Some Salt Lakes of the Northern Rift Zone. By Douglas Orr and Dr. D. R. Grantham. Pp. 23. (Dar es Salaam: Government Printer.) 4*s*.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1382 (Ae. 507—T. 2918): Some Cases of Flow of Compressible Fluids. By Prof. G. I. Taylor. Pp. 16+5 plates. (London: H.M. Stationery Office.) 1*s*. net.

Eton College Natural History Society. Annual Report 1930–31. Pp. 106+12 plates. (Windsor.) 5*s*.

(University of London): County Councils of Kent and Surrey. The Journal of the South-Eastern Agricultural College, Wye, Kent. (No. 28, 1931) Edited for the College by Dr. S. Graham Brade-Birks. Pp. 313. (Wye.) 8*s*. 6*d*.; Residents in Kent and Surrey, 4*s*. 6*d*.

Board of Education. Educational Pamphlets, No. 85 (Industry Series, No. 10): Report by H.M. Inspectors on the Provision of Instruction in Applied Chemistry in Technical Schools and Colleges in England and Wales Pp 55. (London: H M. Stationery Office.) 1*s*. net.

The Scientific Proceeding of the Royal Dublin Society. Vol. 20 (N.S.), No. 8: Award of the Boyle Medal to Sir John Purser Griffith. Pp. 85-87. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd., Turner's Hill, Cheshunt, Herts. Sixteenth Annual Report, 1930. Pp. 92. (Cheshunt.)

British Museum (Natural History) Picture Post-cards. F32: British Trees—Holly. 2 cards in colour and 2 in monochrome. F33: British Trees—Larch. 2 cards in colour and 2 in monochrome. F34: British Trees—Hornbeam. 2 cards in colour and 2 in monochrome. F36: British Trees—Common Lime. 2 cards in colour and 2 in monochrome. F38: British Trees—Juniper. 2 cards in colour and 2 in monochrome. F44: British Trees—Aspen 2 cards in colour and 2 in monochrome. F45: British Trees—Wild Service. 2 cards in colour and 2 in monochrome. F46: British Trees—Hawthorn. 2 cards in colour and 2 in monochrome. (London: British Museum (Natural History)) 6*d*. each set.

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1930 Pp 231. (Bristol)

Joint Board of Research for Mental Diseases: City and University of Birmingham. Annual Report of the Laboratory for the Year ending March 14th, 1931. Pp. 10. (Birmingham)

Empire Cotton Growing Corporation. Report of the Executive Committee to be submitted to the Meeting of the Administrative Council on July 23rd, 1931. Pp. 10. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), No 9: A Study of Bacteria belonging to the Sub-genus *Aerobacter*. By M. Grimes and A. J. Hennerty. Pp. 89-97. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Norman Lockyer Observatory. Director's Annual Report, April 1, 1930–March 31, 1931. Pp. 8. (Sidmouth.)

FOREIGN.

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 6, No. 6, June, R.P. Nos. 314-328. Pp. 917-1158. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 85, No. 3: Addenda to Descriptions of Burgess Shale Fossils. By Charles D. Walcott (Publication 3117.) Pp. 46+23 plates. (Washington, D.C.: Smithsonian Institution.)

U.S. Department of Commerce: Bureau of Standards. Research Paper No. 325: The Waidner-Burgess Standard of Light. By H. T. Wensel, Wm F. Roeser, L. E. Barbrow and F. R. Caldwell. Pp. 1103-1117 (Washington, D.C.: Government Printing Office) 5 cents.

The Memoirs of the Imperial Marine Observatory, Kobe, Japan. Vol. 4, No. 2, February. Pp 53-226. Vol. 4, No. 3, April. Pp. 227-271. (Kobe.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 305: Raman Effect for Liquid Hydrazine By Sunao Imanishi. Pp. 7. 20 sen. Nos. 306-309: Researches on Hypoglycemia producing Substances, 2: pseudo-Thiourea, Amidine and Urea Derivatives, by Sin'iti Kawai, Tatsuo Hosono, Yoshio Shikinami and Shunychi Yonechi; A Contribution to the Character of Triarylcarbinal Derivatives (1), by Sin'iti Kawai and Kunisaburo Tamura; On the Reaction between 2 4 6-Trichloropyrimidine and Dimethylaniline, by Sin'iti Kawai and Takashige Miyoshi; β-Hydroxy-ethylguanidine and its Condensation with Acetoacetic Acid, by Sin'iti Kawai. Pp. 9-28. 40 sen. (Tōkyō: Iwanami Shoten.)

U.S Department of Agriculture. Farmers' Bulletin No. 1665: The Silverfish as a Pest of the Household. By E. A. Back. Pp. ii+6. (Washington, D.C.: Government Printing Office) 5 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. African and Malagasy Blattidae (Orthoptera), Part 1. By James A. G. Rehn. Pp. 305-387+plates 31-35. (Philadelphia.)

Transactions of the San Diego Society of Natural History. Vol. 6, No. 23: Notes on the Worm Snakes of the Southwest, with Descriptions of two New Subspecies. By Laurence M. Klauber. Pp. 333-352. Vol. 6, No. 24: *Crotalus tigris* and *Crotalus enyo*, two little known Rattlesnakes of the Southwest. By Laurence M. Klanber. Pp. 353-370+plate 23. (San Diego, Calif.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 136: Hardy Perennials for Landscape Planting in Michigan. By C. P. Halligan. Pp 80. Circular Bulletin No. 137: Pests of Apple and Pear in Michigan. By R. H. Pettit and Ray Hutson. Pp. 63. Special Bulletin No. 211: A Comparison of Alfalfa Strains and Seed Sources for Michigan. By C. R. Megee. Pp. 8 Technical Bulletin No. 112: Residual Effects of Fruit Thinning with the Lombard Plum. By J. H. Waring Pp 36. Technical Bulletin No. 114: Fertilizers and Soils in relation to Concord Grapes in Southwestern Michigan. By N. L. Partridge and J. O. Veatch. Pp. 42. Technical Bulletin No. 116: The Fruiting Habit of the Peach as influenced by Pruning Practices. By Roy E. Marshall. Pp. 58. Technical Bulletin No. 117: Experiments with the Tuber Index Method of Controlling Virus Diseases of Potatoes. By J. E. Kotila. Pp. 26. (East Lansing, Mich.)

Zoologica: Scientific Contributions of the New York Zoological Society. Vol. 13, Nos. 1 and 2: Bermuda Oceanographic Expeditions, 1929–1930. No. 1: Introduction; No. 2: List of Nets and Data. By William Beebe. Pp 36. (New York City.)

Bulletin of the Michigan College of Mining and Technology. New Series, Vol. 4, No. 4: Announcement of Courses, 1931–1932. Pp. 145. (Houghton, Mich.)

CATALOGUES.

Zeiss Field Glasses. (List T 500 £.) Pp. 58. (London and Jena: Carl Zeiss.)

Thermo-electric Pyrometers for Indicating and Recording Temperatures to 1400° C. (2552° F) (List No. 194.) Pp. 24. (London: Cambridge Instrument Co., Ltd.)

Apparatus for X-Ray Therapy. (Bulletin T 1.) Pp. 24. Diathermy. (Bulletin W.1.) Pp. 16. (London: Watson and Sons (Electro-Medical) Ltd.)

Liver Extract B.D.H. for the Treatment of Pernicious Anæmia and Allied Conditions. Pp. 13. Elixir Valibrom B.D.H. and Elixir Valibrom Compound B.D.H. Pp. 4. (London: The British Drug Houses, Ltd.)

McGraw-Hill Books on Business and Economics. (List 4.) Pp. 64. (London: McGraw-Hill Publishing Co., Ltd)

Catalogue of Important Natural History, Botanical and Horticultural Works. (No. 17.) Pp. 82. (London: John H. Knowles.)

Respice-Prospice: Lewis's 1844–1931. An Illustrated Account of its Foundation and Development, with a Description of the Services offered to the Medical, Scientific and Teaching Professions. Pp. ii+30+5 plates. (London: H. K. Lewis and Co., Ltd)

A Clearance List of Books on Zoology, Mathematics, Chemistry, Geology, etc., with an Appendix of Valuable and Interesting Books (Clearance List "A '.) Pp. 28. (London: Wheldon and Wesley, Ltd.

SATURDAY, AUGUST 15, 1931.

CONTENTS.

	PAGE
Scientific Men as Administrators	237
Jules Janssen, 1824–1907	239
Physical Attributes in Plant Processes. By L. J. F. B.	240
Living Zoology	242
Short Reviews	243
The Ecological Viewpoint. By Prof. J. W. Bews	245
The Architecture of the Solid State. By Prof. W. L. Bragg, F.R.S.	248
News and Views	251
Letters to the Editor :	
Velocity of Deep Currents in the South Atlantic.—G. E. R. Deacon	267
Subjective Interpretation of Loudspeaker Frequency Response Curves in terms of Loudness.—D. A. Oliver	268
Classification for Bibliography of Science.—Dr. S. C. Bradford	268
The Velocity of Light.—Dr. V. S. Vrkljan	269
The Bottle-Pipe Resonator —A. E. Bate	270
Absorption Spectra of the Ce^{+++} Ion in Solution.—Prof. D. M. Bose and S. Datta	270
Band Spectrum of the Green Flame of Phosphorus —Dr. E. B. Ludlam	271
Ultra-Violet Absorption Spectra of Cyanogen and the Cyanogen Halides.—R. B. Mooney and H. G. Reid	271
The Critical Increment of the Adsorption of Hydrogen on Amorphous Carbon at 400°–520° C.—Dr. F. E. T. Kingman	272
Intensity of Raman Scattering in Gases.—S. Bhagavantam	272
Anomalous X-ray Diffraction Intensities.—W. A. Wood	272
Research Items	273
Astronomical Topics	274
Royal Society of Canada. ANNUAL MEETING IN TORONTO	275
Conference of Empire Survey Officers, 1931	276
Coloured Glass as a Deterrent to House Flies	277
University and Educational Intelligence	278
Birthdays and Research Centres	278
Societies and Academies	279
Official Publications Received	280
SUPPLEMENT	
Noise and its Measurement. By Dr. G. W. C. Kaye, O.B.E.	253

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Scientific Men as Administrators.

FREQUENT reference has been made in these columns to the relative positions of administrative officers and of scientific and technical officers in the service of the State. As we remarked when discussing the report of the Royal Commission on the Civil Service (NATURE, Aug. 8), proficiency in science whether pure or applied is regarded almost as a disqualification for a high administrative post, the suggestion being that knowledge of a particular branch of science makes a man biased in favour of that branch. The corollary of this proposition is that the best administrator is one who has no scientific knowledge at all, even though every day he has before him problems which can only be understood and solved with the aid of science.

It is not strange that this paradoxical condition of things should have resulted in much dissatisfaction among scientific and technical officers in Government service, both in Great Britain and overseas. They find themselves frequently in distinctly inferior positions in comparison with those occupied by men who graduated in literary or historical subjects, and their rates of pay as well as promise of promotion are similarly on a lower scale, purely because they chose to take science for their degrees. No one could suggest for a moment that a science student is essentially of lower mental capacity than one whose inclinations are in literary fields, and it cannot be held that the knowledge and training he receives in his scientific course are detrimental to efficient service in a modern State. Notwithstanding this, we find that of two men with equal academic distinctions in the two different fields, one with a science degree is expected always to be subordinate to his fellow who graduated in ancient languages and literature.

Specialists are largely employed as a matter of insurance to safeguard the production of animal and plant materials and of minerals, or to watch over the health of the community. The last function is carried out by the medical officers, who are members of a well-organised and by no means inarticulate profession. It is far otherwise with most specialist services, and here the differential rate of pay, which particularly in a Colony may mean a lower position and social life, is a serious matter.

The problems to be considered by the scientific man in the Colonial Services are not those of his own choice; they are governed by local circumstances. Text-books and laws to which he can refer are non-existent, for the difficulties of each country have an individuality of their own. Such a man is paid on an average about twenty-five per cent less than his brother of equal academic standing, from the same university, who is in the administration—and this is often associated with longer terms of service, fewer higher posts to which he can aspire, and always by a relatively lesser pension. As compared with an academic career, the initial pay and security are often better, but there are singularly few posts carrying salaries equal to those of professors in the greater universities. The relative liberty of the latter is so well known to their students that those with the highest academic distinctions prefer teaching and research to State service.

Of course, especially in modern civilisation, the State must employ men of the highest class in all its services. This is particularly the case in the Civil Service, which was the concern of a Royal Commission in 1912–14. A Treasury Committee (1917) afterwards remodelled its examination through which the Higher Civil Service, the Indian Civil Service, and certain Foreign Office, Consular, and Colonial Services are recruited. In this examination all candidates must first qualify in a section which allows 100 marks each for five compulsory subjects, namely, essay, English, present day (questions on contemporary subjects), everyday science, and auxiliary language, and 300 marks for vivâ voce. In another section 1000 marks are distributed, *at the choice of the candidate*, amongst sixty-one subjects that represent every side of the teaching of universities. The age limit is twenty-four, and the examination is obviously arranged in reference to university courses of instruction. The following sciences are represented by papers of Lower and Higher Grades, for each of which 200 marks is offered, and both grades of which can be taken: chemistry, physics, botany, geology, physiology, and zoology. Of kindred subjects a candidate can take five papers, each of 200 marks, in mathematics, and usually there is little blending of this subject with science. The same remark applies to engineering and geography, to which are severally assigned 400 marks; to two sections of anthropology, each 100 marks; and to agriculture, 200 marks.

Science candidates have little to criticise, for the compulsory subjects represent a necessary, minimal, general education. Still less can they object to the vivâ voce, for it is the only practical means of estimating personality, especially as seen in the gifts of sympathy, readiness, and resource. In any event, it reduces an element of uncertainty common to all examinations, and the pure examinee will be accepted even if he possesses none of these gifts, and it is to be hoped that his deficiencies will be hidden in a useful, impersonal job. The study of the marks assigned in the vivâ voce is interesting, for it shows that the qualities sought are not peculiar to candidates from any single class of life or of learning, the examination being above suspicion.

The small importance of the subject of "Everyday Science" is perhaps more open to criticism in a State which largely owes its position to the application of science. The average individual would understand, by such a title, an elementary knowledge of his own actions and of the world around him. The examiner (1930) is apparently dominated by academic teachings, since candidates are asked about relativity, molecules, and atoms, the distance of heavenly bodies, adaptations of birds for flight other than wings, communal life among insects, and so on. To judge by the marks, this was a satisfactory paper, but such questions could be answered better by judicious cramming than by a general scientific education. In the separate sciences the Higher Grade is of similar standard and type to that of the final honours examination of universities, and so should afford a reasonable scope to specialists in science.

The schemes of the voluntary papers are all on the same lines; they include all the subjects taught in universities, and thus reflect the life and requirements of the nation. To ensure a Civil Service ready for all emergencies, each side of educated thought and progress should be adequately represented therein. It is accordingly evident that if any branch of learning, which is vigorous and promising in the country, should show numerical poverty in the Civil Services, there is a condition which calls for explanation and possibly remedial measures. Applying this criterion to the present state of the Civil Service, we find there a startling lack of scientifically educated men. In these circumstances it is difficult to understand how the independent scientific services of the State can be understood and properly used by an administration unfamiliar with the methods and aims of scientific workers. Here are the analysed figures for the higher examination of the Civil Service for 1930:—For the Foreign Office and Department of Overseas Trade, only 1 candidate out of 67 took any of the voluntary scientific subjects. For the Home Civil and Indian Civil Services and for the Eastern Cadetships there were 316 candidates, of whom only 20 presented science as the predominant group of their choice. Of these, 17 offered lower and 9 higher chemistry; the number in physics was 15 and 10; botany, 4 and 3; geology, 5 and 1; and zoology, 4 and 3. There were no candidates in physiology; 4 candidates sat for engineering, and 2 for geography.

Civilisation being so closely coupled to-day with the developments of science, these figures reveal a position which should be altered. These cover every field in Great Britain and the Dominions, but at present are mainly biological in the Crown Colonies. The basal factor in the latter is the native of the country, who is being profoundly altered by the introduction of hygienic conditions. The problem of the 'poor whites' in the Southern States of America has its counterpart in almost every Oriental country. Malaria, yellow fever, bilharzia, and a host of other diseases are ceasing to be endemic in successive generations. As a result, the future natives of many of these countries are likely to be physically and mentally superior to their ancestors. To-day there is everywhere an increasing call for science in the development of the races themselves and of the countries which they occupy. It follows that success in administration here will increasingly depend not on the knowledge of the history of colonisation and of the theories of governance, but on the scientific understanding of the changes wrought in the last hundred years and of the psychology of the governed.

Teachers of science must wake up to their responsibility in this matter, which is to direct the attention of suitable candidates to the needs of the State. For research, students of peculiar aptitude and mentality are required, and they for the most part desire to concentrate on one section of natural phenomena. There is a bigger class who have no such predilections in the early stages of their work. They want to understand all the diverse sides of science—physical, chemical, biological—with often a special fancy towards the economic, rather than to follow out any one line. They are as fitted as any other students for appointments in administration, and it is to this class that the Empire must look for its future administrators. Such men would have peculiar sympathy with the work of scientific men in their districts and encourage the application of their economic results. Their knowledge would inevitably create in themselves a deep interest in the country in which they dwell, thus adding to their happiness and efficiency. A special responsibility therefore rests upon those at the universities who have it in their power to influence likely science students to compete for administrative posts in the Civil Service.

Jules Janssen, 1824–1907.

Œuvres scientifiques. Par Jules Janssen. Recueillies et publiées par Henri Dehérain. Tome 1. Pp. vii + 545 + 12 planches. Tome 2. Pp. 648. (Paris: Société d'Éditions géographiques, maritimes et coloniales, 1929.) n.p.

THESE two imposing volumes are the second fruits of the devotion of Mlle. Janssen to the memory of her father. On Janssen's death, in December 1907, she took upon herself the task of raising a memorial of his long and distinguished scientific career, and with the co-operation of M. Dehérain, whose father and Janssen had been close friends from boyhood, a fund was accumulated for the erection of a monument on the terrace of the observatory at Meudon, which, during a period of more than thirty years, "he had paced with slow and regular step". The undertaking was on the point of consummation when the War supervened, and, laying aside all other considerations, Mlle. Janssen devoted herself throughout the ensuing period of hostilities to the care of the wounded. At the conclusion of the War this project was resumed, and on a beautiful afternoon in October 1920, a distinguished company paid homage to the memory of the dead astronomer.

Monuments are symbols; but a great man's works are realities; they alone are his true memorial. During his long life, Janssen wrote much but he never published a book. Mlle. Janssen accordingly began the collection of the articles and the writings which her father had contributed to various periodicals, and in this again she had the assistance of M. Dehérain. Unhappily, she has not lived to see the completion of this second mark of filial devotion. Among her last wishes was the desire that M. Dehérain would carry the project to fulfilment, and the volumes before us testify that he has discharged his commission in a manner of which she would assuredly have approved.

Janssen's long list of scientific works began in 1859, with a carefully prepared and illustrated paper describing experiments on a property of the eye relative to radiant heat—a thesis which was presented for the doctorate of physical science to the Faculty of Sciences of Paris. This involved him in some correspondence, and later in work with the ophthalmoscope. It was a natural transition from this to the spectroscope and spectrum analysis, which, in its turn, directed his attention to the heavenly bodies, and thenceforth Janssen's labours were almost exclusively astronomical in character. His first astronomical problem was concerned with the possibility of detecting the existence of a lunar atmosphere by means of the spectroscope. Many years later he returned to this subject and was able to settle the question definitely by observations of a partial eclipse of the sun.

Janssen's name will long be remembered through two brilliant pieces of work—his invention of the method of observing solar prominences in full daylight, and his beautiful and still unrivalled photographs of the solar surface, showing the granulations which he named the "réseau photosphérique". The former achievement, which, as is well known, was announced to the Paris Academy of Sciences simultaneously with that of an identical but independent discovery by the late Sir Norman Lockyer, might almost be said to be the most important event in the history of solar physics, for with it began the long and extremely fruitful course of observation—aided later by the spectroheliograph—which has culminated in the present physical theory of solar and stellar atmospheres. The French Government was not slow to recognise the significance of the discovery, and it at once set about the establishment of an observatory for Janssen, which, in spite of the disastrous war of 1870–71, was erected, first at Montmartre and later, in 1876, at Meudon.

Mention of the Franco-Prussian War reminds us of Janssen's historic escape from besieged Paris by balloon to observe the solar eclipse of December 1870. "En dépit du siège," he wrote to the Academy in October of that year, "et sans avoir à demander à nos ennemis le passage à travers leurs lignes, un observateur pourrait, au moment opportun, se diriger vers l'Algérie par la voie aérienne ; il emporterait seulement avec lui les parties les plus indispensables de ses instruments, sauf à les compléter à Marseille avant l'embarquement. Si l'Académie veut bien m'accorder son appui pour la continuation des travaux dont je viens de l'entretenir, une partie des ressources pourrait être employée à la réalisation de ce projet et je m'offrirais pour tenter ce voyage, heureux de donner ainsi à la science ce témoignage de mon entier dévouement." The observations, unfortunately, were ruined by clouds ; but the incident is eloquent of the ardent spirit of the man.

These are the achievements by which Janssen is mostly remembered ; but it should not be overlooked that much of his other work has become so absorbed into the traditions and common data of astronomy, that its authorship is almost forgotten. It was Janssen who gave us the term 'telluric lines', and he not only did work of fundamental importance in identifying such lines, but also placed their origin beyond doubt by observing them in the spectrum of a bonfire at a distance of 13 miles. For his observations of the transit of Venus in Japan in 1874 he invented a "revolver photographique", which is, in principle, the modern cinematograph, yet who thinks of Janssen in connexion with that device now ?

The volumes under consideration, which are enriched by some beautiful photographs, tell of a long lifetime devoted with conspicuous success to the service of science. M. Dehérain has done his work well ; he has given us a fitting memorial of a great man.

Physical Attributes in Plant Processes.

Life Movements in Plants. Edited by Sir Jagadis Chunder Bose. (Transactions of the Bose Research Institute, Calcutta, Vol. 6; 1930–1931.) Pp. vi + 211. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1931.) 18*s*. net.

IT is now almost axiomatic that, to get what you want involves continuous perseverance, often patient repetition, and sometimes decades of undivided attention and devotion. Perseverance underlies the success of things which primarily may have seemed impossible. Men and women have fought, have devoted their lives, and have even given their lives, in order to achieve the apparently impossible. Some aims are impossible, and that is one reason why, whereas some champions have been successful in reaching their ultimate goals, others have fallen by the wayside.

We wonder into which category Sir Jagadis Chunder Bose will ultimately be placed. For about thirty years now, he has fought the cause of the physiological against the purely physical in plant physiology ; also to prove that plants and animals exist by virtue of the same inherent phenomena. "The results of the experimental investigations that have been carried out in my Laboratory during the last thirty years suffice to prove that the mechanism as well as the life-processes in the plant and in the animal are essentially similar." His prolific publications go to show his firm conviction of this.

The physiological concepts of Bose, his firm belief that physiological phenomena succeed in explaining where physics fail to explain certain life processes, are well known to every experimental physiologist. To lift the science of plant physiology from the morass of chemistry, physics, and mathematics and to relegate it to a more exclusive position has been the life-work of this experimentalist—this maker of a mixture of poetry and science, as Prof. Donnan chose to call him. Bose is not only convinced of such possibilities, but also believes them to be proved. But we are still looking forward to the time when more of the ‘ physical physiologists ’ enter the lists with our physiological knight-errant and bring the issue either to a more definite understanding or, better still, a decisive climax, one way or the other. This state of scientific chaos, which exists in the mind of the physiologically interested onlooker, seems to be due apparently to two reasons: one, Bose's ignoring the work of his contemporaries to a large extent, and the other, the silence of his contemporaries; the latter probably being the more cogent.

This new publication helps the reader little in this respect. It is edited by Bose, who himself contributes short essays, interspersed as introductions to the other papers ; but every author of the various chapters is a worker at the Bose Institute and, judging from the work done and the conclusions arrived at, each one seems to have imbibed to the full the philosophy of his director.

Many interesting new experiments are recorded, with methods constructed on true ‘ Bosian ’ lines, which need no introduction to the physiologist; but nothing very new is added to our stock of knowledge, hypotheses or contentions, where plant irritability and the ascent of sap are concerned.

We would rather see references to such works as Pfeffer's “ Plant Physiology ” and “ Strasburger's Text-book of Botany ” omitted in favour of more up-to-date works, and the conclusions of contemporary plant physiologists either made compatible with those of the vitalist or completely and irreparably refuted. But probably the others are really to blame. An almost eerie silence has pervaded this branch of botany for some years, which leaves us almost bewildered with perplexity. What is the reader to believe ?

The revival of a drooping leaf on irrigation, and correlated experiments, demand much attention of Bose and his co-workers in “ Life Movements ”. The rapid erection of a wilted, vaselined leaf on irrigation, as shown by Bose on pp. 14 and 15, and the failure of a poisoned leaf, similarly treated, to respond to the supply of water, certainly seems, as the author claims, to demonstrate the presence of some type of propulsive activity within the plant, which is independent of transpiration. The attainment of the erect position in about three minutes is indeed very quick, unless *Centaurea lanata* is a physiological monstrosity. The experiment is simple enough, ‘ fool-proof ’ as Bose described some of his experiments at the meeting of the British Association at Oxford in 1926. Why other physiologists cannot check such a conclusion by simple repetition of the experiment, especially one which is so antagonistic to the generally accepted conceptions (so far as we dare have any) of the ascent of sap, is very difficult to understand.

Chapter iii. is devoted to further work along the same lines on the characteristics of the erectile response of leaves, by U. C. Sen. Varying conditions are examined and their results recorded. Bose himself, in Chap. iv., describes his ‘ diagnostic ’ methods for recording erectile response of the leaf by the electromagnetic tapper and the automatic recorder. Not so ‘fool-proof’, we imagine ; for, here, Bose is in that electrophysiological element peculiar to his own ingenuity. Further conditioning factors are examined by G. P. Das in Chap. v.

The effect of temperature of the water of irrigation on the rate of the ascent of sap is recorded by J. P. Sirdar in Chap. vi. Very important data are brought to light. Suction is annulled below 5° C. and then follows a steady logarithmic curve to 35° C. At the maximum temperature, investigations ceased. This is surprising in a worker who has clearly boosted the physiological against the physical. At just above 35°, many plant physiological processes begin to fall off, owing to the so-called killing of the tissues. In these inquiries, with vital propulsions and rhythmic activity at issue, we should expect that studies of the effect of temperature just above 35° would have been equally as important as those below. The results obtained from such temperatures and incorporated in the graph on p. 69 might have proved of the greatest utility. It is a pity that this has not been done, especially since previous experiments with water only at temperatures of 4° and 30° and 4° and 35° gave results which might have been expected, whatever view of the mechanism of the ascent of sap we are prepared to accept.

The effect of various normal and artificial factors on the pulsatory movement of the leaflet of the now too familiar *Desmodium* constitutes the basis of the work by Bose and Deb, recorded in Chap. viii. Here, again, greater value might have been attached to the results, when examining the effect of temperature, had the investigators used several

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temperatures *seriatim* instead of the minimum of 4° and the optimum (?) of 35° only.

Coming to the identity of plant with animal mechanisms, B. K. Dutt, in Chap. xii., shows that just as excitatory impulse is initiated by a specific polar action of an electrical current in the conducting nerve of an animal, so it is in the case of plants. Observations were made at different values of E.M.F. Another all too familiar plant, *Mimosa,* was used as the subject. After all, such plants are almost physiological freaks, and to generalise from such particular cases is scarcely good logic, or fair play. Bose and N. N. Das carried out similar experiments on the nerve tissue of *Bufa melanosticus* and, having obtained like results, conclude that " The results conclusively prove that the transmission of impulse in plants is an excitatory process of the same nature as that of the nervous impulse in animals ". Similar conclusions are arrived at as a result of experimentation with the nerve of *Rana* and also *Mimosa.* But all this conveys nothing new so far as theoretical conceptions are concerned.

The book concludes with some work by Prof. N. C. Nag and H. N. Banerjee on the " Proteolytic Enzymes in *Carica papaya* " and by Nag and K. N. Bose on " Chemical Examination of some Indian Medicinal Plants ". Nag and Banerjee disagree with Willstätter, who considers that papain contains only a single protease, and this of a tryptic nature. Their findings come more in line with those of Vines, who states that there are two enzymes present, one of a peptic nature and the other ereptic. In this chemical work it is refreshing to see contemporary and past investigations taken into account, which considerably enhances the value of the results obtained.

This chronicle of contemporary work being done at the Bose Institute, Calcutta, gives us very little that is now startling. Yet it serves one valuable purpose. It supplies much evidence which may easily be verified by other workers. We should like to see this done ; but are beginning to despair of such hope. In any case, the book should be on the shelf of every physiologist, for if he is sympathetic with the views of Bose, it will help to give him still further satisfaction. If, on the other hand, he supports the more physical views and prefers to segregate plant from animal processes, the book should give him another opportunity for putting his own house in order. But we doubt if the book will carry enough conviction to change the opinions of anyone.

L. J. F. B.

Living Zoology.

Principles of Animal Biology. By Prof. Lancelot T. Hogben. Pp. xxiv + 332. (London : Christophers, 1930.) 8*s.* 6*d.* net.

THE main problem before the writer of an elementary text-book is usually what to leave out. Prof. Hogben, by leaving out most of the contents of other elementary text-books, has succeeded in writing a book which should interest not only the intelligent student, but also his teacher. Throughout it the animal is dealt with as a group of events rather than a structure. The anatomy of the circulatory system is only considered after a general account of its physiology has been given ; the brain and its nerves are rather summarily described after a more detailed account of reflexes and the behaviour of isolated nerves and muscles.

What is more, zoology itself appears as a growing and far from adult science. The second part of the book is devoted to genetics and evolution, and comparative anatomy is introduced not as an end in itself, but as a means to classification. Thus the molluscs are described to explain why Cuvier's classification was superior to Lamarck's, and the cœlenterates in turn justify Leuckhart's emendation of Cuvier. So much space is devoted to the evolution of zoology, that the even more fascinating though more speculative study of the evolution of animals is perhaps treated a little summarily. Thus the clearest demonstration of evolution is to be found in the study of continuous change in such organisms as *Micraster* or *Gryphœa,* and some account of these gentes might have been more appropriate than a repetition of Dr. Buckland's alleged joke about glacial striation.

A very satisfactory account of elementary genetics is given, though this does not include the fact, which might have induced the author to alter the argument of his last two pages, that organisms can now be produced experimentally which will breed freely together, but not with their parents. A set of problems in genetics, though well chosen, unfortunately refer entirely to the domestic fowl and *Drosophila melanogaster.* Just as good data could have been obtained from the genetics of men, other mammals, fish, crustaceans, and gastropods. It would seem that the very men who are trying to dethrone the old morphological types such as the frog and dogfish are in danger of setting up *Drosophila,* an animal whose genetics are far from typical, as the principal genetical type.

It is doubtful how far this book will be adopted as an elementary text-book of zoology. Undoubtedly a medical student who had mastered it would be far better prepared for his medical studies than is now usually the case. But from what one knows of the history of university teaching, so violent a change is improbable. If it is made at all, it is likely to be made in stages. Meanwhile we can think of no volume of its size more suitable than Prof. Hogben's to supplement the orthodox zoological text-book, in the hands of both intelligent students and teachers. In this capacity, at any rate, it is to be hoped that it may find a wide circulation.

Short Reviews.

The Origin of Life. By Gilbert Rumbold. Second Impression. Pp. 128. (London: The Norfolk Press, 1931.) 5*s.*

THE true philosophical mind is not connoted exclusively by an ability of learned and scholarly criticism of existing theories, but primarily by the inquisitive attitude which has really given birth to philosophy, and the courage and power of stating one's findings about the problems considered. The author of "The Origin of Life", though not a professional philosopher, displays in his book a true philosophical mind in presenting to us his particular answer to the time-honoured question which he asked himself, "What is it all about?"

Seeking unity of structure and purpose in the world in which we live, the author claims to have found a more adequate explanation of life by means of his "Proton Theory of Living Matter". This theory, which reminds one of a combination of Epicurean physics with Leibnizian monads and Darwinian selectionism, the whole mashed with the language of contemporary physics, is simple and suggestive. In order to bridge the gap between mind and matter, the author imagines the existence of 'egos' or 'earth-minds' of which human minds are but a sub-class. These 'egos' have the property of expressing themselves in the world of matter, the size of their 'modes' of expression being no wider than the proton nucleus of an atom. Then intervenes the principle of natural selection, which directs the 'egos' to meet other 'egos' and thus form the original cells of the living matter. The establishment of a proper hierarchy between these formations leads to an all-embracing explanation of life, while secondary developments of this theory offer tentative explanations of habit, instinct, sex, and suggest possible solutions of some higher problems of philosophy.

These views are indeed very interesting; but before discussing them in detail, one would wish Mr. Rumbold to expand his epitome in such a way as to show exactly the intermediary steps between his dogmatic assertions, and to indicate the connexion of some of his expressions with the standard theories they inevitably conjure up in his readers' minds.

T. G.

Annales de l'Institut Henri Poincaré. Fascicule 2, Vol. 1. Pp. 77-203. (Paris: Les Presses universitaires de France, 1931.) 35 francs.

THE first number of the *Annales* was noticed in NATURE of Oct. 11, 1930 (p. 564). In the second number we have de Donder on Einstein's theory of gravitation, Pólya on some points in the theory of probability, Lévy on the fundamental theorem of the theory of errors, and Kostitzin on some applications of integral equations.

De Donder's paper is a summary of a series of six lectures dealing not only with relativity, but also with wave mechanics and thermodynamics. He tries to show that, contrary to a widely held belief, there is no need to modify the general theory of relativity, for if this is understood in a sufficiently wide sense it is in harmony with the most modern theories of wave mechanics. There are several references to the work of J. M. Whittaker, and it is pointed out that the material tensor, the electric current, and the photonic currents properly so-called are all expressible in terms of Whittaker's photonic potentials.

Pólya's paper is divided into two distinct parts. The first deals with a characteristic property of the Gaussian or normal law, while the second deals with other laws of frequency, obtained by the superposition of small causes which are not independent of one another. Lévy's paper also deals with the normal law.

Kostitzin's paper deals with integral equations which have an infinite number of solutions. He advances the view that by restricting ourselves to linear equations with unique solutions we get an impression of definiteness and causality in Nature which is valid only as an approximation. The multiplicity of solutions corresponds to the more modern view of indeterminacy in detail, with definiteness arising only from a statistical average. In an interesting preface it is suggested that the sceptical and even pessimistic tone of Poincaré's last utterances on the physics of his time was due to his insight into its concealed weakness and his power of anticipating future developments.

H. T. H. P.

Animal Ecology and Evolution. By Charles Elton. Pp. 96. (Oxford: At the Clarendon Press; London: Oxford University Press, 1930.) 4*s.* 6*d.* net.

THIS little book consists of three lectures, "The Regulation of Numbers", "The Significance of Migration", and "The Real Life of Animals". An environment is an entity composed of plants and animals, the species of which are constant. But it is pointed out that the numbers of the different species of animals vary not only in accordance with the periodic changes of temperature, rainfall, etc., but also in an irregular manner. There may be an optimum density for a species and, when its population varies too far from this, the species changes its behaviour. The most obvious change is that of migration into a region which may be very different from its old home, a new habitat. It seems to be an inherent impulse, for the individuals which migrate are often annihilated, without in any way eliminating the impulse in the species when the disadvantageous circumstances which caused it recur.

The emphasis on migration rather hides the fact that every free living animal has in the small affairs of its life a considerable amount of freewill. Examples are given, all from air living animals, but we think they would be easier to understand and found to be even stronger in aquatic forms. The third part is really an examination of these views with regard to the current conceptions of evolution. The idea of all structure in animals having an adaptive relation to the environment is surely out of date amongst zoologists, as also is the formation of species by natural selection by the accumulation of small variations. The whole question of mutations arises, and we agree that "without the aid of any adaptive advantage" such will never be able to spread beyond a certain point. But, if mutation has once occurred, the potentiality is there in the species and it may often reappear. We do not propose to follow the author in his discussion. We content ourselves with thanking him for indicating many sides of the study of living animals that may be pursued with advantage. J. S. G.

The Heavens and the Universe. By Prof. Oswald Thomas. Translated by Bernard Miall. Pp. 288. (London: George Allen and Unwin, Ltd., 1930.) 7*s.* 6d. net.

THIS book has been written by a star-lover for star-lovers. It is couched in simple, conversational language, suitable for the earnest but not very learned mind. The author has for many years been accustomed to conducting night excursions into the woods near Vienna for the purpose of observing and studying the heavens, and he here tries to extend the usefulness of his talks to a wider circle. He has done very well. The book will appeal to the many persons whose interest in the sky will always be primarily a sentimental one, but who, nevertheless, feel a desire to know something of what the astronomer by his cold, intellectual inquiry has been able to discover. Prof. Thomas tells him this in a way which he will appreciate; the style is humane without undue preciosity. Anecdotes are common and usually to the point, and the illustrations have been successfully conceived.

The professional astronomer will probably meet with statements which will seem to call for criticism, but if he is wise enough to remember the purpose of the book he will turn a deaf ear to them. They are, in any case, few and of little significance, and the negative virtue of freedom from inaccuracy counts for little beside the many positive virtues which characterise the book. The translation—which achieves the merit of not being recognisable as such—is very satisfactory. Prof. Thomas's book is possibly the only popular astronomy which contains no photographic illustration. This, it must be confessed, is a defect, but the reader will probably have become so familiar with some of the admirable celestial photographs now available in such a variety of ways that the disadvantage will be reduced to a minimum.

Intermediate Mechanics. By D. Humphrey. Vol. 2: *Statics and Hydrostatics.* (Longmans' Modern Series.) Pp. xi + 438. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 10*s.* 6*d.*

THIS very competently written volume, designed to cover "all requirements up to Higher Certificate and University Scholarships standard", leaves one with a dream-like feeling that the Saturnian days of the old Cambridge mathematics have not yet passed away. Here are no philosophic doubts concerning the definitions of force and matter; a balance must still be (i) *true*, (ii) *sensitive*, (iii) *stable*, and (iv) *rigid*; the conventional systems of pulleys are carefully and clearly explained, with illustrative examples of every degree of ingenuity, and not so much as a picture of a Spanish Barton: and all our old problems concerning rods in bowls, jointed rhombuses, slipping ladders, sliding rings, jamming drawers, and examples of practically every type of question that the perverted imagination of an examiner can suggest, are assembled under their due headings and worked out in clear and orderly fashion. The book expands beyond the limits usually assigned to such work in well-written and fully illustrated chapters on beams and catenary problems, on graphical statics, and on virtual work.

There is no doubt that the book will provide all the guidance necessary for candidates taking examinations of the Intermediate standard, and will serve as a useful introduction to more advanced work. Whether books of this type are of real assistance in the training of engineers or of mathematicians is a matter concerning which we do not express any opinion. A. F.

A Compilation of Culture Media for the Cultivation of Micro-organisms. By Prof. Max Levine and H. W. Schoenlein. (Monographs on Systematic Bacteriology.) Prepared at the request of the Society of American Bacteriologists and financed by a Grant from the Digestive Ferments Company, Detroit, Michigan. Pp. xvi + 969. (London: Baillière, Tindall and Cox, 1930.) 67*s.* 6*d.* net.

THIS large volume is a compilation of various media used for the cultivation of bacteria, yeasts, and moulds. In all, about seven thousand have been assembled. These have been subdivided primarily into groups on the basis of physical characteristics and the nature of the solidifying agent used, and secondarily upon the chemical characteristics of the media. The use of each medium is indicated.

The book is one of a series of monographs on systematic bacteriology and was prepared at the request of the Society of American Bacteriologists. References are given with each medium, and an excellent list of references at the end of the volume. The compilation of so vast an amount of scattered material is difficult, and has been admirably done. The book is a valuable addition to bacteriological literature.

The Ecological Viewpoint.*

By Prof. J. W. BEWS, Principal of the Natal University College.

THE study of the history of science, and particularly the detailed history of single sciences, is of very great importance for all scientific workers. The history of botany is as interesting as any. As the content of the subject, like other sciences, increased so vastly during its development, specialisation in modern times became inevitable. Specialisation in itself is not necessarily a bad thing, indeed it is necessary for the progress of science; but by itself it is not enough. Specialisation should be combined with as sound a knowledge as possible of the subject in general.

The question is whether botanical specialisation in these days has become universal. Are there any botanists left who adopt the right attitude of mind? The answer is that this is exactly the claim put forward by the ecologist. Ecology, as its followers have maintained, is not a special branch of botany; it is simply a way of looking at the subject. The ecologist adopts what one might describe as the holistic point of view. Ecology seeks to explain, as fully as possible, not only why plants occur where they are found, but how and why they are as they are, and why they behave as they do. It is, therefore, essentially synthetic. It draws upon palæobotany, for example, because to understand why plants are as they are to-day it is necessary to study their past history. The study of plant pathology is essentially ecological because disease in plants, as in animals, is due to maladjustment to their environment. Experimental work in ecology, as Clements has pointed out, is purely a study of evolution, and the facts of the latter are the materials with which taxonomy deals. The value of genetics to the ecologist is sufficiently obvious. Ecology and physiology are clearly so allied that the latter may very well be included in the former.

SOUTH AFRICAN ECOLOGY.

In many ways in South Africa I was fortunate, for, when I began work here in 1910, I was brought closely into touch with the late Dr. Medley Wood, with Dr. T. R. Sim, with Dr. Marloth, Mr. J. S. Henkel, and others from whom I was able to learn a great deal in a comparatively short time. Descriptive ecology can, of course, be made as detailed as one pleases, but the recognition, description, and rough general analysis and distribution of the major plant communities in Natal and some other parts of South Africa could be carried through fairly rapidly.

The second stage of my South African ecological studies dealt with the developmental history of various plant communities, or what is commonly referred to as plant succession. One of the most important things is to be always on the lookout for cases of plant suppression, that is, examples of one type of plant being killed by another. For example, as one walks along the margin of a forest one can often discover the dead remains of light-demanding shrubs just within the outside belt of trees. This means that the forest is progressive and is gaining ground at the expense of the surrounding grassland. Similarly, in the grassland itself, tufts of deep-rooted wire grasses (*Aristida*) may be found being smothered by the more shallow-rooted, more luxuriant red grass (*Themeda*).

Everywhere, a dead or dying plant should act as a 'flag signal' to the ecologist. The immediate cause of death is usually the attack of some fungal or bacterial parasite. But the more remote causes are various, depending usually, in a general way, on the lack of power to respond to changes in the environment, and, since the biotic environment is most liable to change, death is most often brought about in this way. One stage of development of the plant community gives way to the next, until a climax, a more or less stable condition, is reached.

As soon as one has obtained a sufficient number of carefully recorded comparative observations in different areas, a complete analysis of the full developmental history of any plant community can be given, and, for the more important plant communities in South Africa, that has been done. Over the whole eastern side of South Africa the main course of the plant succession is similar to that found in other parts of the world. Bare surfaces are colonised by light-demanding plants, among which annual weeds and other 'ruderal' plants are common and characteristic. The earlier stages of all succession on dry land are more xerophytic than succeeding stages.

In a pastoral country such as South Africa, the proper management and control of the natural pastures is of paramount importance. It is possible to sum up almost in a single sentence what are the results of overstocking, veld burning at unsuitable seasons, and other modes of interfering with the natural vegetation. Man's interference always tends to send back the plant succession. Climax stages are destroyed and earlier stages take their place. Over wide areas of climax grassland this is undesirable, for the earlier wire-grass stages are less palatable and less nutritious. On the other hand, in forest climatic areas it may be a good thing to replace trees and shrubs by earlier pure grassland stages. A careful study of the plant succession can show us when burning the grass is necessary and when it is not. There are many other practical problems in connexion with veld management that can be solved by studying plant succession, plant indicators, and, in general, applying field ecological methods.

Pioneer species tend to be very widespread; they are more plastic physiologically; they show a greater range of physiological variation. It is also particularly interesting to note that pioneer species are usually to be regarded as advanced types from the phylogenetic point of view. On the other hand, the species that belong to later stages of the succession differ in all these respects from the pioneers. They are much more numerous than the pioneers, and they belong to a greater variety of growth forms, since, in addition to the dominating species, there are so many that occupy subordinate positions. One of our South African forests, for example, does not consist merely of trees. There are abundant climbing plants, epiphytes, shrubs, undershrubs, and herbs, as well. Since they vary so much in form, so also they vary in their phylogenetic standing. Many of the trees are relatively primitive in this respect. Some of the subordinate forms may be very advanced. For the climax stages the living environment (or biota) is as important as, if not more so than, the inorganic environment.

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* From the presidential address delivered on July 6 to the South African Association for the Advancement of Science, at Grahamstown.

The third phase of the ecological work which I have been privileged to carry out in South Africa followed naturally from the previous work. It consisted in the study of the interrelationships of taxonomy (based on phylogeny) and field ecology, and in particular dealt with the origin and migrations of the South African flora and the evolutionary history of plant forms. More recently I have applied the same methods to the study of a single group of flowering plants—the grasses.

By combining the study of taxonomy with the study of distribution it soon became apparent that the oldest flora lay to the north of us, in the great moist tropical areas of Africa. In support of this view is the further important fact that the tropical flora of Africa in many of its elements unites closely with the tropical floras of Asia and America. It is probably the oldest angiospermous flora in the world. In South Africa, from this tropical element, a subtropical one has been produced, which has become more and more highly evolved and modified in response to the winter resting season and dry conditions generally, until in our Karroo regions and dry desert areas of the western side we find the culmination of the process. The Karroo has a flora which has good claims to be ranked as the most highly evolved in the world.

The temperate element of our flora, however, is rather distinct from the tropical and subtropical. It is allied to the tropical, from which many of its elements have obviously been derived, but the temperate flora of the southern hemisphere occurring to-day in South Africa, Australia, and South America is undoubtedly a very ancient flora. It connects along our great mountain ranges of central Africa with the flora of the Mediterranean region.

The evolutionary history of plants can only be described with any degree of certainty when we know a great deal more, not only about palæobotany, but also about the past history of the world throughout geological time. With the aid of geology, the syntheses can be made more complete. The history of the flowering plants in the world has been mainly a history of response on the part of a widespread, uniform, moist tropical flora to climates which became gradually cooler and drier. In South Africa, owing to its relative geological stability ever since Cretaceous times, the whole process has had a longer time in which to take place, and, apart from certain climatic oscillations of which there is evidence, the process has not been interrupted in any drastic way, as would have occurred if large areas had sunk below sea-level. South Africa throughout the history of the flowering plants has been above the sea and has been joined to the tropical regions to the north. The derivative Karroo flora, therefore, is not only highly evolved but also, in comparison with similar semi-desert floras in other parts of the world, is a rich flora. Those arid plains have been colonised by families such as the Compositæ (regarded by all botanists as the highest of all plants), by relatively advanced members of other circles of affinity, for example, the tribe of Stapelieæ of the asclepiad family, the Mesembryanthemeæ among the Aizoaceæ, and so on. There is a magnificent field here for the study of plant colonisation on a grand scale. A comparative cytological investigation of the numerous species involved should at the same time be undertaken. The importance of isolation in the origination of new forms has long been recognised. Modern work in genetics has shown more clearly the reasons for it. They seem to depend chiefly on the fact that if a new form is prevented from interbreeding with the parent species then the chances of survival are enhanced.

The thing that interests us most for the moment is the undoubted fact that in South Africa we have unequalled opportunities for the study of the facts bearing on such problems. Ecology tends to unify the whole study of botany, and the adoption of the same point of view, with perhaps, to some extent, even the adoption of the same methods and technique, would, I think, tend to do the same thing for other biological sciences.

HUMAN ECOLOGY.

It is a very natural thing to inquire what bearing biological studies of any kind have on the life of man himself. Experience, however, ever since the publication of Darwin's "Origin of Species", and even before that, has gone to show that there is need for caution in applying biological theories to man. The point of view of no single one of the human sciences is broad enough to explain fully why man is as he is and why he behaves as he does. Ecology alone stands apart. The student of man and his works, whether he calls himself archæologist, ethnologist, anthropologist, sociologist, economist, geneticist, geographer, historian, educationist, psychologist, or physician, would do well to become more of an ecologist and try to adopt more and more the general point of view.

Plant ecology may be taken to include plant pathology, since diseases depend on a maladjustment to the environment. So human ecology should also include the study of medical science. Just as plant ecology binds together very effectively all the branches of botany, so human ecology should help to unify—so far as they can be unified—all the separate sciences which deal with man. No one, of course, can attempt to master them all, and no one would be foolish enough to advocate such procedure.

The development of the study of human ecology will probably follow lines similar to those followed by plant ecology. Man reacts to his environment as plants do, but man can control his environment in a way that plants cannot. Nevertheless, the point of view remains the same.

The first phase of human ecology must necessarily be descriptive. The greater the literature dealing with man is in point of bulk, the more need there is for seeking some means of determining the relative value and significance of all its varied content; and that, I feel sure, can be done by applying the test of its value to ecology. It is dangerous to press analogies very far, and it will almost certainly be found in practice that human ecology will not develop on exactly the same lines as plant ecology. The results obtained in the field of plant ecology must be applied with great caution when human communities are studied. At most they may be utilised to suggest hypotheses and useful lines of investigation.

Pioneer men, like pioneer plants, are more plastic in their reactions to the inorganic environment. If the environment is very adverse, complex plant communities cannot be built up; the pioneer stages remain more or less the final stages as well. This is equally true for human communities. The total numbers of pioneers among men as among plants are much smaller than those belonging to later stages of communal development. Pioneers among men, like their analogues among plants, tend to become widely scattered over the world. It is their business to conquer new habitats. They are ready to meet any emergency; they can fight their way through all the varied difficulties presented to them by Nature, but they fail to subordinate themselves to the community as a whole, when that becomes more complex. They remain pioneers and must always strike out along new pathways. They are stifled by the atmosphere of our great cities.

It is unnecessary to carry the analogy any further. It is enough if it has suggested to us that, fruitful as the comparison of pioneer and climax types in the plant world has been, a similar comparison of pioneer and climax types among men (without any reference to plant ecology) may prove even more interesting and valuable. I am aware, of course, that students of sociology have already contributed a great deal to the study of development in human communities: for example, Spencer, Bain, Mill, Hobhouse, McDougall, McIver, Graham Wallas, Westermarck, Saunders, and many others. But few or none of them, so far as I have discovered, have devoted much attention to the advances that have been made in plant ecology, or have adopted the ecological viewpoint. Nowhere could it be better carried out than in South Africa, where we still have almost every possible stage of development of human communities.

A comparison of different stages of development among human communities will probably at the very outset demonstrate quite clearly that our education policy in the past has not been a very wise one. Up to a very few years ago, we were teaching in all our South African schools (whether attended by whites, Indians, natives, or 'coloured' people) more or less exactly the same subjects. There has been and there still is far too much uniformity in our educational system. It is a mistake which is only slowly being put right, and it is doubtful whether it ever will be properly rectified until we carry through more intensive comparative studies of communal development such as I am advocating. In South Africa we are concerned not only with the development of a more or less uniform white race, but the problem is made more interesting and more complicated by the presence of a black race (not to mention the presence of South African Indians as well). The question at once arises as to whether two or more very distinct races can successfully occupy the same territory and, if so, under what conditions. More than ever is caution necessary if we try to apply results obtained in the study of plant ecology to such a problem. If two distinct races of man wish to occupy the same region, whichever of the two is the better suited to the environmental factors will in the long run succeed, while the other will fail.

We often hear the opinion expressed that South Africa is a black man's country. The white man, we are told, can only exist here by virtue of his superior intelligence, which enables him to dominate the blacks and force them to do all the really hard work. Some of the facts already established by plant ecology do seem to have an important bearing on this problem. The climate of South Africa is not tropical. Its vegetation is warm-temperate or subtropical, but not tropical; yet the Bantu peoples of South Africa are a tropical people that left the tropics and migrated southwards not so very long ago.

The idea that the black man is better suited than the white to the South African climate wants very careful consideration. It is true that so long as they do not come into very close and intimate contact with the white man, the black races can occupy and have occupied large tracts of land in South Africa, and that, too, at higher altitudes, such as Basutoland. On the other hand, during times of stress, for example, during the great influenza epdemic of 1918, apparently the black races suffered much more than the white. Those in the best position to know tell us that many diseases, such as tuberculosis, are spreading rapidly among the blacks, with disastrous results. But our information is all vague and unsatisfactory. I am not concerned now with possible explanations of these facts, if they are facts. What I do want to plead for is more organised systematic ecological research. It is surprising, in spite of the great advances in science during recent years, how little really scientific research work has been done on the kind of social problems that concern us most. I have said nothing about the mixed or so-called 'coloured' peoples of South Africa, though most of us probably realise that these present the most important and scientifically the most interesting problem of all, a problem calling for intensive research on ecological lines.

In conclusion, I should like to stress once more the importance of combining different lines of attack on any problem. However valuable specialised studies may be—and that they possess great value no one will deny—they must be combined with a study of each problem as a whole, and that, in its essence, is the ecological method. Of all the sciences which deal with man, modern geography, as it is studied in the best schools, perhaps comes nearest to what I have called ' human ' ecology. It is human ecology, but it scarcely attempts to cover the whole field of what I would include in that subject. It has, however, largely adopted the ecological viewpoint. Similarly, the study of sociology on modern lines, so far as it goes, is pure ecology.

The study of human communities is not the only science which deals with man. Ecology has gone further than sociology in its efforts to synthesise. Human ecology is certainly concerned with social studies and should make full use of all the social sciences, but it should aim also at making equally good use of every other branch of humanistic study, in seeking as perfect an answer as possible to that all-embracing question of how and why man has come to be as he is and to behave as he does.

The Architecture of the Solid State.*

By Prof. W. L. BRAGG, F.R.S.

THE electrostatic basis of the interatomic forces explains in a very elegant way the structures of compounds which contain a number of ions of different kinds. The principle of electrostatic valency in such compounds has been formulated by Pauling.

Suppose a number of ions to come together to form a crystalline solid. The ions are of different sizes, each kind has a characteristic positive or negative charge, and their relative numbers are necessarily such that the whole structure is electrically neutral. How will they arrange themselves so that the electrostatic energy in the interspaces is as small as possible? The governing factors are those of size and charge.

The first feature is that of 'packing'. The ions will fit closely together in order to reduce the interspace with its electrostatic energy. The largest ions are the negative ones, which therefore have the main effect in determining the packing, and the positive ions fit into the spaces in between. To see what arrangement will make the electrostatic energy as small as possible, it is useful to make a picture of the structure in which the electrostatic field is represented by lines of force. These start from the positive ions and end on the negative ions, their numbers being determined by the charges. Our complicated three-dimensional condenser will tend to take up a form such that all lines of force have as short a path as possible.

The result may be illustrated by a structure such as that of beryl, $Be_3Al_2Si_6O_{18}$, shown in Fig. 5. The large spheres are oxygen, and tucked between them one can see silicon (black), aluminium (shaded), and beryllium (white). The oxygens are the negative plates of the condenser, the other atoms the positive plates, and the packing is clear in the diagram. In order that all lines of force may have the shortest path, a certain relation must hold between the electric charges (Pauling's rule). Silicon has a valency 4, aluminium 3, beryllium 2. As shown in the lower part of the diagram, the lines of force Si^{4+} end on four oxygen ions, O^{2-}, thus balancing a charge $-e$ on each. Al^{3+} surrounded by six balances a charge $-e/2$ on each oxygen, and Be^{2+} surrounded by four also balances a charge $-e/2$. The same structure is shown as a skeleton in Fig. 6, and it will be seen that the oxygen atoms (large circles) are of two kinds, and that *each kind has its charge exactly neutralised.* One kind of oxygen is linked to two silicon atoms $(4/4 + 4/4 = 2)$ and the other to silicon, beryllium, and aluminium atoms $(4/4 + 3/6 + 2/4 = 2)$. There is thus local neutralisation of charge in the crystal, and our picture of lines of force is one in which they merely join one atom to the next, and those starting from a positive ion are not forced to wander to distant atoms in the crystal before finding an equivalent negative charge on which to end.

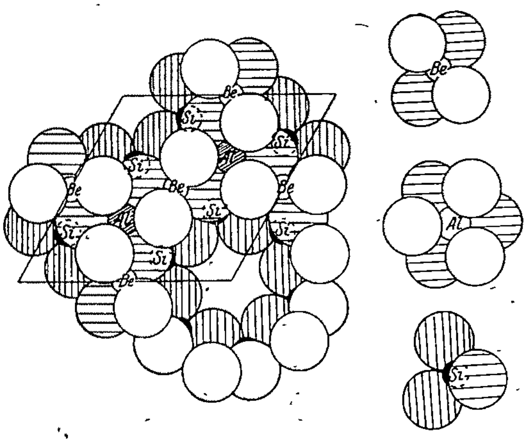

FIG. 5.—The arrangement of atoms in the structure of beryl, $Be_3Al_2Si_6O_{18}$. The large oxygen atoms are densely packed, and the atoms of metal and silicon are in the spaces between them.

It is surprising how the simple rule, with a few hints from X-ray analysis, enables one to build up very complex structures. One stacks the groups together, always obeying the electrostatic rule, and the whole crystal pattern falls into place. It is the electrostatic counterpart to the more rigid rule of valency in organic compounds, when each unit of valency is represented by a single indivisible bond. In the typical inorganic compound the valency can be divided into fractional parts, because it is due to an electrostatic charge, but it still remains true that when these fractional valency bonds between all the atoms are drawn the contributions of the bonds to every atom add up to its valency. As in the case of an organic compound, the formula of an inorganic compound cannot be expressed by a formula merely giving the relative numbers of atoms. The only complete formula is a model of the structure, showing the relationships of its constituent atoms; nothing less can express the valency laws involved.

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* Continued from p. 212.

Acid radicals, such as $(ClO_4)^-$, $(SO_4)^{2-}$, $(PO_4)^{3-}$, consist of four oxygen atoms surrounding the central atom. The group as a whole has a negative charge, and in a salt these groups are held to the positive ions by electrostatic forces. Now although an oxygen atom can be bound to one sulphur or chlorine atom in this way, forming part of an acid group, it cannot be bound to two without causing an intense localisation of positive charge, because the negative charge of the oxygen atom is more than balanced. Hence these acid groups generally only involve one central atom, such as sulphur or chlorine, rarely two or three. The position is different as regards silicon, for (as in beryl) an oxygen atom common to tetrahedral groups around two silicon atoms satisfies the rule as to equivalence of charge. There is thus no limit to the extent to which silicon-oxygen groups can link up, so that silicon builds a very characteristic class of compounds. The silicon-oxygen tetrahedra can form groups as in beryl, where each unit has the composition Si_6O_{18}. They can link by corners to form endless rows, like long negatively charged chains (Fig. 7). These are attached sideways by positive ions, and form characteristic fibrous structures such as asbestos. They are linked side by side to form extended sheets, as in mica, with positive ions between. When we split a piece of mica we are pulling apart the plates of a condenser. Each acid radical, negatively charged, extends as a sheet, over the whole mica surface.

So far we have considered the crystal as a structure with static equilibrium between the forces of attraction and repulsion. This equilibrium is disturbed when the crystal is elastically strained, or the atoms set in motion by heat vibration.

A very interesting result of X-ray analysis is that we can measure the amplitude of vibration of the atoms at different temperatures, as was first predicted theoretically by Debye, and shown experimentally by Sir William Bragg. A series of such measurements by James is shown in Fig. 8. The X-ray results can be used to make a picture of sheets of atoms in the crystal planes, and the peaks in the diagram represent a cross-section of the crystal density taken normally to certain crystal planes of sodium chloride. The large peak is chlorine, the smaller sodium. As the crystal is warmed, the sharp peaks become broadened, due to the vibration of the atoms, just as the image of an oscillograph is drawn out into a band when it vibrates. A very interesting feature, shown by James, Waller, and Hartree, is that even when the results are extrapolated to the absolute zero, the peaks are not so sharp as they should be according to Hartree's atomic models. The atoms appear to be vibrating even at absolute zero, and calculation shows that the vibration corresponds to the 'zero-point energy' of quantum theory. The extent of vibration is quite considerable at room temperature, and still greater nearer the melting-point. For example, sodium and chlorine atoms at room temperature have an average amplitude of $0{\cdot}22 \times 10^{-8}$ cm., and at 600° C. of $0{\cdot}6 \times 10^{-8}$ cm. as compared with their distance apart of $2{\cdot}8 \times 10^{-8}$ cm.

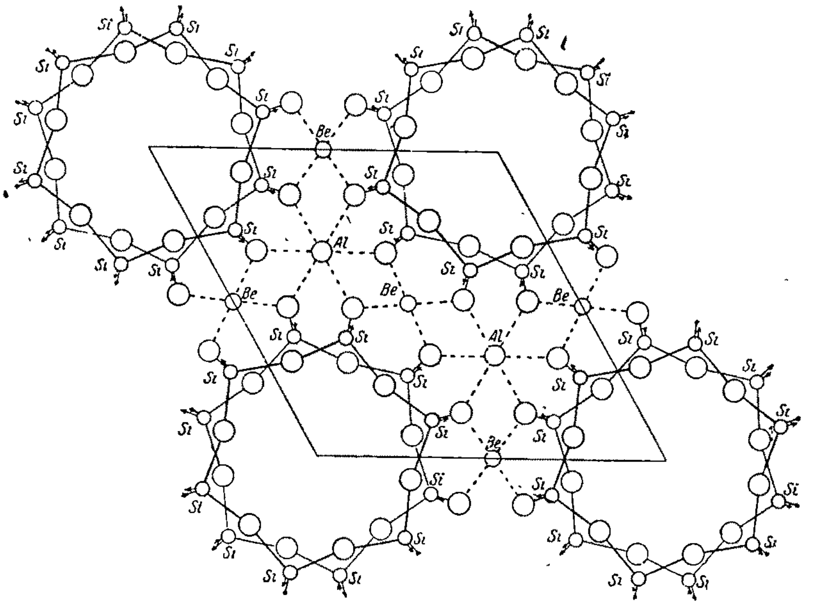

FIG. 6.—The structure of beryl arranged to show the way in which the two kinds of oxygen atoms (large circles) are linked to silicon and silicon, or to silicon, aluminium, and beryllium, in accordance with Pauling's rule.

We may think of the crystal as a three-dimensional spring mattress, the atoms being linked together by springs. Heat causes shivers to sweep backwards and forwards through the solid, displacing the atoms from their normal positions. Two most important properties of the solid are those of thermal expansion and thermal conductivity, and it was first pointed out by Debye that these effects are both paradoxical unless a refinement in considering the repulsive forces between the ions is introduced. If the restoring forces when the atoms are displaced were simply proportional to the displacement, bodies would not expand when heated. In the spring-mattress model, an atom vibrating between two neighbours pushes the one towards which it is displaced and pulls the one from which it is displaced; on the average, such pushes and pulls cancel. But when a departure from the linear relation between displacement and force is taken into account, the pushes are increased and the pulls weakened. Each vibrating atom, then, helps to force the whole structure apart.

Thermal conductivity, in the case of those solids which are not electrical conductors, depends upon transference of atomic vibrations from hot to cold regions. The heat motion consists of waves, and if these waves traversed in the body quite independently of each other, any agitation at one end of the body would immediately rush to the other at the speed of elastic waves in the body. Hence thermal conductivity should be almost infinitely great. Actually the different wave-trains are not independent, but influence the motion of each other. They therefore scatter each other, and the advancing region of wave agitation has to fight its way towards the cold end of the body through a fog of waves which it itself creates.

The question of the outer form of a crystal, the relative growth of its crystal faces, falls in another category. The lattice theory can tell the relative surface potential energy of the various crystal faces, and the form of the crystal should be one which makes the total surface energy a minimum. However, one can scarcely expect successful prediction in this case, when we know how greatly crystals vary in form when grown under different conditions. Small traces of foreign bodies in the solution or liquid entirely alter the crystal form. The energy of the surface is too small compared with that of the crystal as a whole, and reacts too sensitively to adsorbed layers.

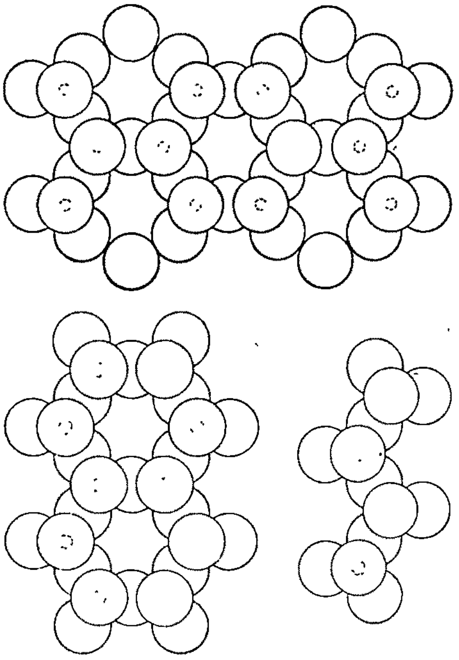

Fig. 7—Chains and sheets of silicon-oxygen groups in the silicates Silicon, shown as a small circle, always lies between four oxygen atoms and the tetrahedral groups are linked by sharing oxygen atoms.

In the explanation of the tensile strength, as ordinarily measured, the lattice theory breaks down entirely. Rocksalt should be rather stronger than the strongest steel, whereas Joffe has shown that it breaks under a stress only 1/500th that calculated theoretically, and explains this by supposing a crack always starts at a weak place and the crystal tears rather than breaks. An initial break at any point in a crystal concentrates the strain upon the neighbouring regions, which break in their turn. In order to get a body which has a high tensile strength, it must be ensured that, when at any point a break does occur, the resulting increase of stress is distributed widely. Tensile strength is, in other words, not so much a question of strength of bonding in the direction of the stress, as of weakness of bonding at right angles to it. The strength of a sheet of mica, or a fibre of asbestos, is due to the very feeble forces with which the sheets or fibres are attached to each other laterally, so that if one fibre gives, the additional stress is shared by the rest of the bundle of fibres.

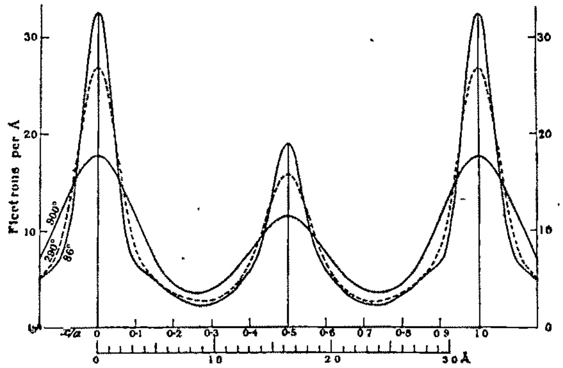

Fig 8.—The vibration of the atoms when sodium chloride is heated. The octahedral crystal planes consist of alternate sheets of chlorine and sodium atoms, represented in the figure by the large and small peaks respectively. As the temperature is raised, the sheets become broader and more diffuse owing to thermal movement. (James and Firth.)

The tensile strength is one example of many in which the behaviour of the real crystal, built of a number of crystalline elements, differs from that of the ideal perfect crystal and requires a new type of treatment. X-ray analysis has always shown that actual crystals are composed of a number of small blocks, or ' mosaic ' as Ewald terms it, of crystals which are nearly in the same orientation, but not quite. There must be a misfit at the boundaries between these blocks. For some crystalline properties, such as heat of formation or double refraction, the mosaic structure has no influence. For other properties it is all-important, and tensile strength appears to be such a property. Smekal has always insisted on the important difference between the ' ideal ' and ' real ' crystal, and believes many properties to be essentially dependent upon it.

Thus, when one considers the properties of the solids which are of technical importance, in contrast to those of the ideal crystal, little success in exact interpretation can be claimed. However, the knowledge of atomic arrangement has performed a service, the usefulness of which is not so obvious, but is yet very great; it has provided a new language, or series of conceptions, in which to express the vast amount of empirical knowledge about the behaviour of materials which has been accumulated.

News and Views.

The subject of noise and its measurement, dealt with by Dr. G. W. C. Kaye in his recent Royal Institution discourse, which forms our supplement this week, is one of great practical importance and wide interest. It is becoming increasingly apparent that excessive or particularly irritating noise is injurious to health, happiness, and working efficiency. Laboratory measurements have shown that even during sleep sufficiently deep to render the sleeper unconscious of any sounds, response to such sounds as are made by the early morning milkman is readily detectible. There are numerous practical difficulties in the quantitative measurement of noise, since acoustical, psychological, and physiological factors are all concerned. A general survey of the methods at present in use is given by Dr. Kaye. The results gathered from several independent sources deal with all types of noises, from the whispering human voice, the crying of twins, and the applause at Lindbergh's reception in New York, to transport noises, the roaring of lions, and the sounds of Niagara Falls.

It is noteworthy that increased speed of transport is only obtained at the cost of increased noisiness, the average loudness levels in decibels above threshold inside various vehicles being for a recent type of bus or a saloon car or express train about 60, whilst for aeroplane cabins the value is about 100. Much of the noisiness of modern transport could only be reduced by redesign of the machinery involved, and it is unfortunate that the silence of the exhaust of the luxury motor car is obtained only by a certain loss of engine efficiency. For this reason, the same methods could not easily be used to reduce the machine-gun-like noises of the motor bicycle exhaust. The absolute amount of sound energy lost by even the noisiest of machinery is negligibly small, and quieter machinery is therefore only more efficient because of better mechanical design and not because of absence of sound-energy losses. From noise measurements made inside buildings, it is evident that stillness could be much more readily obtained in the Victorian home with its general solidarity, heavy hangings, and absence of loud speaker and gramophone, than in the modern ideal home with its thin walls and flimsy hangings.

On Aug. 20 occurs the centenary of the birth of the eminent Austrian geologist Eduard Suess, who was born at No. 4 Duncan Terrace, Islington, a house which now, thanks to the action of Dr. F. A. Bather, bears a commemorative tablet. The son of a German merchant then resident in England, but who afterwards lived at Prague and Vienna, Suess was educated in the University of Vienna, and became an assistant in the Imperial Museum. At the age of twenty-six years he was made an extraordinary professor in the University, and ten years later was appointed to the chair of geology, a post he held until 1901. A most successful teacher, he counted among his pupils Mojsisovics, Fuchs, Waagen, Penck, and Neumayr, who became his son-in-law. In addition to his academic posts, he held seats in the Municipal Council of Vienna and the Diet of Lower Austria. It was largely through him that Vienna obtained an adequate water supply. He was chosen president of the Academy of Sciences of Vienna, was elected a foreign member of the Royal Society, and received the Copley Medal, while the Geological Society awarded him its Wollaston medal. He was included among the Scientific Worthies whose work has been reviewed in Nature, an account of his life being given in our columns in 1905 by Sir Archibald Geikie. Suess died at Vienna on April 25, 1914.

Much of the earlier work of Suess dealt with the geology of the Vienna basin and the Alps, but he will always be remembered for his monumental work, "Das Antlitz der Erde". Setting himself the task of taking a comprehensive survey of all that had been accomplished in elucidating the geological structure of every part of the globe, he published the first part of his great book in 1885, the second in 1888, and the third in 1901. "The supreme scientific success attained by this great work", says von Zittel, "was a tribute to a work accomplished with the highest bibliographical skill and literary finish, the fullest geological and geographical knowledge, a convincing array of scientific facts that never fail to suggest an endless reserve in the background, and, above all, a calm, judicial, elevated tone of inquiry which the end of the nineteenth century may well feel proud to have witnessed and carried with it into its boasted wealth of scientific enlightenment." "Das Antlitz der Erde", it has been said, takes its place as a scientific classic beside Hutton's "Theory of the Earth" and Lyell's "Principles of Geology"; while of Suess, Prof. J. W. Gregory remarked, at the unveiling of the tablet in Islington, that "he ranked as the greatest original force in geological philosophy of his time".

One of the recommendations of the Committee on National Expenditure was the abolition of the Empire Marketing Board. The Board's report for 1930–31, which has recently been published (H.M. Stationery Office, price 1*s*.), forms an adequate comment on which we need not enlarge. In spite of the world-wide economic depression, record imports for sixteen commodities from the Empire into Great Britain have been established, the increase being attributed largely to the greater attention paid by the producers to grading and marketing and to the closer contact attained between the home traders and the overseas producers. Although its activities are developing considerably, the methods of the Board have been similar to those in previous years. Economic investigations and market inquiries have been extended, and grants for research work both in Great Britain and overseas are being continued. A complete list of the latter is appended, with a short account of the work under investigation in a number of cases. The importance of collecting and disseminating information regarding the supplies of Empire and foreign commodities available is fully recognised, and the issue of the weekly notes for fruit and dairy produce has been extended to include figures for the quantity of butter in cold storage, thus making a study of the consumption of imported butter possible for the first time. Two further reports on economic investigations, entitled respectively "The Marketing of Cheese" and "The Preparation of Fruit for Market", have been published, bringing the total number of this series up to twenty-five, and statistical surveys of world production and trade in beef and wool, similar to those already issued for oranges and cocoa, are nearing completion. Publicity has been obtained in a variety of ways, and definite success has attended the experiment of the opening of two shops in which samples of Empire produce are sold, under conditions which secure the goodwill and co-operation of the traders. The report concludes with a list of the publications of the Empire Marketing Board and the Imperial Economic Committee.

THE use of electricity to heat the soil around plants so as to force their growth has been experimented with successfully by engineers connected with the Southern California Edison Company. The main factor to which the success of the experiment is due is that the product can be placed on the market early, so that the price is three or four times greater than later on. When all the crops mature at the same time, the market is flooded and the price falls. Two exactly similar plots of ground were taken. One had insulated wires running through it about four feet apart and at a depth of eight inches. The current in the wires was regulated by a thermostat so as to maintain a temperature of about 70° F. Current flowed on an average two hours out of every five. The other plot was not electrically heated but was prepared in exactly the same way. Cucumber seeds were planted in both plots, in rows about four feet apart. It was found that more than one half of the crop in the wired portion had matured and been marketed before the first cucumber had reached maturity in the unheated plot. The net revenue obtained from the electrically heated plot was about £20 greater than from the other. Details of the experiment are given in the *Electrical Review* for Aug. 7.

MARCONI'S Wireless Telegraph Co., Ltd., has acquired from the British Air Ministry the full rights and drawings for the design and erection of radio beacon stations of the rotating type. Marconi fixed beacon transmitters have been installed at important coastal points in many parts of the world as an aid to maritime navigation. The company will now be able to provide for aerial navigation as well. Both kinds of navigation will doubtless benefit by having alternative beacons. The experimental rotating beacon stations at Orfordness, Gosport, and Farnborough have been reported on favourably. A special feature of the rotating beacon system is that it requires only an ordinary radio receiver and a stop-watch to enable a ship or an aircraft to take its bearings. It is likely, therefore, that the system will prove valuable in extending the use of radio navigation even to quite small ships. The beacon makes use of a vertical closed aerial rotating at a uniform speed of one revolution in 60 seconds. The radiation from such a loop is a maximum in the plane of the loop, and zero, or a minimum, at right angles to that plane. For the calculation of bearings, two distinctive signals—a 'north signal' and an 'east signal'—are transmitted at regular intervals as the aerial rotates. The normal method of observation at the receiving station is to start a stop-watch at the moment the north signal ends, after which the time taken for the zero signal to be reached indicates the bearing of the observer from the beacon. If the observer is due north or south of the beacon, he may not be able to read the north signal, owing to the directional effect of the transmission. In this case the east signal is taken as the starting point. The number of seconds from the reception of the signal to the reception of the minimum signal gives the bearing in degrees. It seems likely that when navigators have become accustomed to radio beacons, it will be possible to dispense with several lightships.

FOLLOWING on the excavation of a seven-roomed house, later converted into baths, at North Wharnborough, Hampshire, which was discovered in 1929, a building of considerable size has been brought to light, as is announced in the *Times* of Aug. 10, which may furnish much-needed evidence bearing on the rural organisation of Roman Britain. The buildings are situated only 8½ miles from the city of Calleva Atrebatum (Silchester); but they lie on no known Roman highway. The larger structure, like the smaller, would appear to have served two purposes; for at some time in its history it was converted by the erection of interior walls of wattle and plaster, relatively less substantial than the solid outer walls, into a system of cubicles, probably intended for farm labourers. Four buildings outside the south-west outer wall are probably stables. Coins, all belonging to the Constantine period or later (A.D. 306–381), were found. Presumably Silchester served as the market town for the villa. This is in some measure supported by the discovery of a potsherd inscribed 'Peregrini'. There were two potters of the name of Peregrinus, one from Southern Gaul, of the age of Domitian, A.D. 81–96, the maker of ware which has been found on several sites in Britain, and notably at Silchester.

THE academic study of comparative law is, as a rule, confined to codified law. This is due in part to the fact that material for study of non-codified law has not been available. In the nineteenth century opportunities for collecting data were neglected, as it was considered inevitable that such systems were destined to disappear. The event has proved that this view was erroneous; at the present day one half the globe is under the jurisdiction of Oriental and tropical customary law. Further, juridical science is coming to recognise more and more the importance of the non-codified systems of law. The whole subject, however, is in need of organisation before systematic

(*Continued on p.* 265.)

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Noise and its Measurement.[*]

By Dr. G. W. C. KAYE, O.B.E., Superintendent, Physics Department, National Physical Laboratory.

FREQUENCY AND INTENSITY RANGES OF THE EAR.

AS is the case in many branches of science, the physics of acoustical research owes its present facility and exactitude largely to the development of electrical methods of measurement. The key lay in the invention of the electronic valve, and to this the subject owes an impetus which it had long needed.

Before we pass on to the question of noise measurement, we shall be well advised to review the relevant physical facts about the ear, which is of course the ultimate critic in matters of noise. The foundations of the subject rest largely on experiments with pure notes, and here it should be recognised how greatly our present knowledge of both hearing and speech is due to the noteworthy investigations of Dr. Harvey Fletcher and his colleagues at the Bell Telephone Laboratories in New York.

With reference to frequency, the average ear can perceive a range of frequencies from about 20 to 20,000 cycles per second, the upper limit declining with advancing years. In the various practical developments of acoustics, however, attention is largely restricted to the ranges 50 to about 5000 for speech, and 35 to 7000 for music.[1]

As regards intensity, it has been shown by Wegel and others, from experiments on pure notes, that there is a certain minimum amplitude for each frequency below which the average ear fails to detect the note. Moreover, the ear is much more sensitive to notes of medium pitch than to higher or lower notes. The threshold or lower limit of intensity passes, in fact, through a minimum at about 2000 cycles per second as we steadily change the frequency.

Similarly, there is a maximum amplitude peculiar to each frequency, above which the ear no longer functions—hearing is subordinated to a tickling sensation or even actual pain. Again the ear shows to advantage in the middle of the range (about 500 cycles per second), and so the upper limit of intensity or threshold of feeling passes through a maximum as we progressively vary the frequency.

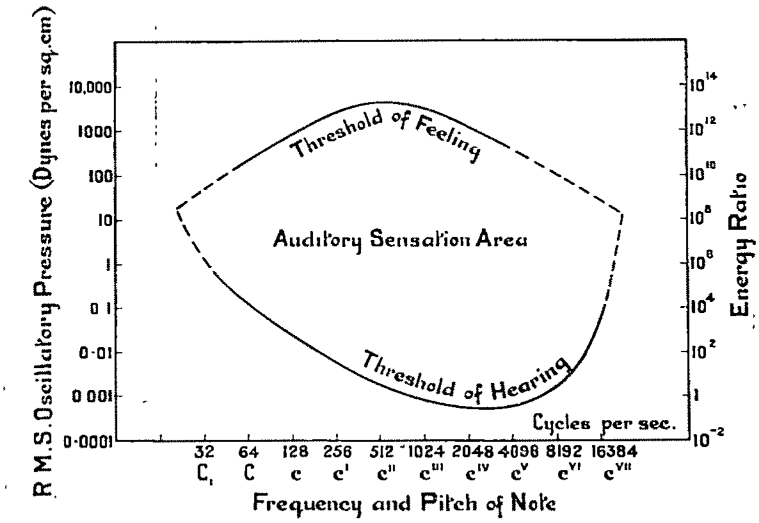

FIG. 1.—Average area of normal hearing, showing auditory ranges of frequency and intensity. (From Fletcher's "Speech and Hearing".)

Fig. 1 shows the auditory sensation area for the average ear as determined by Fletcher and Wegel. The boundaries are constituted by the two threshold curves, the dotted portions being those which are difficult to determine. We see that the range of audibility passes through a maximum (at about 1000 cycles per second) as the frequency is varied, and is greatly reduced towards each end of the musical scale. This maximum range corresponds to about a million million-fold variation in power, or a million-fold variation of acoustical pressure from about, say, 0·0005 to 3000 dynes per sq. cm. We note also in the case of very high and very low notes the great intensity that is essential for audibility and how restricted the range of audibility is. A familiar illustration is the sound from a 32-ft. organ pipe, which one feels rather than hears.

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[*] From a Friday Evening Discourse given at the Royal Institution on May 8.

THE MATCHING AND MASKING OF SOUNDS.

As regards the matching of sounds, it is found that the average ear can recognise under very favourable conditions a 10 per cent difference of energy when two pure notes of medium loudness are sounded alternately without break. This figure is more than doubled if there is an interval of silence between the two notes of so little as half a second. Under ordinary conditions, however, the smallest average change in energy level detectable by the normal ear is of the order of 26 per cent for sounds of medium intensity and frequency. The figure is greater for feeble sounds, and less for very loud sounds. The value is also greater for very high or low frequencies than for the middle of the range.

From the fact that it is a percentage increase rather than an additive increase of energy which the ear associates with a change of loudness, it is evident that, while the steps in the scale of sensation of loudness advance arithmetically, the physical intensities advance geometrically, the relation thus resembling the logarithmic scale of powers of a slide-rule. Here is, then, another illustration of the Weber-Fechner law—the physiological effect is roughly proportional to the logarithm of the energy producing the stimulus.

Kingsbury has carried out experiments on the matching of pure tones to determine the relation between the physical intensity and the aural loudness for different frequencies. These experiments indicate that for frequencies between about 700 cycles and 4000 cycles per second the relation between loudness and intensity is independent of the frequency. For notes of lower frequency the loudness increases proportionately more rapidly than the intensity. Kingsbury's results are set out in Fig. 2, which shows a number of equal loudness contours superposed on the auditory sensation area. As will be seen, these contours are roughly parallel to each other for medium frequencies above about 700 cycles per second.

An experimental illustration based on such loudness contours is to operate a pure sound at constant intensity, and gradually increase the frequency, when the loudness will be heard to pass through a maximum at about 2000 cycles per second. This is evidenced by the track of the horizontal line in Fig. 2 at a level of about 0·1 dyne per sq. cm.

The masking of one pure note by another is usually measured by the extent to which the threshold of audibility of the masked note is raised. In general, a particular note is masked (1) most readily of all by another of approximately the same frequency; (2) more readily by a note of lower frequency than one of higher, at any rate for loudnesses about and above speech level.

The position is not so simple with loud complex sounds such as noises, as the masking may be confused by other factors such as the masking of the individual components and the formation of subjective tones (see Fletcher's "Speech and Hearing").

THE DECIBEL.

We are now aware of the area of auditory sensations which we have to measure, and we have to decide what is to be our 'yardstick' or 'degree'. Our task is to try to correlate aural loudness with physical intensity or energy; and already we have seen that while the sensation of loudness advances, as it were, by simple addition, the energy level increases by leaps and bounds on a scale which extends over almost astronomical magnitudes. This is a cumbersome relation, and it is clear that there will be a real convenience in adopting a scale of ratios of energy for our purpose. A similar need which arose in telephone engineering was met by the introduction of the 'bel', a name chosen in honour of Alexander Graham Bell, the inventor of the telephone. One 'bel' expresses a tenfold increase of power or energy; in other words, two intensities in the ratio $r : 1$ differ by ($\log r$) bels.* It has been generally agreed to adopt the bel for acoustic requirements also, or rather the 'decibel' (db.), since the bel is a little too large for the purpose. We thus have the following tabular relation:

Ratio (r) of Intensities.	No. of Decibels (10 log r).
1	0
10	10
100	20
1,000	30
10,000	40
	—
10^{13}	130

It will be realised that this scale of decibels is in no sense physiological but is based wholly on intensity as measured by physical methods. The scale has, however, the specific advantages (1) of being a rough fit with the aural scale of loudness sensation; (2) that experiment shows that the decibel, as above defined, corresponds approximately to the least perceptible change in loudness of a sound of medium loudness under average conditions. In actual fact, the loudness step in question is sometimes a little more and sometimes a little less than a decibel (ranging from 0·2 db. to 9 db.), according to the frequency and the location in the auditory sensation area.

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* Logarithms are to base 10.

We are now in a position to set up a definition of the sensation level of a pure note of specified frequency in physical terms. Our 'degree' will be the decibel, our 'zero' the threshold of audibility for that frequency, and the sensation level of a pure sound may accordingly be defined as the intensity in decibels above the threshold of audibility of that frequency.

On this basis experiment shows that, for pure sounds of medium frequency, the range of audibility between the thresholds of hearing and feeling is covered by about 130 decibels. This figure is rather less for high and low frequencies.

The position, however, is not so straightforward when we come to the broader question of comparing the loudness of pure sounds of different frequencies. We find at once that there is no simple relation of wide application between physical intensity and loudness. Two pure sounds of different frequencies do not in general produce the same loudness sensation, even if (*a*) their physical intensities are equal, or (*b*) their physical intensities bear the same ratio to their respective threshold values, that is, if the sounds have equal sensation levels. Further, if the intensity levels of two pure sounds of different frequencies which appear equally loud are increased by the same amount, the sounds will not in general remain equally loud.

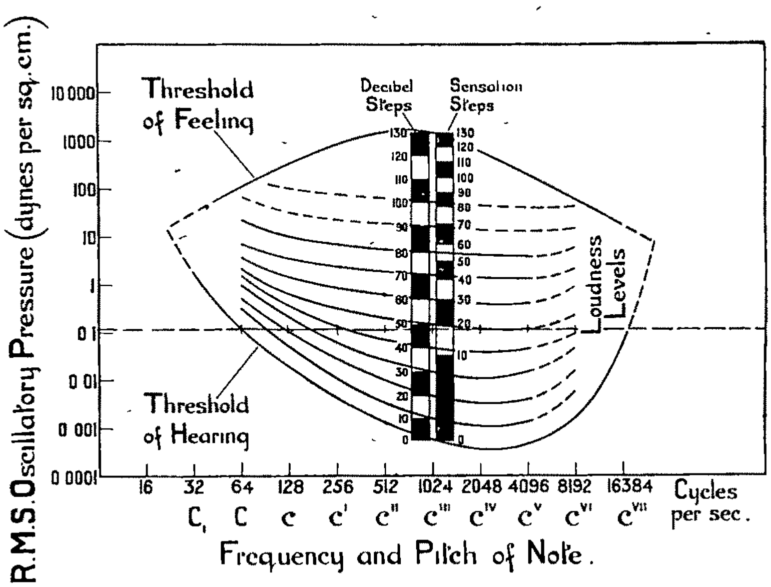

FIG. 2.—Auditory sensation area, showing equal loudness contours; also decibel 'ladder' and sensation-step 'ladder' for a frequency of 1000 cycles per sec.

It follows that, in the case of sounds of different or mixed frequencies, neither the physical intensity level nor the sensation level can be used as a measure of loudness. In the circumstances, we have to adopt an arbitrary scale as a practical standard, and a suitable one for the purpose is the sensation scale of a pure note having a frequency in the region of 1000 cycles per second. Then the loudness of any sound, whether pure, or a mixture such as noise, is defined as the sensation level (expressed in decibels above the threshold value) of the standard note which appears equally loud to the ear. It may be mentioned that the zero or threshold value of a 1000-cycle scale corresponds to a pressure of about 1 millidyne per sq. cm.

It should be reiterated that such a standard scale is quite arbitrary, and that equal increments on the scale do not in general approximate very closely to an equal number of sensation steps. For example, in the case of the 1000-cycle scale, the step from 0 to 10 decibels corresponds roughly to about 1 perceptible gradation of loudness under average conditions, the step from 50 to 60 contains about 10 gradations, and the step from 100 to 110 about 15. In other words, we may ascend the range of physical intensity lying between the two thresholds, either by the decibel ladder with equally spaced rungs, or by the sensation-step ladder with rungs first widely spaced and afterwards more narrowly though more evenly spaced (see Fig. 2).

It may be added that, in adopting a practical scale of loudness, some latitude is possible in the choice of the standard frequency, in view of the fact that for medium frequencies above 700 cycles per second there is a constant relation between loudness and sensation level. For example, the standard frequency chosen for much of the work at the National Physical Laboratory is 800 cycles, while, in the United States, 1000 cycles has been largely used.

SPEECH AND NOISE.

The masking effect of a background of noise on the ease of conversation is one of primary interest. Conversation begins to be difficult when the background of noise reaches 70-80 db., while at 90 db. conversation, even by shouting, is virtually impossible.

It should be remembered that the greater part of the energy of the human voice is in the low-frequency region. Some sixty per cent of the energy lies in frequencies below about 500 cycles per second, and about eighty-five per cent below 1000 cycles per second. It is known, however, that the intelligibility of speech rests largely on the high-frequency consonants (say above 1000 cycles per second) rather than on the low-frequency vowels (say 120 cycles for the male voice and 240 cycles per second for the female), despite the fact that the low-frequency components carry the major part of the energy.

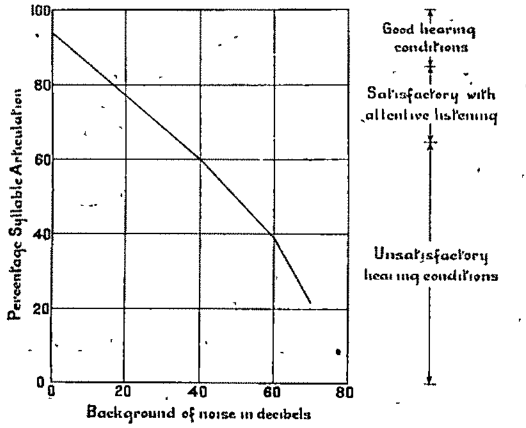

FIG. 3.—Effect of extraneous voice on intelligibility of speech of normal loudness (50 db.). (Knudsen.)

Davis and Evans at the National Physical Laboratory have observed that conversation in an enclosure is facilitated if high-pitched noises are excluded from without. It is fortunate that such notes can be more readily excluded than low notes, and particularly so where limits are set to the massiveness of the walls of the enclosure, as in an aeroplane cabin. Furthermore, such high notes as gain-entrance are more readily absorbed by mounting absorbent on the inner walls.

As regards the effects of noise on the hearing of speech, Knudsen found in 1925 that, if the interfering sound is a pure note at about speech-level, the interference with speech is almost independent of frequency, but that for greater intensities low-pitched notes interfere more than high. He also states that the interfering effect of noise is greater than that of a pure note whatever the pitch. Fig. 3 (due to Fleming) summarises Knudsen's results on the effect of extraneous noise on the intelligibility of speech as interpreted by articulation tests with speech of normal loudness (50 db.). As will be seen, even a little noise affects speech reception adversely, while a noise level of some 30-40 db. reduces the intelligibility by an intolerable amount.

ANNOYANCE AND NOISE.

The association of annoyance and noise has recently been the subject of experiment. Precise measurement could scarcely be expected perhaps, but it is clear that both frequency and loudness are among the factors which play a part. As to pitch, it is probable that the majority of people find shrill sounds more offensive than low. They find, for example, the high-pitched motor horn, to the staccato use of which the Paris taxi-driver is so addicted, more irritating than the lower pitched horn which is generally used in England. This impression is confirmed by the work of Laird and Coye, who found that annoyance is a function of both loudness and pitch, high pitches being intrinsically more annoying than low or medium pitches, and very loud high pitches being especially irritating. In the case of pitches below about five hundred cycles per second the annoyance was, however, purely a matter of loudness. In this connexion it is of considerable interest to note that the range of pitches which man normally employs in his own speech appears to be the least annoying to him. The irritation produced by certain tenor and soprano voices is claimed by Laird and Coye as being in harmony with their findings.

The annoyance produced by complex noises such as those resulting from motor horns appears to be largely influenced not only by sheer loudness, but also by the presence of strong high-frequency components as well as by strong inharmonic components.

ABSOLUTE MEASUREMENT OF ACOUSTICAL ENERGY.

A standard method of measuring the absolute energy of waves in general is to absorb them completely in some suitable material and measure the amount of heat generated. But, even if such absorption were possible in the case of sound waves, the absolute amounts of energy in speech and most other sounds of everyday experience are so small as to be on the borderline of the capacity of the most sensitive heat-measuring instruments we have. For example, the average speech power of the conversational voice is about ten microwatts. This value rises to about a thousand microwatts for the shouting voice, falls to 0·1 microwatt for the quietest speech, and to about 0·001 microwatt for the softest whisper. To take an illustration, a Final Cup-Tie crowd of 100,000 at Wembley Stadium all talking continuously and rather loudly would provide as much speech power as would, if converted, light a small electric lamp throughout the game. Alternatively, by the end of the match the acoustical energy expended would have been sufficient if transformed into heat, to boil enough water to make one cup of tea. An especially enthusiastic crowd which shouted vigorously all the time might similarly manage ten cups—perhaps enough to fill the Challenge Cup itself!

There are, however, one or two outstanding examples of acoustic disturbances in which substantial amounts of energy are involved. Measurements in New York on ships' sirens have shown a power-level of about 6 microwatts per sq. cm. at a distance of 115 feet, so that the total acoustic energy emitted by the siren would appear to be about ⅛ h.p.

For sounds of ordinary magnitude, however, it is clear that the outlook for thermal methods of measuring acoustic energy absolutely is not promising, and we must turn to some other property of the sound waves. The oscillatory variation of the air pressure in the track of the advancing sound wave, the accompanying minute changes of refractive index and of temperature, the velocity of the oscillating air particles, and the radiation pressure exerted on a reflecting surface have all been employed. A conversational sound corresponds to an alternating pressure (*R.M.S.*) of about 1 dyne per sq. cm.,* in other words, to a pulsation of 1 millionth part of the atmospheric pressure. The change in refractive index for such a pressure variation is about one part in a thousand million, the temperature variation about 1/1000° C., the particle velocity of the air about 1/40 cm. per second, and the radiation pressure only some 10^{-11} of an atmosphere. The corresponding power is about 1/1000 microwatt per sq. cm., it being recalled that the power (or energy) varies as the square of the pressure and the amplitude.

For the purposes of absolute measurement, we are led to look for a measuring instrument which will give readings independent of both frequency and wave form of the sound. One of the most convenient is the Rayleigh disc, which measures the air or particle velocity. It is, however, a fragile instrument, to be regarded rather as an ultimate standard of reference, the use of which is necessarily restricted to the standardising laboratory. More convenient and robust instruments are essential for practical purposes, and recourse is usually had to electrical microphones, preferably of a non-resonant type. These translate acoustical oscillations into electrical oscillations which are amplified by a suitable valve amplifier, and so can be conveniently and accurately measured provided proper precautions are taken.

A variety of other devices, many of them of the mechanically resonated type, have also been proposed from time to time as sound measurers or recorders, but for a number of reasons their use has been almost entirely discontinued in favour of electrical microphones, particularly those of the condenser or electrostatic type.

The condenser microphone consists essentially of a metal diaphragm tightly stretched and mounted parallel and very close to a metal plate, the gap being only about 1/1000 inch. The thin section of air enclosed adds materially to the stiffness of the stretched diaphragm so that its resonant frequency is very high—usually above the normal range of acoustic frequencies. To the condenser formed by the plate and diaphragm a potential difference of about 200 volts is applied through a high resistance. Sound waves incident on the diaphragm cause it to vibrate, resulting in variations of the capacity of the condenser which, in turn, produce across the series resistance an alternating E.M.F. which can be readily valve-amplified and so measured by means of a rectifier (such as a thermojunction) and microammeter. Alternatively, the wave form may be examined by a cathode ray oscillograph. The condenser microphone, though somewhat insensitive, enjoys the advantage of a fairly uniform response over the acoustic range of frequencies, and thus provides a useful standard instrument, which can be calibrated in absolute units.

MEASUREMENT OF NOISE.

It was, I think, Lord Kelvin who said that once we find out how to measure a thing, we begin to learn something about it. As regards noise, however, it is evident that the question of its measurement is one of some complexity, involving not only physics but also physiology and psychology. Nevertheless, so far as the physical aspect goes, it is clearly desirable that there should be a consensus of opinion on the choice of a system of physical quantities. They should be preferably of an absolute character, so as to assist, *inter alia*: (*a*) in translating vague aural judgments and comparisons into facts and figures; (*b*) in elucidating the causes and characteristics of noises; (*c*) in comparing the results of different investigators; and (*d*) in setting up such arbitrary standards of noise as may be desired in the light of social, technical, or legal requirements.

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* It is estimated that the street noise of New York exerts an average pressure of about 5 dynes per sq. cm. and may even reach 20 dynes per sq. cm.

The practical measurement of noise usually comprises one or more of the following operations:

(1) The physical measurement of the 'over-all' power or energy-content of the noise, the result being ultimately expressible in absolute units (for example, dynes or microwatts per sq. cm.).

(2) The physical analysis of the noise into its spectrum of frequency components (cycles per second). This is often most illuminating in tracking down the sources of individual components, particularly of machinery noises.

(3) The physical determination of the wave form of the noise, though this is often difficult to interpret and to utilise quantitatively, particularly if the noise is aperiodic.

(4) The aural measurement in some accepted unit of the loudness of the noise, or, in other words, the evaluation of the 'noisiness' as perceived by the ear—the physiological arbiter of noise.

PHYSICAL MEASUREMENT OF NOISE.

We have already discussed the measurement of sound energy by means of the condenser microphone and amplifier. The amplified current is connected either to a rectifier and microammeter (graduated in decibels if desired) for measurement purposes, or, alternatively, to a cathode ray oscillograph if it is desired to examine the wave form. In view of the fact that the microammeter readings are measures of physical intensity and not of loudness (owing to the selective sensitivity of the ear to pitch), a frequency-weighting network is sometimes interpolated in the circuit with the object of approximating the results more closely to the average aural interpretation. The weighting curve may conveniently be chosen for a loudness corresponding to that of a 1000 cycle-tone at 30-40 db. above the threshold of audibility.

If it is desired to analyse the noise, this may be effected by incorporating electrical tuning or band-pass filtering devices into the circuit and so determining, in turn, the amount of energy associated with individual components or bands of frequency. It is not always possible, however, by such means to get sharp selectiveness, but, in any event, we have to recognise that as yet our knowledge is not sufficiently general to enable us to correlate exactly the over-all loudness of a noise with the energy or loudness of its constituents.

SEARCH-TONE METHODS OF NOISE ANALYSIS.

The question of the practical analysis of noises which are reasonably periodic has been much facilitated by the introduction of search-tone methods, which in general enable sound to be more conveniently analysed and with higher selectivity over a wide frequency range than is possible by the method of tuned circuits.

When search-tone methods are employed, the noise to be analysed is received in a microphone, the current of which is amplified and 'mixed' in a valve-rectifier or modulator with that of a pure search-tone of constant intensity and variable known frequency from a heterodyne oscillator. As a consequence, the modulated current contains not only the search-tone, but also the summation- and difference-tones formed from the search-tone and the various individual constituents of the noise. For example, if the frequency of the search-tone is S, and that of a particular constituent of the sound is C, the frequencies of the summation- and difference-tones so formed will be $(S+C)$ and $(S-C)$ respectively.

One way of revealing the existence of either of these tones is to apply the modulated current to a highly selective mechanical resonator, such as a steel bar capable of vibrating longitudinally. Thus, as the search frequency is varied continuously, the bar will begin to resonate whenever either $(S+C)$ or $(S-C)$ becomes equal to the natural frequency of the bar. As we know S, we can evaluate C; and further, the degree of response of the bar, which is observed by suitable means, will give us a measure of the energy in the constituent in question. In practice, S may range from, say, 11,000 cycles to 16,000 cycles per second, while the natural frequency of the bar may well be of the order of 16,000 cycles per second for the summation-tone method and 11,000 for the difference-tone method.

Grützmacher uses, instead of a mechanical resonator, a low-pass filter arranged to transmit frequencies less than about 30 cycles per second. It follows that, in the great majority of cases, both the search-tone and all the summation-tones are ruled out, and only those difference-tones with frequencies less than 30 cycles per second will pass the filter and be recorded by an appropriate amplifier and detector. Thus, as the search frequency is continuously varied, the detector will only respond when the frequency is within 30 cycles per second of that of a constituent tone of the noise. The magnitude of the detector reading can be made to afford a measure of the intensity of the component in question. In the outfit at the National Physical Laboratory the frequency of the search-tone is varied from, say, 30 cycles to 10,000 cycles per second by the rotation of an air condenser through 180°.

AURAL MEASUREMENT OF NOISE.

As we have already seen, if we are provided with a standard pure note of medium frequency (above 700 cycles per second) the loudness of which is variable at will over a range which has been calibrated by physical means, then we can evaluate by aural matching or equality the loudness of any other pure note or, in general, of any complex note. Alternatively, measurements may be made of the loudness of the standard note which is just masked or drowned by the sound to be measured. The standard note may be produced by an electric diaphragm buzzer (as in the Siemens-Barkhausen audiometer with a single frequency of about 800 cycles), a valve oscillator (for example, the Western Electric audiometer with a choice of eight frequencies), or a gramophone record (with pure or 'warbling' notes), together with a suitable attenuator, in each case.

With all the various types of audiometer, the reading is best approached by a series of progressive comparisons alternating on either side of the critical value. In general, experience indicates that most people find themselves able, after a little practice, to obtain fairly consistent results with even the simpler forms of audiometer, at any rate with noises which are more or less continuous. On the whole, masking results are easier to obtain than matching or equality values. In the United States, masking results are usually preferred, affording as they do a measure of the degree of 'deafening' or the raising of the threshold limit for the particular frequency or band of frequencies used.

CLICKER EXPERIMENTS ON NOISE MEASUREMENT.

In 1929 I made some rough experiments on noise measurement, by the aid of a flexed steel-strip 'clicker', such as is sometimes used by lecturers. The note of the clicker is high pitched and surprisingly penetrating, and can be heard in quiet surroundings nearly 1000 feet away. The masking range of audibility was determined under a variety of conditions. In an aeroplane cabin or near a pneumatic road breaker or a riveter the range shrinks to 2-3 ft., while near an aeroplane engine the range is only a few inches. On the somewhat doubtful assumption of the inverse square law, the clicker confirmed the fact that the interior of a tube train (75-80 db.) is appreciably louder than that of an express train travelling at about 60 m.p.h.—even in the corridor with some of the windows open (70 db.). It is, of course, common knowledge that it is difficult to converse and listen in a tube train, but not difficult in an ordinary train with the windows closed, particularly in a first-class carriage, with its more generous upholstery.

The cabin of an aeroplane in a cross-Channel flight was found to be at least a thousand times (30 db.) noisier than an express train, although the plywood cabin walls cut down the noise of the engine a hundred-fold (20 db.). The preference exercised by knowledgeable passengers for seats in the rear of the cabin rather than in the region of the side propellers was confirmed, there being some 10 decibels difference. It was found that the customary practice of aeroplane passengers of plugging their ears with cotton-wool resulted in a reduction of the noise experienced by about 10 decibels.

TUNING FORK MEASUREMENTS OF NOISE.

A very convenient and portable means of measuring noise has been suggested and used by Davis * at the National Physical Laboratory. A tuning fork is struck in some convenient standard manner—against the heel of the boot will do quite well, and no unusual care is necessary. The fork is then held with the flat of the prong towards the opening of the ear and as close as possible without actually touching. The time of striking the fork is noted, and the interval of time is observed until the loudness falls to the level of the surrounding noise. If desired, the time interval before the note of the fork is masked by the noise can also be measured. The rate of decay of the fork is calibrated in decibels

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* NATURE, Jan. 11, 1930.

by a buzzer or other type of audiometer. As the decay of the loudness of a fork is practically logarithmic, the calibration curve of decibels against time is roughly linear. Readings are facilitated in practice if, as the fork is approaching the matching value, it is moved to and from the ear, so that its sound is alternately louder and softer than that of the noise.

A particular fork used by Davis had a frequency of 640 cycles per second. Its loudness when it was struck was about ninety db., and the rate of decay was about 1½ db. per second. Noises as high as 110 db. were measured by means of masking observations.

Davis has used the method for determining the loudness of a variety of noises over the range of hearing, and obtained results which, as will be seen from Table I., are in good agreement with audiometer measurements by American observers.

TABLE I.

LOUDNESS LEVELS OF VARIOUS NOISES.

Traffic Noises.

Source.	Distance.	Average Decibels above Threshold	Observer.
Very busy traffic, New York	..	75	Free
Very busy traffic, London	..	70	Davis, N.P.L.
Busy traffic, New York	..	70	Free
„ London	..	60	Davis, N.P.L.
Quiet street, New York	.	60	Free
„ London	..	50	Davis, N.P.L.
Quiet residential street, New York	..	40	Free
Quiet suburban street, London	..	30	Davis, N.P.L.
Quiet suburban garden, London	..	20	„ „

Road Transport Noises.

Source.	Distance.	Average Decibels above Threshold.	Observer.
British.			
Tram on very noisy rails	In street	90	Davis, N.P L
Tram or open bus top .	„	70	„ „
Bus, recent type . .	Interior	50-60	Kaye, „
Motor car, quiet . .	In street	50	Davis, „
Saloon car, average 25 m p.h.	Interior	40	„ „
Saloon car, average 35 m.p.h	„	60	„ „
Saloon car, quiet, 35 m p.h.	„	40	Kaye, „
American			
N.Y. street car (tram) .	10-15 ft	70-75	Galt
„ „	Interior	70	Parkinson
Motor lorry, average .	15-50 ft.	70	Galt
Motor car, average .	15-50 ft.	65	„
„ quiet . .	15-50 ft.	50	„
Horse vehicle, paved street	15-50 ft.	75	„
Horse vehicle, asphalt street	15-50 ft.	60	„
Horse trotting . .	15-50 ft.	60	„
Motor horn (British)	20 ft.	80	Davis, N.P.L.
Motor horn (N Y) Directed at microphone	23 ft.	70-100 (average 90)	Galt
Motor horn (N.Y). In street	25-100 ft.	70	„
Police whistle (N.Y) .	15 ft.	80	„
„ „	15-75 ft	75	„

Train Noises.

Source.	Distance.	Average Decibels above Threshold.	Observer.
British.			
Express train . .	12 ft.	100 (?)	Davis, N P L
„ „ 60 m p h .	In corridor, windows open	70	Kaye, „
Train, windows open	Interior	60	„ „
„ windows shut .			
„ 3rd class	„	55	Davis, „
„ 1st „	„	50	„ „
1st class sleeper .	„	45-50	Kaye, „
Suburban electric train starting	..	70	Davis, „
Tube train (London) .	Interior	80	„ „
„ „ .	„	75-80	Kaye, „
American.			
Express (Limited) train	Interior Pullman car	60	Parkinson
Suburban train .	Interior	65	„
New York Subway, express	15-25 ft.	95	Galt
New York Subway, express	Interior	95	Parkinson
New York Subway, local	6-30 ft	90	Galt
New York Elevated train	15-20 ft.	90	„
„ „	Interior	75	Parkinson

In American Pullman Railway Car. (Parkinson.)

3 db. increase in noise for 10 m.p.h. increase in speed.
5 db. „ „ by opening window.
5 db. „ „ when passing another train.
10 db. „ „ in tunnel.
5 db. „ „ in corridor.
5-10 db. decrease „ when berths are made up.

Miscellaneous Noises.

Source.	Distance.	Average Decibels above Threshold	Observer.
General.			
Conversation . . .	..	40-60	Galt
Whispering . .	5 ft.	10-40	Davis, N.P.L.
Applause N.Y. (Lindbergh)	In crowd	90	Fletcher
Restaurants (London) .	Interior	40-70	Davis, N P L
Typists' room . .	.	70	..
Church bells . . .	1200 ft.	60	Galt
Thunder	1-3 miles	65	„
Animals			
Lion roaring (N.Y. Zoo)	18 ft.	85	Galt
Siberian tiger roaring .	7 ft.	80	„
Bengal tiger snarling .	15 ft.	75	„
Dog barking, in street .	20 ft.	65	„

Very Loud Noises.

Source.	Distance.	Average Decibels above Threshold	Observer.
General.			
Riveting . . .	35 ft.	95	Galt
„	200 ft.	80	„
Pneumatic drill . .	20 ft.	90	Davis, N P L
Printing-press room	..	90	..
Steamship siren .	115 ft	95	Galt
„ „ . .	1500 ft.	60	„
Steam pile driver . .	20-80 ft	85	„
Hammering, building	100 ft.	75	„
Niagara Falls . . .	Noisiest spot	85	Royce
Aeroplanes			
Aeroplane engine .	10 ft.	110	Davis, N P.L.
„ „ .	18 ft	115	Parkinson
Aeroplane cabins (various)	Interior	80-110	Davis Evans } N.P.L.
Aeroplane cabin .	„	95	Parkinson
Three aeroplanes in flight	3000 ft	60	Galt

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RELATION BETWEEN THE LOUDNESS VALUE AND THE MASKING VALUE OF NOISES.

As the masking effect of a noise is dependent on its composition, theoretically it is, in general, not possible to associate the loudness value of a noise (as determined either physically or by aural matching) and the masking value as determined aurally by one or other of the available audiometers. As a practical fact, however, it would appear that, for most of the ordinary complex and fairly continuous noises of everyday life, the loudness value exceeds the masking by a fairly constant difference, which tends to increase somewhat for louder noises, or for those of an intermittent staccato character.

For normal street and interior noises, the New York Noise Commission found that, on the average, the loudness value exceeded the medium-frequency masking value by about 15 db. For a very loud noise (90 db.), such as the intense cheering of a large crowd, it would appear from the Commission's Report, "City Noise", that the two values differed by 20 db. Davis in his tuning fork experiments found a like difference for a loudness of 110 db. He also deduces an approximately linear relation between masking and matching values for moderately loud noises.

In the case of measurements of aeroplane propeller noises of very high intensity made for the Aeronautical Research Noise Sub-Committee by the National Physical Laboratory, the two values differed by about 20-30 db., though it will be realised that measurements under such conditions are necessarily somewhat rough.

EXAMPLES OF NOISE MEASUREMENT.

Some simple illustrations of the measurement of everyday noises may be of service.

The loudness of speech ranges between about 40 db. and 60 db., an ordinary conversational tone being about 50 db. If, however, the lips of an average speaker are within half an inch of the ear of a person with normal hearing, the latter will receive the speech at a level of about 100 db. An average motor horn sounded about twenty feet away illustrates a loudness of about 80 db. Twins crying together are only 3 decibels louder than one crying alone! Another way of increasing a noise by 3 db. is for the observer to move 30 per cent nearer (that is, when in the open air); movement of another 20 per cent nearer (that is, halving the distance) would give a total gain of 6 db.

Fig. 4 shows a kind of 'noise thermometer' of common noises ranging up to 100 db.—a level which is unlikely to be exceeded in everyday experience. Some broad general groupings of noises are indicated on the left. Above 50 db. the scale is differentiated as containing in general those noises which we should do well to endeavour to moderate so far as it may be practicable to do so, and we can perhaps regard this figure as a kind of 'temperate' level on our noise thermometer.

Table I. contains a collection of loudness levels (rounded to the nearest 5 db.) of various noises as determined in Great Britain by the National Physical Laboratory, and in the United States mainly by the New York Noise Commission (the figure for the medium frequency test note being selected). Certain points of general interest are discussed below:

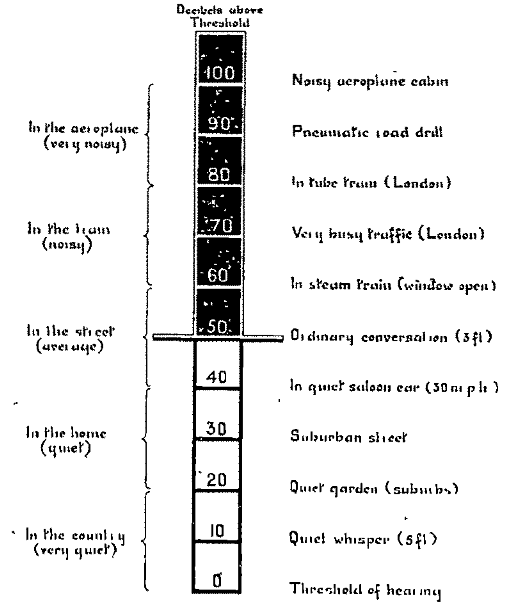

FIG. 4.—Loudness levels of common noises.

Table I. includes a variety of traffic noises both in London and New York, and, so far as it may be possible to draw a fair comparison, it would seem that a street in New York is on the average about 10 db. noisier than a like street in London. Although there are thoroughfares in London where at times a barking dog would not be heard 20 feet away, there are traffic centres in New York where, as the Commission has pointed out, a tiger could roar indefinitely without attracting the auditory attention of passers-by. It is stated that certain street corners in New York are normally noisier than anywhere so far discovered in the world; for example, the corner of Sixth Avenue and Thirty-fourth Street, which rejoices in three main streets, three tram-car lines, a double track line of the elevated railway, and the Subway (Underground). The arch sinner is the elevated railway, and nothing, I imagine, is less likely than that London will ever allow anything approximating to an overhead railway to override its streets.

The New York Commission found that the ebb and flow of noise from hour to hour closely parallels the density of the traffic, at any rate up to a figure of 50 vehicles per minute.

Some diminution of the traffic noise heard would naturally be expected in the higher stories of a building, but the effect is largely nullified if there are high buildings on both sides of the street. In such cases, even with 'sky-scrapers', appreciable relief only comes to the stories just above the first set-back. Wise travellers book bedrooms on the twentieth floor upwards in certain hotels in New York and Chicago.

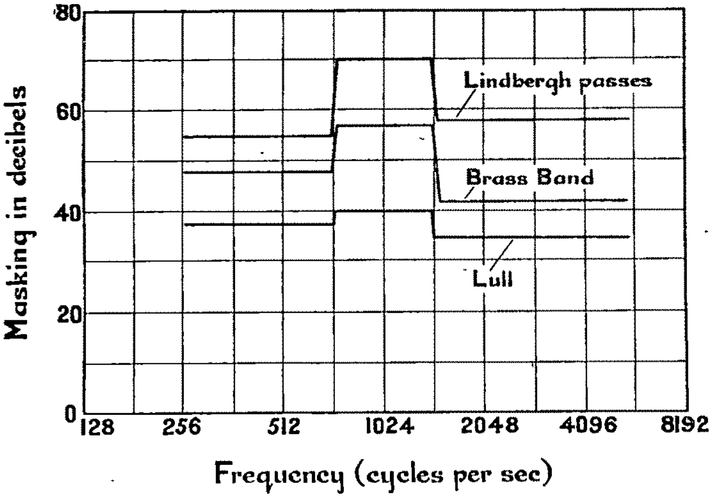

FIG 5.—Crowd noises measured 110 feet away.

Fig. 5, due to Galt, shows masking measurements of crowd noises obtained by the use of a 3-band warbler audiometer on the occasion of Lindbergh's arrival in New York after his Atlantic flight. The observers were on the fifth floor, about 110 feet from the street. The masking effects of the noise produced by the crowd's welcome as Lindbergh passed are pronounced—quite sufficient, in fact, to mask the sound of a brass band not many yards distant. It is clear that here is a quantitative method, as Mr. Galt remarks, by which footlight and other favourites of the public can periodically assess their popularity.

As regards the individual components of traffic noise, it would seem from the limited data available that British and American tram-cars do not on the average differ appreciably as regards noise. The same remark probably holds for motor cars. It is of interest to note quantitative evidence that a modern car at moderate speeds is quieter than a horse vehicle on a paved street.

Among the contributory factors to traffic noise are motor horns, into the noisiness and stridency of which an inquiry of a restricted character was undertaken in 1929 by the National Physical Laboratory on behalf of the Ministry of Transport. Observations were made in a closed chamber with heavily lagged walls. Both physical and aural methods of measuring noise were employed, cathode ray oscillograph records being also made of the average wave form. It appeared from the limited observations that stridency was bound up largely with sheer loudness, but that strong high-frequency components, strong unrelated notes, and any marked starting characteristics were among the probable contributory factors. It was not found possible to correlate stridency with wave form.

The New York Noise Commission arrived at much the same conclusions. It considers that horns with sound levels in excess of about 90 db. when heard 23 feet away are unnecessary and objectionable. It finds that complaints of stridency are unlikely to arise when fundamental frequencies lie between 200 cycles and 300 cycles, when the overtones are all harmonics of the fundamental and share the energy evenly, and when there is an absence of strong high frequencies.

As regards trains, the noise levels of express and suburban trains in England and America seem to be not unlike for a similar class of accommodation. The American method of dividing up Pullman sleeping cars partly by means of heavy curtains seems, despite its other drawbacks, to result in a noise level comparable with that of our own more secluded first-class sleeping berths. In such circumstances, however, much depends on other factors, such as the good fitting of doors and windows, which restrict noise admission.

With reference to underground railways, the New York Subway stands in a class apart for noise —as anyone who has travelled by it will testify. London 'tubes' appear to be at least 10 db. quieter, though questions of speed may come in.

Among the loudest things one is likely to encounter are the noises of riveting, pneumatic road drilling, steamship sirens, and printing presses. More untoward events are lions and the Niagara Falls, which can apparently roar equally loudly (85 db.). But the arch offender is the aeroplane engine at close quarters (110 db.). The noise in the cabins of aeroplanes in flight ranges between 80 db. and 110 db., according to the type of machine. The noise of the propeller is probably the dominant factor, though engine exhaust and general engine clatter run it close, and all three must be seen to if an improvement is to be apparent. In the view of the Aeronautical Research Noise Sub-Committee, there are, however, good prospects that the noise in aeroplane cabins will presently be substantially reduced (possibly to that of a railway train) by using propellers with lower tip speeds, providing more effective silencers on the exhausts, reducing engine clatter by enclosing the engines, and constructing cabins of double walls containing a suitable filler.

PROTECTION FROM NOISE.

The best way of securing protection from noise is to quieten it at its source. This is much more effective than trying to control it later. For example, machines may be enclosed, or better balanced, or better shaped, and mounted on insulating materials.

As regards traffic noise, a great deal of the more objectionable noise is due to vehicles which are ill-cared for and in bad condition or badly loaded. Indiscriminate horn blowing is not, I think, a characteristic British trait. Where there is considerable traffic noise, much can be done to add to the comfort of a building by creating sound shadows, and by architectural ingenuity in providing 'buffer' rooms, a recent example of which is afforded by the new headquarters of the British Broadcasting Corporation.

The protective shielding by buildings is well illustrated by the sylvan quietness of enclosed quadrangles, such as the Inns of Courts, which are in close proximity to noisy streets. The bedrooms opening on a hotel courtyard are usually much quieter than a room on the outside of the building, though sometimes the domestic quarters are so situated as to nullify the advantage.

There are two main practical methods for insulating an enclosure against air-borne noises: (*a*) By using single non-porous rigid walls or partitions. (*b*) By using multiple partitions as independent as possible and separated by air or some kind of loose filling.

In the case of the single rigid type of wall, the weight is the primary factor, the insulation value (in decibels) being proportional to the logarithm of the mass of the wall per square foot of area. Prisoners in the castle dungeons of old could not have been greatly troubled by air-borne sounds! Fig. 6 illustrates the measurements of Davis and Littler at the National Physical Laboratory. Their results, with those of Knudsen, the Bureau of Standards and others on single partitions, are summarised in Table II. for a medium frequency (512 cycles per second). The insulation values are in general rather less for low frequencies and rather more for high frequencies. As panels transmit sound mainly by diaphragm action, resonance effects may come into operation at low frequencies, but under normal conditions are probably of secondary importance.

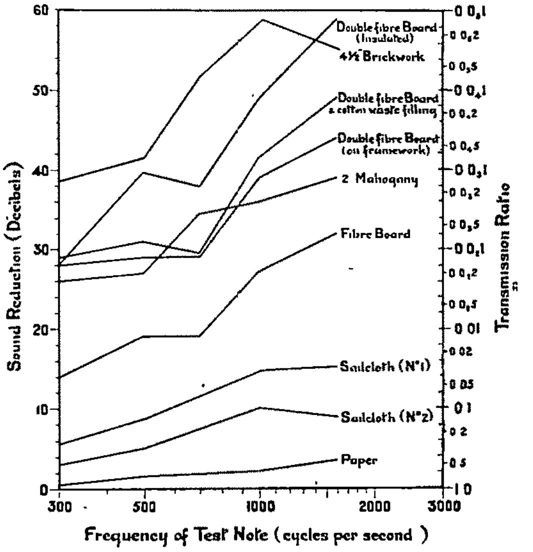

FIG. 6.—Insulating values of various materials for notes of different frequencies. (Davis and Littler.)

TABLE II.

SOUND INSULATION VALUES OF RIGID SINGLE PARTITIONS FOR AIR-BORNE SOUNDS.

Mass per sq. ft. of Wall Area.	Reduction of Sound in Decibels.
0·1 lb.	9
0·2	14
0·5	20
1	24
2	29
5	33
10	38
20	43
*40	48
60	51
100	54

* 4½ in. brick wall.

As a rough working rule, doubling the mass increases the insulation value by about five decibels, though resonance effects may spoil the relation.

In the case of porous flexible materials, Knudsen states that the insulating value is proportional to the mass of the wall per square foot of section rather than to its logarithm. Often a combination of the porous flexible material and the rigid dense partition is advantageous.

It may be here mentioned that for the stages of talking-film studios, insulation values of from 50 db. to 70 db. are aimed at according to the circumstances.

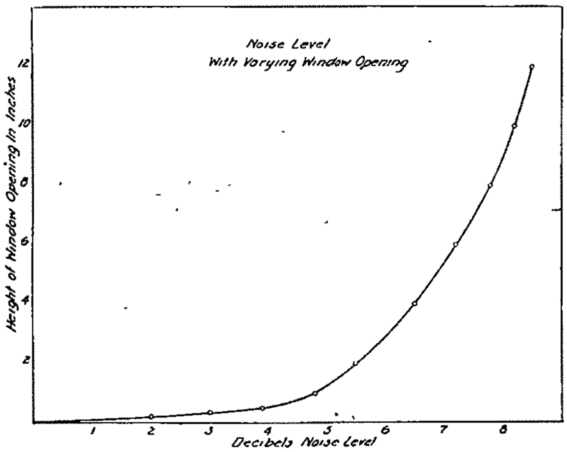

FIG. 7.

As regards multiple partitions, they should be wholly free of cross ties, that is, completely isolated from one another, if the combination is to be any better (as it may be) than one single partition of the same over-all thickness. Whether or not a loose filling material should be sandwiched between the panels is a matter for experiment, as such a filler may or may not be beneficial. On one hand, it may act as an absorbent and a damper of vibration, and on the other it may serve as a tie.

The question of protection from structure-borne noises is one to which it is hoped attention may be paid in the new Sound Laboratories which are to be erected at the National Physical Laboratory, as there is need for systematic experiment. Heterogeneity and discontinuity appear to be of value, and loose fillers may prevent the drumming of resonant panels or walls, which is often an accompaniment to such vibrations and may result in pronounced sound emission.

In many houses the windows are the chief offenders in admitting external noises. Sound-proof construction would be greatly simplified if windows could be abolished! This, of course, is not to be contemplated, but we can at any rate use substantial windows of thick glass. Opening a window even a little will, of course, largely nullify the benefit of noise shielding and absorbing devices. Within limits the amount of sound admitted by a crack or opening is proportional to its area. In the case of a door or window affording, say, 30 decibels insulation, a crack with an area 1/1000 of that of the door would admit as much sound as passes through the door or window.

Fig. 7 (due to Norris) shows the progressive increase in the noise level in a room when a window opening on to external noise was gradually opened. It will be noted that a small opening may produce a large effect.

Finally, considerable advantage may accrue in preventing noise which has gained entrance into a room from building up into a high level of reverberant sound by lining the walls and ceilings with absorbent materials. Certain banks and business houses in the City already employ the plan with advantage. I understand that many houses in New York line the roofs of their entrance porches with acoustic absorbent, deriving, it is stated, beneficial effects.

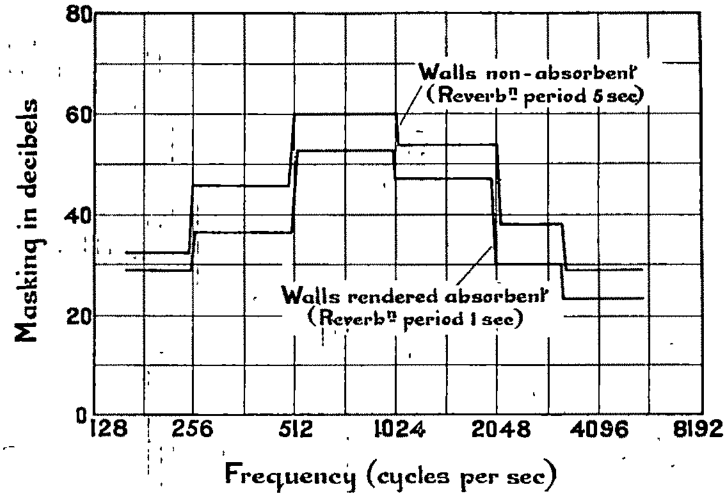

FIG. 8.—Room noises.

Fig. 8 (due to Galt) illustrates the effect on masking measurements in a room subjected to traffic noise of lining the walls with absorbent. As will be seen, the masking value was reduced by about seven decibels on the average, corresponding to a reduction in the reverberation period of from 5 sec. to 1 sec.

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study will become possible. We welcome an announcement which appears in *Man* for June that the Salle de Travail d'Ethnologie juridique of the Faculty of Law of the University of Paris is prepared to act provisionally as a central bureau for the study of customary Oriental and tropical law, and to serve as a channel of intercommunication between those who are interested in such studies. For this purpose, the subject has been divided into eight divisions according to geographical areas, and a beginning has been made by the printing of a dictionary of Indonesian law with the assistance of the International Academic Union. The study of Indonesian law will be further served by existing institutions, the Adat Law Section of the Royal Batavian Society of Arts and Sciences at Batavia, founded in 1926, and the Adat Law Foundation at Leyden, which was established in 1917. An inquiry is to be instituted in the Philippines in the current year.

AT the ninth meeting of the Executive Council of the International Institute of African Languages and Cultures, held in Paris under the presidency of the chairman, Lord Lugard, on May 27–29, it was announced that the Rockefeller Foundation had promised a grant to the Institute, not to exceed £10,000 per annum, for a period of five years. Of this amount, £5000 per annum is a fixed grant. The remaining £5000 will be paid on the basis of £1 for each £2 obtained from other sources. The grant is for research work; and with this amount at its disposal the Institute will be enabled to prosecute a regular scheme of organised research, such as it has always contemplated since its foundation. A programme has already been discussed by the Executive Council. It is now being elaborated for submission at the next meeting of Council to be held in Paris in October. This generous recognition of the importance of the problems of Africa, of which the Rockefeller Foundation has shown itself convinced on previous occasions, should stimulate possible benefactors to ensure that the full amount of the grant may be made available for studies bearing upon what is held by many to be the gravest of the problems which will confront modern civilisation in the future—the relation of the white and the black races.

THE sixth annual meeting of the British Association of Commercial Seed Analysts was held on July 25 at the National Institute of Agricultural Botany, Cambridge, the president, Mr. N. L. Dickson, being in the chair. The report of the past year showed that a considerable amount of work has been accomplished, particularly interesting results having been obtained by co-operative work among members in the testing of exceptionally difficult seeds. Six papers, including valuable notes on "New Crop Germinations", have been published and an exchange of papers made with various Colonial and American departments of agriculture and the American Seed Analysts' Association. All publications received have been added to the library and are available to members on loan; further, it is hoped to issue summaries of such papers, in addition to extracts from the *News Letter* (the official organ of the Association of Official Seed Analysts of North America). Papers on the question of the germination of damaged seeds, read by Mr. F. H. G. Neale and Mr. W. Hallam Harding, aroused considerable interest and tended to confirm the opinion that many so-called damaged seeds will eventually produce normal plants. It was announced that Dr. Nelson, of the Royal Botanic Gardens, Edinburgh, a former president of the Association, has kindly offered to help members with any difficulties that might arise with unusual species, and the hope was expressed that members will not hesitate to communicate the results of their research work, experiences, or difficulties to the secretary Mr. F. H. G. Neale, "Emmandee," Hawthorn Gardens, Reading, as by this means the Association can prove of the greatest benefit to all its members.

THE South African Museum, in Cape Town, is to be congratulated upon the additions to its capacity made during the year through the aid of the Union Government. Storage and workroom accommodation has been increased, and the erection of a new wing and the taking over of rooms occupied by the Art Gallery will give much-needed opportunity for an adequate exhibition of the animals of South Africa. We trust that systematic zoology, which after all is but one aspect of a big subject, will not claim all the new space, and that a definite allocation may be made of room to illustrate the general teachings of natural science. Another side of the activities of this Museum deserves commendation. It sends annual expeditions to the country for the observation and collection of the native fauna, and in its journal, the *Annals of the South African Museum*, it publishes contributions to the knowledge of the animals of South Africa which, for quality and quantity, equal, and indeed exceed, the products of many much wealthier institutions. The abstract of accounts, which appears at the end of the Report for 1930, shows that the total grants made to the Museum fall short of £8000, and of this sum, more than £400 was devoted to the publishing of scientific results, evidence of the research enthusiasm of the staff.

THE Imperial Bureau of Fruit Production, East Malling, Kent, has produced the first number of a journal, *Horticultural Abstracts*, that it is proposed to issue quarterly. The annual subscription, five shillings, is very reasonable, so that this publication may appeal to a number of horticulturists and students of horticulture. On the other hand, it is difficult to know where scientific work of a biological character definitely ceases to be of interest to horticulture, so that many workers will probably prefer the bigger and more expensive *Biological Abstracts* now issued by the Union of American Biological Societies, which includes a special section for abstracts of a definitely horticultural character. In the present number of the new journal, 108 papers are dealt with; the abstracts, whilst commendably brief, seem to give a very clear idea of the general character of the papers. It is certain, however, that four issues upon this scale will not cover comprehensively the annual output of general scientific work of interest to the worker in horticulture.

ONE important outcome of the Conference of Empire Surveyors in 1928 has been the foundation of the quarterly *Empire Survey Review*, of which the July issue is the first. It is published at 3*s*. a number by the Crown Agents for the Colonies. The issue opens with an article by Mr. O. G. S. Crawford on primitive English landmarks and maps, which traces some of the influences that led to the division of lands and the institution of boundaries up to the fifteenth and sixteenth centuries. Another article, by Capt. D. R. Martin, describes the ingenious map-mounting machine which for a few years has been used by the Ordnance Survey in place of hand mounting or of the use of linen-backed paper in the printing room. There are also several shorter articles on technical problems of survey, as well as reports on various Empire survey departments.

ON Aug. 6, Mr. J. A. Mollison made a forced landing on English soil near Pevensey at 1.35 P.M., thus reducing the time for the flight between Australia and England by about two days. The actual time taken for the flight was 8 days 20 hours 19 minutes, the previous record, made by Mr. C. W. Anderson Scott, being 10 days 22 hours. The flight was an adventurous one, and Mr. Mollison experienced many difficulties, due chiefly to vagaries of the weather, which caused a certain amount of delay. The distance covered was about 10,000 miles, thus giving an average of about 1100 miles a day. The machine used was a Gipsy Moth, and, apart from extra petrol tanks, was a standard machine used for training amateur pilots. The engine was a Gipsy II. (120 h.p.).

IT is with regret that we announce the death, on Aug. 6, of Prof. Archibald Barr, F.R.S., who was formerly Regius professor of civil engineering and mechanics in the University of Glasgow, and past president of the Royal Philosophical Society of Glasgow and of Section G of the British Association. Prof. Barr was seventy-six years of age.

THE following appointments have recently been made by the Secretary of State for the Colonies: Mr. A. J. W. Hornby, agricultural chemist, Nyasaland, to be assistant director of agriculture, Nyasaland; Mr. A. C. Miles, provincial superintendent of agriculture, Gold Coast, to be assistant director of agriculture, Gold Coast; Mr. R. O. Williams, superintendent, Royal Botanic Gardens, Trinidad, to be economic botanist, Trinidad; Mr. G. F. Clay, senior agricultural officer, Uganda, to be deputy director of agriculture, Uganda.

IT will be remembered that the Faraday Society has convened a Colloid Committee to organise periodical meetings for the discussion of subjects connected with colloid science. The first meeting was held in Cambridge last year to discuss "Colloid Science Applied to Biology". Arrangements are now on foot for the second meeting, which will be held in Manchester in the autumn of 1932 to discuss "Textile Materials. their Components and Related Topics". A special organising committee has been convened to draft the programme of the meeting.

THE new edition of the "Guide to Current Official Statistics of the United Kingdom" (H.M. Stationery Office, 1*s*.) has now appeared. This annual volume is of value to all workers who have occasion to use any of the statistical reports of various Government departments. A glance at its pages shows the wealth of material available. The greater part of the 320 pages is a detailed subject index with references to the numbers of the publications, which are listed also in numerical order under the various departments.

WE have received from Messrs. Watson and Sons (Electro-Medical), Ltd., Sunic House, 43-47 Parker Street, Kingsway, London, W.C.2, two new catalogues dealing respectively with diathermy apparatus and equipment for X-ray therapy. In each a brief introduction is given on the principles of the apparatus employed, followed by lists of outfits and accessories which experience has shown fulfil requirements. These include 'Sunic' condensers and spark gaps, induction coil apparatus, current generators, tubes and valves, filters and applicators, Greuz ray apparatus for treatment of skin affections, and protective materials.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two marine biologists (one a planktologist and one a benthos specialist) in the Marine Fisheries Laboratory of the Egyptian Government Coastguards and Fisheries Service, Alexandria—The Royal Egyptian Legation, 75 South Audley Street, W.1 (Aug. 20). A teacher of handicraft (woodwork, metalwork, and technical drawing), and an assistant master to teach, principally, elementary science and mathematics, at the Junior Technical School of the Castleford, Normanton, and District Mining and Technical Institute, Whitwood—M. G. Swaine, Education Offices, Castleford (Aug. 21). A graduate assistant at the Abertillery Mining and Technical Institute, and an engineering instructor at the Ebbw Vale Mining and Technical Institute—The Director of Mining Education, County Hall, Newport, Mon. (Aug. 24). A demonstrator of anatomy at the Royal Veterinary College—The Secretary, Royal Veterinary College, Camden Town, N.W.1 (Aug. 31). Two research assistants at the Institute of Agricultural Engineering, Oxford University, with special qualifications in, respectively, physics and engineering—The Secretary, Institute of Agricultural Engineering, 37A St. Giles, Oxford (Aug. 31). A male assistant curator of the Leeds Museums—The Committee Department, Town Clerk's Office, 26 Great George Street, Leeds (Sept. 9). A university reader in pathology at Westminster Hospital Medical School—The Academic Registrar, University of London, S.W.7 (Sept. 18). A William Julius Mickle fellow of the University of London—The Academic Registrar, University of London, South Kensington, S.W.7 (Sept. 30). A rector of Glasgow Academy—The Secretary, Glasgow Academy, 190 West George Street, Glasgow (Oct. 1). A Scottish medical secretary of the British Medical Association—The Medical Secretary, British Medical Association, Tavistock Square, W.C.1 (Oct. 1). A sixth form chemistry master at the Crypt School, Gloucester—The Headmaster, Crypt School, Gloucester.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Velocity of Deep Currents in the South Atlantic.

In view of the great difficulty with which the speed of a deep current is measured, the following investigation is of considerable interest. The observations on which it is based were made by Mr. H. F. P. Herdman and me in the R.R.S. *Discovery II.* during the recent passage home from the Antarctic.

Vertical sections were made along the 30th meridian from 60° S. to 15° N. showing the distribution of temperature, salinity, oxygen, phosphate, nitrate, and nitrite content, and of the hydrogen-ion concentration. They show that the surface water found in the region of the West Wind Drift between 41° S. and 50° S. sinks rapidly below the surface along its convergence with the warmer sub-tropical water in 41° S. After sinking, it spreads northwards as a poorly saline layer between the depths of 500 and 1500 metres and covers the whole of the South Atlantic. It is then generally known as Antarctic Intermediate Water. As it sinks, it carries with it large quantities of dissolved oxygen, which are used up by the living animals and by the oxidisable matter in the water as it flows northwards. The accompanying table shows the depths of the minimum salinity values which represent the nucleus of the Antarctic intermediate layer, and also the oxygen content of the water in these depths, for different latitudes.

Latitude.	Depth of Minimum Salinity. Metres.	Oxygen Content in the Salinity Minimum. C.c./litre.
46° 42·5′ S.	330	6·02
43° 08′ S.	410	5·94
38° 10·5′ S.	800	5·45
34° 08′ S.	910	5·19
31° 16·25′ S.	940	4·86
26° 06·5′ S.	850	4·59
21° 13′ S.	850	4·24
15° 37′ S.	700	4·08
09° 47′ S.	750	3·50
03° 17·75′ S.	690	3·36
02° 59·25′ N.	740	3·06
08° 54·25′ N.	800	2·18
14° 27·25′ N.	800	2·37

Owing to differences in the temperature and the quantity of phytoplankton, the amount of dissolved oxygen in the surface of the West Wind Drift varies from season to season, and the amount which sinks and flows northwards must also vary. Fig. 1 shows the oxygen content of the Antarctic Intermediate Water plotted against latitude. It will be seen that the oxygen content decreases rapidly in the water as it flows northwards, but the points which represent the determinations lie on a curve which shows well-defined maxima and minima.

The water in the West Wind Drift has its maximum oxygen content in the spring, and the maxima on the curve represent the oxygen content in the water which has left the surface in successive years.

It is thus possible, by measuring the distance between two maxima on the curve, to find the distance the water has travelled in a year. The minima can be treated similarly.

Fig. 2 shows the velocities which have been calculated in this way. The circles represent velocities calculated from the maxima, and the crosses those calculated from the minima. The difference between the two curves can be explained if the cold water which sinks in winter flows more quickly than the warmer water which sinks in summer. This might be the case owing to greater density of the cold water.

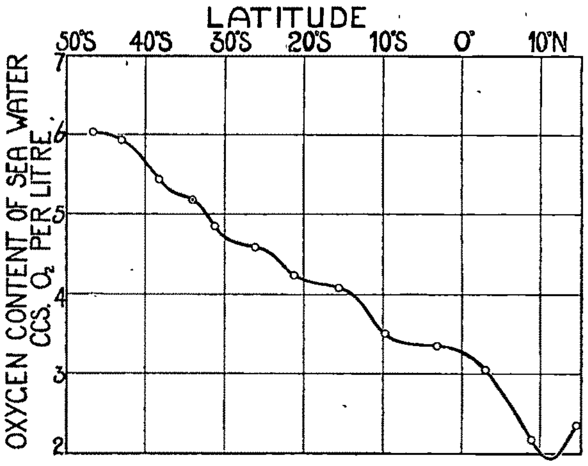

Fig. 1.—Variation of the oxygen content of the Antarctic Intermediate Water with latitude.

The conclusions reached are:

1. The stream of Antarctic Intermediate Water takes approximately five years to cover the 3300 miles between 40° S. and 15° N.
2. The northerly and principal component of its velocity increases from an average value of 1·2 miles per day in 40° S. to 2·5 miles per day in 7° S.
3. South of 20° S. there is a difference between the velocities of the water which sinks in winter and in summer.
4. The oxygen in the Antarctic Intermediate Water is used up between 40° S. and 10° N. at the rate of 1 c.c./litre in about 850 miles.

A similar method of investigation is being used to find the velocity of the North Atlantic Deep Current flowing southward at a depth of 2000–3000 metres.

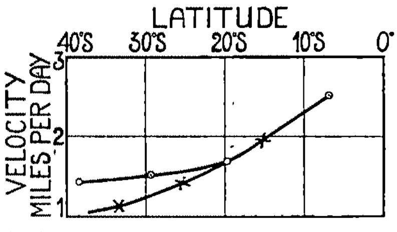

Fig. 2.—Variation in the velocity of the Antarctic Intermediate Current with latitude.

The curve of oxygen content is, however, affected by the influence of the Mid-Atlantic Ridge on the deep water movements, but a possible figure for the velocity of the deep current is 2·2 miles per day in 10° S.

This method of measuring current velocities in the Atlantic Ocean is described by Wattenberg[1] for the North Atlantic Deep Current, but no figures are given.

G. E. R. Deacon.

52 Queen Anne's Chambers,
London, S.W.1, June 29.

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[1] Wattenberg, "Die Deutsche Atlantische Expedition, Gesammelte Expeditionberichte", 1925–27, p. 139.

Subjective Interpretation of Loudspeaker Frequency Response Curves in terms of Loudness.

IN objective measurements of the overall response of sound reproducing systems, the need is continually felt of a method of interpreting them subjectively. We have found it possible, by utilising Kingsbury's scale of loudness and his measurements at different frequencies connecting the sensation level of a pure tone with its loudness,[1] to derive loudness-frequency characteristics. By way of example, in Fig. 1, is shown a typical measured acoustical response curve for a high quality loudspeaker. This type of curve can refer to the loudspeaker when supplied with constant current or when associated with its amplifier, or to the overall response characteristic corrected for different factors such as the change in the polar distribution of radiation with frequency.

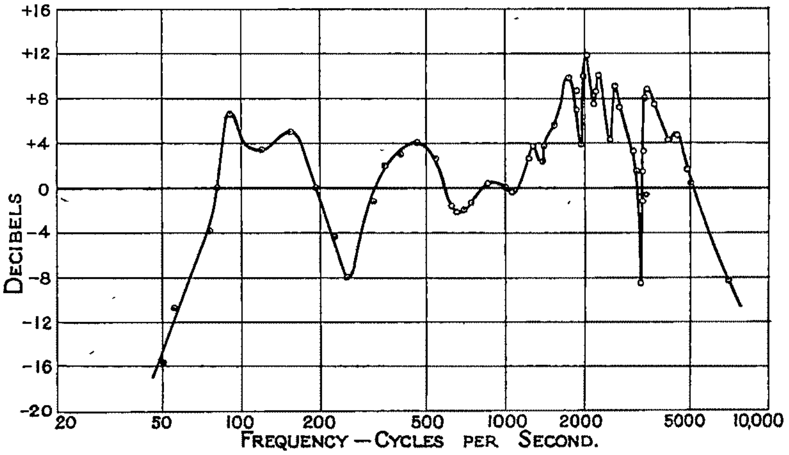

FIG. 1.—Typical acoustical response characteristic for a loudspeaker.

In Fig. 2 are shown the deduced loudness-frequency characteristics, corresponding to the objective curve in Fig. 1, for specified sound pressure levels at 1000 cycles per second (the frequency of zero level in Fig. 1), and these characteristics refer to the loudnesses of single pure tones when listened to in silent surroundings. The smooth chain curves passing through them refer to an ideal system in which the response is perfectly uniform at all frequencies. Departures of the actual loudness curves from these smooth curves give a measure of the frequency distortion of the apparatus in terms of loudness, and an observed variation in response in Fig. 1 is seen to cause a greater percentage change in loudness as the volume level of reproduction is decreased. Such curves as those shown in Fig. 2 are valuable as showing quantitatively how the apparent frequency range and tonal balance depend upon the absolute value of the sound pressure at the ear. The effect is analogous to the well-known change in tonal quality as one walks away from a band playing in the open air. The sound pressure at the ear is determined by either the distance from the source of sound or the overall characteristics of the electro-acoustical system. Solid models can be constructed from which the loudness may be read immediately at any frequency and sound pressure.

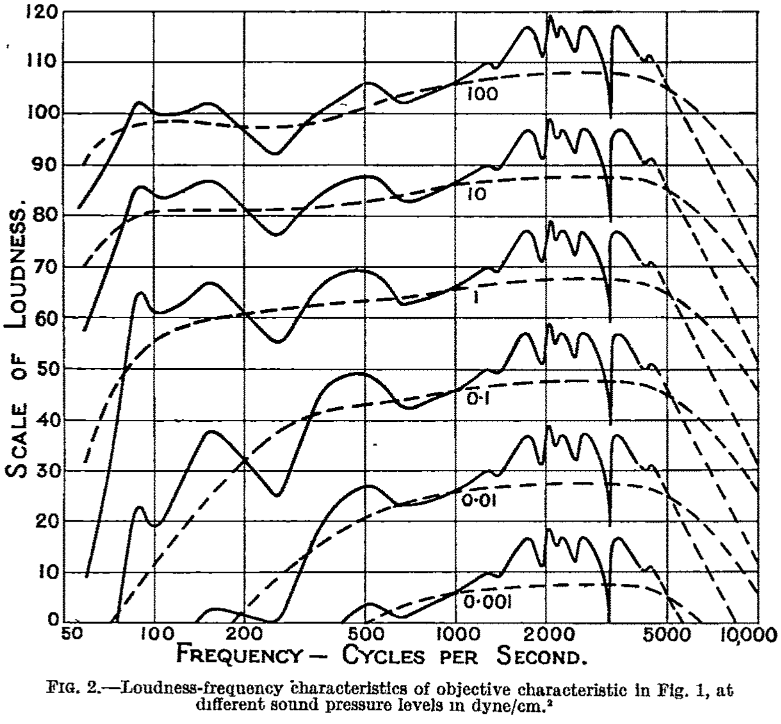

FIG. 2.—Loudness-frequency characteristics of objective characteristic in Fig. 1, at different sound pressure levels in dyne/cm.^2

It is hoped to discuss some cases of technical interest at a later date.

D. A. OLIVER.

Research Laboratories of the
General Electric Company, Ltd.,
Wembley, July 15.

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[1] Kingsbury, *Phys. Review*, 29, 588; 1927. Also "Speech and Hearing", by H. Fletcher, p. 230. Fig. 108.

Classification for Bibliography of Science.

MR. BLISS[1] has proposed the thesis, with which he is so good as to couple my name, that classification should be applied methodically to scientific literature and that the study of classification should now become a first concern of national and international organisations.

I am very glad to see that Mr. Bliss recognises the necessity for tackling the overwhelming output of scientific and technological writings. But I am not quite satisfied with his presentment of my case. I hope I am not doing him an injustice, but Mr. Bliss appears to be more interested in the perfection of the classification used than in the indexing of the literature, or, he seems to think that a perfectly logical classification is necessary for the preparation of a subject catalogue. But those who are working for the production of a comprehensive index to published scientific and technical information are inclined to look upon the classification adopted as merely a means to an end, and to criticise its comprehensiveness and flexibility rather than its philosophical basis.

In our view, the task of indexing the scientific and technical papers published throughout the world needs the employment of an army of bibliographers, the co-ordination of whose labours depends upon the use of the same classification. In such a way the International Catalogue of Scientific Literature was organised. On account of the many bibliographies of all kinds now in course of publication, we believe that general agreement by a number of bibliographers and bibliographical undertakings to adopt a standard classification would go a long way towards the immediate realisation of an extensive index to recorded information. We recommend the Universal Decimal Classification as being the only code, at present available, which is sufficiently comprehensive and minutely subdivided for the purpose.

I am sorry to be obliged to point out some small errors in Mr. Bliss's letter. The original Dewey classification was adopted by the International Bibliographical Conference (as the basis of an international bibliographical classification) in 1895, before, and not after, the issue of the report of the Committee of the International Catalogue of Scientific Literature.[2] Moreover, there is a large section for Biochemistry, termed Physiologic Chemistry, under 612.015, which is mentioned in the index to Dewey's decimal classification. It need scarcely be said that the subject is fully developed in the Universal classification. Further, I do not understand Mr. Bliss's objection to my use of the name "Universal Decimal Classification", which is the description on the title-page.

Mr. Bliss alleges that this classification is undeniably disqualified as being illogical and unscientific, for the reason that Science in Class 5 is separated from Philosophy in Class 1 and placed subsequent to Social Science in Class 3, which is remote from History in Class 9; that Philology in Class 4 is dissevered from Literature in Class 8, and so all the literatures from their languages; and further, that Biology and Psychology are not treated as distinct fundamental sciences but misrelated and dispersed. I am not quite clear as to the implication of the last sentence, but, as we are admittedly considering only scientific literature, I scarcely think that Mr. Bliss can claim that "These few examples [outside science] . . . justify . . . [the] criticism that . . . [the system] is disqualified and inadaptible ".

In regard to Mr. Bliss's objection to the decimal notation, it may be said that, in practice, numbers are found to be quicker, and therefore cheaper, for filing than letters. It would be interesting to know how Mr. Bliss would classify a paper on "Relation entre les gradients du potential Newtonien sur un plan et son application à l'étude des anomalies gravifiques et magnétiques" according to his system.

Mr. Bliss goes on to say that he thinks that it would not pay to standardise an arbitrary classification for scientific bibliography, and proposes the co-operative development and standardisation of a basic classification and notation, consistent with accepted principles and with the organisation of science. No doubt librarians would be delighted to possess a classification which should be perfectly logical and consistent with accepted philosophical principles. But does Mr. Bliss really imagine that general agreement on the logical arrangement of even the main classes of knowledge could ever be attained? Every expert regards his subject as that in relation to which all others should be arranged, and no two experts would agree. Even if the best compromise were eventually accepted, the progress of discovery would render it obsolete in a day.

In the meantime, we have in the Universal Decimal Classification a bibliographical tool which has gradually been elaborated and improved by the collaboration of many hundreds of experts in the light of a quarter of a century of experience. Somewhat illogical in parts as it admittedly is, in practice, it proves to be adequate for the indexing of scientific and technical literature on the largest scale. Its use is extending day by day, and, with its aid, the 'subject index illusion' is being realised. S. C. Bradford.

8 Merton Hall Road,
Wimbledon, S.W.19,
July 22.

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[1] Nature, 127, 889, June 13, 1931.

[2] Pollard, A. F. C., "The Decimal Bibliographical Classification of the Institut International de Bibliographie", 1926, p. 3.

The Velocity of Light.

In Nature of June 13, 1931, p. 892, Mr. Gheury de Bray brings forward two new possibilities for the explanation of the decrease of the velocity of light. As in my opinion both of these possibilities lead to difficulties, perhaps I may be permitted, in view of the importance of the subject, to offer some comments upon them.

The first possibility is in contradiction to the supposition on which at one time the elastic theory of the light of material ether was built up. I am thinking of the equation $c=\sqrt{N/\rho}$ (Fresnel, Neumann), where c stands for the velocity of light; N, rigidity; and ρ, density of the ether.

As regards the second possibility mentioned in the explanation, that is, the idea of the increase of the distance of the two points in the course of time, the matter is a little difficult, as Mr. Gheury de Bray has not explained it in detail or mathematically, and without a mathematical deduction one cannot clearly gather what he really means. For this reason, I may be permitted to add to the idea of Mr. Gheury de Bray as much as seems necessary in order to explain my calculations.

The velocity of light is determined by the equation $c=s/t$, whereby s is the distance which the light has travelled, and t the time which the light has taken to travel such distance. Let us say that s is the distance of these two 'stable' points (base of measurement), which we required fifty years ago to measure the velocity of light. Let us suppose that this distance is to-day essentially greater; but we cannot ascertain this, as the metre also is increased in the same proportion, so that we shall, in determining the basis, obtain the same measurable numbers as fifty years ago. If the velocity of light (if we can at all express ourselves to-day in previous measurements) has not changed essentially, and if not one unit of time has changed, then we shall to-day, in measuring the velocity of light according to the distance s, obtain another measurable number $c_1=s/t_1$, which is less than the previous one ($c_1<c$) as light now requires a longer time ($t_1>t$) to travel the materially greater distance s, which only by its measurable number appears equal to that of fifty years ago. The decrease of the velocity of light would in this case only be apparent.

It can be gathered from the hypothesis which I have outlined in the foregoing, that the right measure for the distance of the two points would be the time which the light needs to travel the same. If, for example, all distances have increased in the proportion $1:(1+\epsilon)$, then t_1 is $=t(1+\epsilon)$; if we designate $c_1=c-\Delta c$, whereby Δc is apparently a decrease in the velocity of light, then the equation $c_1=s/t_1$ becomes

$$c-\Delta c=s/t\,(1+\epsilon)=c\,(1-\epsilon),$$

and is therefore $\epsilon=\Delta c/c$. By substitution of the value $\Delta c = 2 \times 10^7$ cm./sec. and $c = 3 \times 10^{10}$ cm./sec., the result is $\epsilon = 6{\cdot}7 \times 10^{-4}$. This means that all distances in the last fifty years would have to be increased in the proportion of 1 : 1·00067.

One would have to enlarge in the same proportion the distance of the planets from the sun, and the reciprocal distance between double stars. Let us suppose that the masses of celestial bodies are not altered in space through this increase, and also that the constant of gravitation is not changed thereby with regard to former units of measure, then the period of revolution, T, of each planet and of each double star would have had to change in the last fifty years to T_1 according to the third law of Kepler:

$$T_1^2 : T^2 = 1{\cdot}00067^3 : 1^3,$$

and from this we can calculate that $T_1 - T = T/1000$. This, for example, means that the time which the earth takes to revolve around the sun would have been increased in the last fifty years by 1/3 day!

I must emphasise that, in spite of all these difficulties, the suggestion of the aforesaid hypothesis by Gheury de Bray has its scientific value. It is necessary that all possible explanations be brought forth, in order to illuminate this question from all sides, but it is also the task of science to find out, after a critical examination, which interpretation is the most probable.

I stated last year that the decrease in the velocity of light, if this exists, is not in contradiction with the theory of relativity, and that, therefore, one could interpret this eventual decrease in accordance with this theory, that is, with the changes in time of g_{hk}. The change in the velocity of light would in this case be real. If the expansion of the universe is the cause of the decrease in the velocity of light, then this would mean that this is an actual case of the so-called λ-effect of the general theory of relativity, as one should, according to de Sitter, consider the expansion of the universe as such an effect of this same theory.

V. S. VRKLJAN.

Zerjavićeva ul. 16, Zagreb,
June 26.

The Bottle-Pipe Resonator.

IN the issue of NATURE of Aug. 30, 1924 (p. 309), Aldis gave a formula for a resonator consisting of a closed cylindrical pipe of large diameter (length L) connected to an open cylindrical pipe of smaller diameter (length l) which he termed a 'bottle-pipe', namely, $\tan(2\pi l/\lambda).\tan(2\pi L/\lambda) = S_a/S_D$ where S_a and S_D are the sectional areas of the smaller and larger pipes respectively and λ is the wave-length of the natural frequency. The accuracy of the formula was questioned in a later number.

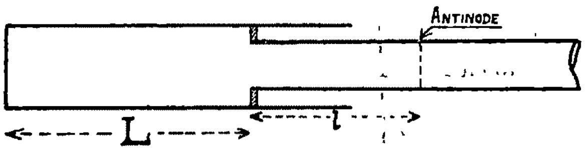

FIG. 1.

I have recently been experimenting on such a bottle-pipe resonator. To sound the resonator and eliminate the end-correction, I attached this resonator to the end of an open organ pipe, of which the diameter was equal to the diameter of the smaller portion of the resonator. The resonator was then adjusted until the system spoke at the original natural frequency of the pipe. The antinode at the end of the open organ pipe thus becomes an antinode of the open end of the bottle-pipe resonator, and the corresponding end-corrections of the pipe and the resonator are, therefore, eliminated (Fig. 1).

The method of blowing the pipe at the proper pressure and the determination of the position of the nodes in the pipe were as described in my papers in the *Phil. Mag.*, November 1929 and October 1930.

The experiment was repeated with varying lengths of the two sections (L and l) of the bottle-pipe resonator, and the results are shown on the accompanying curves (Fig. 2). The dotted curve gives the relation between the total length ($L + l$) of the resonator and the length L of the bottle section, for a frequency of 260 cycles per second. The full curve gives the relation between the two sections of the resonator; it is symmetrical about the axes, which is to be expected from the reciprocal nature of the formula.

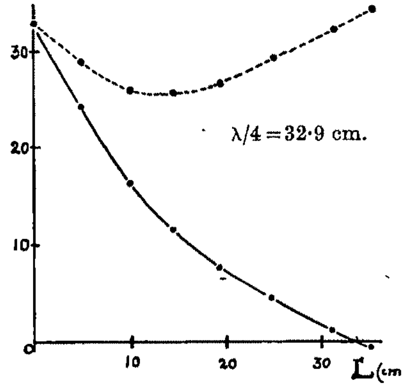

FIG. 2.

It will be seen that the ordinate of the dotted curve passes through a minimum value when the two sections of the resonator are of equal length, that is, $L = l$. In my case, these were found to be 12·9 cm., both practically and by calculation. Further, it will be seen that the relationship remains true even when the bottle section is indefinitely shortened.

I hope to publish shortly the full account of the experiments.

A. E. BATE.

The Northern Polytechnic,
Holloway, London, N.7,
July 10.

Absorption Spectra of the Ce^{+++} Ion in Solution.

THE experiments of J. Becquerel and W. J. de Haas [1] on the paramagnetic rotation of the plane of polarisation of light in a crystal of tysonite (which is a fluoride of cerium and lanthanum) has created an interest in the absorption spectra due to the Ce^{+++} ion. These authors, as a result of their measurements at low temperatures, and on the assumption that the dispersion produced in tysonite is due to the presence of a single absorption band, came to the conclusions that (i.) the rotation phenomena are due to the presence of the Ce^{+++} ion, and (ii.) the position of the absorption band is somewhere in the region of 2370 A.

Gibbs and White,[2] in their study of the relations between the doublets of stripped atoms in the different periods of the periodic table, found in the spark spectra of cerium a doublet with wave-lengths 2779·1 A. and 2457·6 A., which they attributed to Ce$^{\mathrm{iv}}$ corresponding to the transitions $6\,^2S_1 - 6\,^2P_{1,2}$ with $\Delta\nu(^2P_1 - {}^2P_2) = 4707$ cm.$^{-1}$. The nearness in the values of the calculated wave-length of the absorption band in tysonite and that of one of the lines of the doublet attributed to Ce^{+++}, made it appear worth while to investigate the absorption spectra of the Ce^{+++} ion in solution. For this purpose we prepared cerium chloride ($CeCl_3$) from chemically pure cerium nitrate. In solution it is known that the Cl^- ion shows absorption for wave-lengths $< 200m\mu$, and therefore the region where the absorption due to the Ce^{+++} ion was expected would not be masked by the presence of the Cl^- ion. As a result of our investigations, we found two regions of selective absorption, which appear fairly narrow in width and of measurable intensities at two different dilutions. In the following table their positions are given, with the dilutions at which they appear most distinct. The wave-lengths of the emission doublet attributed to Ce^{+++} ion is also given.

Dilution.	Absorption wave-length.	Emission wave-length.
1/40 mol.	2960 A.	2779 A.
1/1000 mol.	2550 A.	2457 A.
	$\Delta\nu = 5432$ cm.$^{-1}$	4707 cm.$^{-1}$

It appears that the agreement between the two sets of values are as good as can be expected under the given conditions. The absorption lines are shifted towards the longer wave-length side. From magnetic measurements made on cerium salts, both in the solid state and in solution, it is known that the Ce^{+++} ion is in the $4\,^2F_{\frac{5}{2}}$ state corresponding to the following electronic distribution :

$$\begin{matrix} 4f & 5s & 5p \\ 1 & 2 & 6 \end{matrix}$$

By light absorption the $4f$ electron is raised to the $5d$ level, giving rise to $5\,^2D_{\frac{3}{2},\frac{5}{2}}$ terms. The calculated relative intensities of the doublet lines due to the transitions $4\,^2F_{\frac{5}{2}} \rightarrow 5\,^2D_{\frac{3}{2},\frac{5}{2}}$ is 14 : 1.

The result of our observation is compatible with the predicted ratio of intensities, if it is assumed that the $^2D_{\frac{5}{2}}$ term represents the higher energy level. The shift of the absorption band towards the longer wave-length side can be explained as due to the work done on the radiating electron by the surrounding dipole water molecules, when it is shifted from the inner $4f$ orbit to the outer $5d$ one, on the periphery of the Ce^{+++} ion.

D. M. BOSE.
S. DATTA.

University College of Science,
Calcutta, June 8.

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[1] *Zeit. für Phys.*, **57**, p. 11; 1929.

[2] *Phys. Rev.*, **33**, p. 157; 1929.

Band Spectrum of the Green Flame of Phosphorus.

I HAVE made several unsuccessful attempts within the last two years to obtain a satisfactory photograph of the band spectrum of the green flame obtained when hydrogen containing a little phosphorus vapour is burnt in the air. The difficulty has mainly been that photographic plates are very insensitive in the green and the flame is not easily maintained for long periods.

I have recently obtained a good photograph, giving an exposure of 100 hours, using a two prism glass spectrograph giving a dispersion of about 10 A. per mm. in the green. In the most intense bands there is considerable overlapping, but a fainter band at λ 5066 comes out clearly, and Fig. 1 is a reproduction of a register of the band made for me very kindly by Dr. Baker, of the Royal Observatory, Edinburgh. The appearance is very like that of an infra-red vibration-rotation spectrum, but might be an electronic band in which the moment of inertia of the molecule in the excited and unexcited condition is very nearly the same.

The separation of the bands is about 14·4 cm.$^{-1}$ on the blue side of the gap and 18 cm.$^{-1}$ on the red side. The frequency differences between the gaps in the strongest two pairs of bands are 1187 cm.$^{-1}$ and 1306 m.$^{-1}$, but these measurements are only rough at present and the analysis of the whole system has not yet been made. The moment of inertia calculated from the value 14·4 cm.$^{-1}$ is $3{\cdot}95 \times 10^{-40}$, which is not conclusive but suggests that the emitting molecule is more likely to be a hydride than the P_2 molecule.

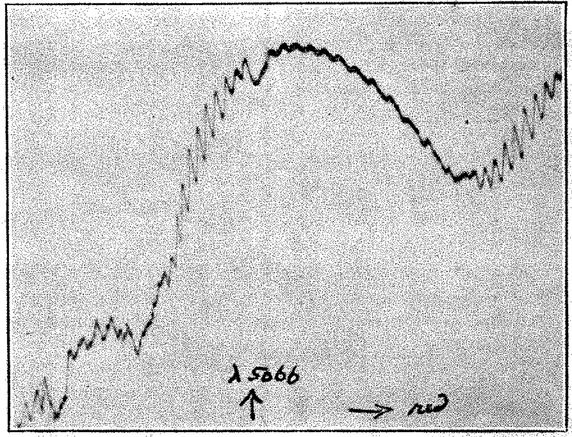

FIG. 1.

E. B. LUDLAM.

Chemical Department,
University of Edinburgh.

Ultra-Violet Absorption Spectra of Cyanogen and the Cyanogen Halides.

WE have photographed the absorption spectra of cyanogen chloride, bromide, and iodide, and cyanogen itself in the gaseous state. The light source was a water-cooled quartz hydrogen tube consuming 0·5 amp. at 10,000 volts, from which the emission was perfectly continuous up to the short wave-length limit of the spectrograph (1840 A.).

Cyanogen chloride (pressure, 760 mm.) and cyanogen bromide (pressure, 76 mm.) showed continuous absorption, beginning about 2240 A. and 2540 A. respectively, and extending in each case to 1840 A. Cyanogen iodide at room temperature has a continuous absorption with long wave-length limit about 2150 A. At higher temperatures (100° - 125° C.) another region of continuous absorption appears with a maximum of 2500 A. and long wave-length limit at 3100 A.

The most probable mechanism for the photo-dissociation seems to be

$$CN.X + h\nu \rightarrow CN' + X$$

where CN′ has the excitation energy 41 kcal. in all cases except the far ultra-violet absorption of cyanogen iodide, where CN′ has 73 kcal. excitation energy. This leads to values 86, 71, and 51–59 kcal. for the heats of dissociation of cyanogen chloride, bromide, and iodide respectively into CN and halogen atom. These values are each about 10 kcal. greater than the mean values given by Eucken for the carbon-halogen linkages in aliphatic compounds.

The absorption spectrum of cyanogen is discontinuous. Between 2380 A. and 1860 A. there are about forty bands, shaded towards the red. Some of these show rotation structure. The bands do not converge before 1850 A. (154 kcal.); the heat of dissociation of $(CN)_2$ into 2CN must therefore be greater than 81 kcal., if the dissociation at the convergence limit leads to CN and CN′ (73 kcal.). The heat of dissociation calculated from thermochemical data is 66 kcal. The photo-dissociation may, however, produce vibrating CN molecules. This would account for the discrepancy. A full description of these absorption spectra will be published shortly.

R. B. Mooney.
H. G. Reid.

Chemistry Department,
University of Edinburgh, July 23.

The Critical Increment of the Adsorption of Hydrogen on Amorphous Carbon at 400° - 520° C.

The rates of adsorption of hydrogen on amorphous carbon have been measured for pressures ranging from 1 cm. to 10^{-3} cm. of mercury. Assuming that the rate of reaction is proportional to the pressure and to the surface covered, the rates will be given by the equation

$$-dp/dt = k(Ap + p^2)$$

where k is the velocity constant and A is a constant containing the area. This equation holds for the whole range of pressures and temperatures investigated, but A is not independent of temperature; it practically doubles as the temperature is increased from 400° to 520° C. The values of log k plotted against $1/T$ give a straight line, and from the slope a critical increment of 30,000 cal. is calculated.

If the reaction be written,

$$(1)\ 2C_s + H_2 = 2C - H,$$

and Mecke's values for the C - C, C - H, and H - H linkings be adopted, namely, 65, 90, and 101 kcal., the reaction is exothermic to the extent of 14 kcal., and if the carbon surface be activated, the heat of reaction will be larger. It is doubtful if the reaction actually occurs in this way, for the adsorbed gas is evolved as hydrogen on evacuating under a high vacuum at 800° - 900° C., whereas if the hydrogen had combined with the carbon, some methane would be expected. There is thus no evidence that the hydrogen has entered into chemical combination with the surface. It is possible, however, that the hydrogen molecules are dissociated into atoms by the process,

$$(2)\ 2C - + H_2 = 2C_s + 2H,$$

which is endothermic to the extent of 30–35 kcal., which corresponds with the observed critical increment. The result of the change is a deactivation of the surface with the production of adsorbed hydrogen atoms. On desorption, however, the surface returns to its original activity, so that if the above process occurs, it must be reversible.

The adsorption of hydrogen on carbon at 450° C. resembles that found previously for the adsorption of hydrogen and carbon monoxide on $ZnO - Cr_2O_3$ at room temperature,[1] and for the adsorption of hydrogen on manganese dioxide at 400° C.[2] It is unlike that of oxygen on carbon at room temperatures, for in this case the oxygen can only be removed from the surface in combination with carbon, and it is different from that of hydrogen and carbon monoxide on $ZnO - Cr_2O_3$ at 100° C., for these gases remove oxygen atoms from the surface on desorption. The adsorption of hydrogen on carbon appears to be of a type intermediate between van der Waals' adsorption and true chemisorption.

The main difficulty in the acceptance of equation (2) lies in the fact that carbon monoxide also gives rise to the intermediate type on oxide catalysts, where dissociation into atoms is not possible.

F. E. T. Kingman.

Department of Physical Chemistry,
The University,
Bristol.

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[1] Garner and Kingman, Nature, Sept. 6, 1930; *Far. Soc.*, **27**, 322; 1931.

[2] H. S. Taylor and Williamson, *J.A.C.S.*, **53**, 2168; 1931.

Intensity of Raman Scattering in Gases.

Using the apparatus described in earlier notes in Nature, it has been found possible to estimate by photographic photometry the intensities of the Raman lines given by various simple gases and to make a quantitative test of the theory put forward by Manneback.[1] The results, on the whole, seem to be favourable to the theory. The intensities of the rotational Raman lines representing the $0 \rightarrow 1$, $1 \rightarrow 3$, $2 \rightarrow 4$, and $3 \rightarrow 5$ quantum transitions in hydrogen gas are respectively in the ratio 1 : 3 : 0·4 : 0·2, Manneback's values being 1 : 2·8 : 0·35 : 0·19. His theory further enables us to express the absolute intensities of these lines as fractions of the undisplaced Rayleigh lines if the optical anisotropy of the molecule is known. This may be computed from the observed depolarisation of the Rayleigh scattering. In the case of hydrogen, the calculated intensity of the $0 \rightarrow 2$ rotational line, the first of the above series, comes out as $3{\cdot}5 \times 10^{-3}$, the observed value being 2×10^{-3}.

Manneback's expressions further show that while the Rayleigh scattering depends on the optical polarisability and anisotropy of the molecules, the vibrational Raman lines are connected with the variation of these quantities with varying nuclear distance. We have at present no experimental knowledge of the latter quantities, but following a method due to Ramanathan[2] it is possible to estimate them theoretically and thus evaluate Manneback's formulæ numerically. In this way it is found that the intensity of the strongest line in the Q branch of H_2 ($0 \rightarrow 1$ vib. $1 \rightarrow 1$ rot.) when expressed as a fraction of the Rayleigh line should be $1{\cdot}63 \times 10^{-3}$, while the observed value is $1{\cdot}5 \times 10^{-3}$. A qualitative agreement is also found with oxygen (O_2) and nitrogen (N_2). It may be noted that the existence of nearly unpolarised rotational Raman scattering with appreciable intensity necessitates a revision of the hitherto accepted values of the depolarisation of Rayleigh scattering, and this has been taken into account in the above computations.

S. Bhagavantam.

210, Bowbazar Street,
Calcutta, India.

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[1] *Zeit. für Phys.*, vol. 62, p. 224; 1930.

[2] *Proc. Roy. Soc.*, vol. 107, p. 684; 1925.

Anomalous X-ray Diffraction Intensities.

The general explanation of the observations previously described under the above heading[1] probably follows, as stated there, from the well-known Laue equations connecting line-breadth with the size of a crystallite measured in a direction a_1. I have recently become aware of a paper by R. Brill,[2] in which this aspect of Laue's work first appears to have been demonstrated quantitatively, and I would like to add this to my former note in order to direct attention to that paper.

W. A. Wood.

Physics Department,
The National Physical Laboratory,
Teddington, Middlesex,
July 17.

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[1] Nature, of May 9.

[2] *Zeit. für Krist.*, **75**, 217.

Research Items.

Hippopotamus Figures from Ancient Egypt.—Mr. W. M. Crompton describes two hitherto unpublished hippopotamus glazed figures in *Ancient Egypt*, 1931, pt. 1. The first was found by the expedition of the School of Archæology in Egypt to the Fayum in 1913–14, in a shaft-grave of the twelfth dynasty near Haregeh. The figure lies with the head turned to the right in a natural pose. It was originally covered with blue glaze, and decorated with designs in black outline, representing the fauna and flora of the marshes frequented by the animal, which was seldom seen except in glimpses through such a foreground. Recently Dr. L. Keimer has published a study of thirty-six decorated hippopotami. On twenty-six examples, including that from Haregeh, decorative motives appear as follows: the flowers of *Nymphaea sp.* appear in all but one, which is entirely decorated with pondweed. The leaves and buds almost invariably appear. Shining pondweed (*Potamogeton lucens* Linn.) appears on five. The papyrus is shown three times only. Rosettes are usual, but not invariable. Birds appear six times; butterflies three, or possibly four times; and a bee once. In one instance there is a frog half emerging from a lotus flower. Decorative bands are found four times and a network once. The representation on an animal figure of objects with which it was supposed to be surrounded was not, until recently, known to occur before the Middle Kingdom. It has now been carried back to the Middle Predynastic period; for Mr. Brunton has found at Badari a fragment of a pottery hippopotamus on which is the design of a ship and men with harpoons, evidently meant as surrounding the animal with intent to destroy it.

Evolution in the Chelonia.—P. E. P. Deraniyagala, in the *Proceedings of the Zoological Society*, Part 4, 1930, gives a reasoned account of his views on testudinate evolution and upholds the thesis that the Athecæ, the leathery turtles, are the more primitive type in the structure of the carapace, as well as in many other features. He points out that the current view that the Athecæ have lost the endoskeletal expansion of the ribs, and consequently the carapace plates, is not necessarily correct, being due to a wrong bias from palæontology. The rarity of Athecæ in any except recent deposits is not due to their recent evolution, but can be explained by the fact that on death their skeletons fall apart and are not preserved as are the well-knit bodies of the Thecophora. As a matter of fact, the earliest known of Chelonian remains, *Psephoderma alpina*, from the Triassic, is claimed as Athecan. The author considers that the original Chelonia were marsh dwellers and at first had a dermal covering with an external layer of ossified scales and a non-retractile neck. It was at this stage that the Athecæ took permanently to marine life, retained the primitive scaling, and never acquired the retractile neck.

Sex-change in the Oyster.—Prof. J. H. Orton and C. Amirthalingam (*Jour. Mar. Biol. Assoc.*, 17, No. 2, 1931) record observations on sex-change in the European oyster (*Ostrea edulis*). Oysters in which a batch of eggs has been passed into the mantle cavity normally immediately begin to develop spermatozoa, and this process is so rapid that in a few hours after extrusion of the eggs small clumps of spermatocytes can be recognised in the gonad. Within about fourteen hours from the extrusion of ova, relatively large clumps of spermatocytes are recognisable in the gonad, and within about forty-five hours the gonadial tubes become filled with maturing sperm. About eight and a half days after the extrusion of ova, when the larvæ which the oyster is carrying have become fully developed veligers ready to be liberated, sperm development may have proceeded so far that the gonadial ducts become filled with ripe sperm-morulæ. After the larvæ have been liberated, sperm production continues, but about a month after extrusion of the ova begins to wane and in another month has usually ceased if the egg-spawning has occurred in early or mid-summer. The gonad passes into a quiescent condition, and a period of fattening, that is, the accumulation of reserves, usually follows. If egg-spawning occurs in late summer, the sperm afterwards developed may be retained over the winter period. Instructions are given for making the microscopic preparations of the gonad, and illustrations are added to represent the condition as seen in fresh preparations and in sections.

Anterior Abdominal Vein in the Toad.—We have received a communication from Prof. Ekendranath Ghosh and Birendrakumar Mitra, of the Medical College, Calcutta, stating that, while examining about fifty dissected toads (*Bufo melanostictus* Schneider) in a medical examination conducted by Prof. Ghosh, they found a normal-sized anterior abdominal vein, arising in the usual way and ending in the left subclavian vein. The vein had no connexion whatever with the liver or hepatic portal vein. The animal was an adult male. This is the second abnormality of its kind to be recorded for this species. The previous example, where the anterior abdominal vein opened on the right anteriorly, was reported by Bhaduri (*Jour. Dep. Sci.* Calcutta, p. 1, 1929).

A Hypothesis of 'Sub-genes'.—Numerous papers have been published on the inheritance of bristles in *Drosophila*. A group of gene mutations which reduce the bristles in different parts of the body has been studied. These genes are shown by their linkage relations to lie at the scute locus of the *X*-chromosome. To account for these phenomena, Serebrovsky and others have elaborated a hypothesis of 'sub-genes' arranged in linear order, each concerned with the development of one or a few bristles on the fly. The various mutations which scute undergoes are then each supposed to represent a change in a different block of sub-genes. Sturtevant and Schultz (*Proc. Nat. Acad. Sci.*, vol. 17, No. 5) have constructed a similar series of bristle-effects from their experiments, but they interpret it in a different way. Hairless is another gene (in chromosome III.) which removes the bristles in a different pattern from that of the scute series, and achete also inhibits bristle development. By experiments involving these series of forms, it is shown that scute 1 and achete act on bristles throughout the length of the series and not on particular bristles alone. Thus since each 'sub-gene' is affecting many or all the bristles of the fly, though in different degrees in different parts of the body, the basis of the sub-gene hypothesis is undermined and the usual conception of the interaction of genes in controlling development is adhered to instead. The pattern of bristle-effects is explained rather as due to the paths and rates of diffusion of certain substances during development.

Pivots and Jewels.—H.M. Stationery Office has issued at the price of 4*s*. a well illustrated 4to pamphlet of 55 pages describing the work done at the National Physical Laboratory, by Mr. V. Stott, on the conditions favouring smooth running and long life of the pivots and jewels which play so important a part in watches and scientific instruments of all kinds. Mr. Stott has investigated the most suitable shape and hardness of a pivot to carry a given load, and has measured the friction between the pivot and jewel and the torque due to it. He finds that during the rotation of the pivot rust is formed, and that this rust is the main cause of the increase of friction during wear. Lubrication does not diminish the friction between the pivot and jewel, but its presence considerably increases the life of the bearing. The relation between the direction of the hole in the sapphire or diamond and its crystalline axis has an influence on the wear of the bearing.

Flame Propagation in an Electric Field.—Prof. W. A. Bone, R. P. Frazer, and W. H. Wheeler have contributed a paper to the July number of the *Proceedings of the Royal Society* on the effects of an electric field upon the propagation of flame through a dry mixture of carbonic oxide and oxygen. The gas was dried by prolonged contact with phosphoric anhydride, the combustion started by a spark, and the progress of the flame recorded photographically. An electric field was applied between electrodes in the gas, and control experiments made in the absence of a field in otherwise similar apparatus. Their results show a definite effect of the sign of the pole on the flame; near the negative pole conditions are much more favourable to the continuance and propagation of the flame; and near the positive pole rather less favourable than in the field-free control experiments. There appear to be two distinct conditions in which the field has an effect: first, when the flame is being propagated through a dry medium in which the field is maintained, and secondly, when the flame fronts have nearly reached the poles and the field breaks down. In the first instance, there is a general drift of the medium towards the negative pole and also a sort of initial wave of positive ions in the same direction; and in the second, combustion is accelerated by the highly ionised condition of the medium. The paper is illustrated by some beautiful photographs of the moving flames.

Structure of XO_3 Groups in Crystals.—A paper by W. H. Zachariasen in the June number of the *Journal of the American Chemical Society* gives the general results concerning the structure of groups XO_3 in crystals, as determined by X-ray analysis. The groups are found to be of two kinds: (1) co-planar groups; BO_3''', CO_3'', and NO_3'; (2) pyramidal groups; SO_3'', ClO_3', AsO_3''', BrO_3', SbO_3'''. In the following table *a* denotes the oxygen to oxygen distance, *r* the cation to oxygen distance, and *h* the displacement of the cation from the plane of the oxygens, all in angstroms.

	BO_3	CO_3	NO_3	SO_3	ClO_3	AsO_3	BrO_3	SbO_3
a	2·35	2·13	2·14	2·24	2·38	3·28	2·76	3·62
r	1·35	1·23	1·23	1·39	1·48	2·01	1·68	2·22
h	..	..	..	0·51	0·49	0·67	0·56	0·75

The groups XO_3 are co-planar if the number of valency electrons in the group is 3×8, whilst a pyramidal arrangement seems to be connected with $3 \times 8 + 2$ valency electrons. An explanation of the formation of the asymmetrical groups in terms of ions and their polarisibility is given in the paper, and the values of *a* and *h* are shown to be related by the expression $12h = a\sqrt{6}$, which suggests a simple picture of the pyramidal groups as tetrahedral groups with three corners occupied by oxygen ions, the centre by the cation core, and the fourth corner by two displaced electrons or an equivalent concentration of electron density.

Astronomical Topics.

Nagata's Comet.—*Science News Letter*, dated Aug. 1 (Science Service, Washington, D.C.), gives information about the discovery of this comet: Mr. Masani Nagata is a native of Japan engaged on fruit-growing near Brawley, California; he possesses a 3-inch telescope, and in the course of observing Neptune on the evening of July 15 (July 16·2 U.T.) he swept up a nebulous object near it; the next night it had moved a degree to the north-east; he sent the news to Mt. Wilson, where Mr. Moore confirmed the discovery. There was a tail 4° long on July 18; the magnitude of the comet was given as 7 on July 23 and 9 on July 25, but it was probably really brighter, as twilight and atmospheric absorption would weaken its light more than that of the stars.

The following positions (for 1931·0) are from Harvard Cards 161–164:

Date.	R.A.	N. Decl.	Place.
July 18, 1792 U.T.	$10^h\ 40^m\ 44{\cdot}7^s$	9° 50′ 57″	Mt. Wilson
19, 1861	10 45 6·0	9 54 46	,,
20, 1795	10 49 22·3	9 58 12	,,
22, 2004	10 57 56·3	10 4 27	,,
23, 1157	11 1 46·1	10 6 50	Yerkes
25, 1933	11 10 20·8	10 11 22	Lick

The following ephemeris for 0^h U.T. is from *U.A.I. Circ.* 329:

	R.A.	N. Decl.
Aug. 19	$12^h\ 42{\cdot}5^m$	9° 52′
23	12 55·5	9 39
27	13 8·1	9 25
31	13 20·4	9 10
Sept. 4	13 32·4	8 54
8	13 44·1	8 37

The comet is receding from both sun and earth, so the brightness diminishes rapidly. The elements of the orbit show some resemblance to those of the comet of 1804; but this is probably not close enough to make identity possible; the inclination of Nagata's comet is about 14° smaller than that of the other.

Accuracy of the Heliometer.—Prof. de Sitter's George Darwin Lecture is printed in the May number of *Mon. Not. Roy. Ast. Soc.* In the course of it, he discusses the relative accuracy of heliometer measures and of those made on photographic plates. His decision is definitely in favour of the heliometer: he says, "the weight derived from an equal time of observing is for the heliometer more than four times that from one plate". One of the advantages of the heliometer is that the images of the two bodies are brought so close together that the eye can be concentrated on both of them at once. Prof. Schlesinger has shown that oscillations due to our atmosphere are alike for a region of considerable size, so that they do not affect the relative positions of the two bodies. He thinks that a heliometer of focal length 5–7 metres, with a power of 750, showing the satellites of Jupiter as discs, would help to settle a few questions, relating to their motions, that still remain uncertain. Most observers appear to consider the heliometer as obsolete; the Cape is the only observatory where it is extensively used: possibly Prof. de Sitter's words may encourage its reinstatement. It will be remembered that the first reliable star parallax was obtained by Bessel with a heliometer.

Royal Society of Canada.

Annual Meeting in Toronto.

On May 20–22 the Royal Society of Canada met at the University of Toronto. During the evening of May 20 Dr. Charles Camsell, Deputy Minister of Mines, gave his presidential address, entitled "Canada's Position in the Mineral Situation of the British Empire". Dr. Camsell, while emphasising the fact that no nation is independent of others in the matter of mineral supply, pointed out that, mainly owing to the diversity and amount of Canada's mineral production, the British Empire approaches much more nearly to a self-supporting basis than any other political unit. At the same meeting, the Flavelle medal was awarded to Dr. F. G. Banting, for his pioneer research on insulin; the Lorne Pierce medal to Adjutor Rivard, for outstanding contributions to literature, and the Tyrrel medal to Dr. Lawrence J. Burpee, for valuable historical work. The customary popular lecture was this year given by Dr. J. S. Plaskett, Director of the Victoria Observatory, on the "Structure and Motions of the Galaxy". A novel feature of the meeting was a series of radio talks by the presidents of the various sections, which were broadcast over the Dominion.

Section III. (chemical, mathematical, and physical sciences) divided into sub-sections to hear its 117 papers. The sectional presidential address was delivered by Prof. F. B. Allan on the position of organic chemistry to-day. A large number of papers were presented on spectroscopy by Prof. J. C. McLennan and his colleagues, Dr. J. S. Foster and his co-workers, Dr. W. H. Martin, and others. Among these papers, mention may be made of a paper by Prof. McLennan and R. Turnbull on "The Absorption Band of Xenon at λ 1469". The results indicate that by the absorption of ultra-violet light of very short wave-length, xenon atoms become enabled to enter a short-lived state of excitation during which they can and may combine with other xenon atoms. They have been able to separate the widening of the absorption band due to the number of molecules from the widening due to the pure pressure effect, for which a theory has been developed and extended by Franck in his lecture at Bristol last summer.

Other papers by Prof. McLennan and Messrs. E. J. Allin, A. B. McLay, M. F. Crawford, L. B. Leppard, A. M. Crookes, and K. E. Hall gave interesting accounts of research work on the properties of atomic nuclei—more particularly the nuclear spins. Further results on the height of the polar auroræ in northern Ontario were presented in a paper by Prof. McLennan, H. Wynne-Edwards, and H. J. Ireton.

Of the papers presented on the Stark effect, the most interesting was on "The Stark Effect in Hα", by D. R. McCrea. Asymmetry in the relative intensities of the components was found in pure hydrogen, which could not be accounted for by the known theoretical probabilities of the transitions. The addition of a small amount of the rare gases causes the intensities to become symmetrical.

In a series of experimental papers on low-temperature work at the cryogenic laboratories of Prof. McLennan, a number of interesting results were reported by Messrs. Wilhelm, Allen, and H. D. Smith. Among these, mention may be made of "The Electrical Conductivity of Ruthenium, Ruthenium Carbide, and Tungsten Carbide", in which the presence of a small amount of W_2C accounted for superconductivity results. Theoretical papers on the superconducting state were given by C. D. Niven, G. C. Laurence, and Prof. L. V. King. Dr. King's paper was perhaps the most outstanding paper of Section III. By assuming that the ion at the space-lattice be polarisable, so that the internal field acting on the free electrons is appreciably different from the measured applied field, he showed that the Wiedemann-Franz ratio depends on the specific inductive capacity of the space-lattice, the variation with temperature of which is given by Debye's formula. A satisfactory explanation is thus afforded of the variation of resistance with temperature. In particular, when the ions have permanent electric moments, the space-lattice may become permanently polarised when the temperature falls below a certain critical value, and superconductivity results. The agreement between theory and the experimental results of Lees and others was satisfactory.

Prof. A. N. Shaw gave new experimental data correlating thermo-electric force with temperature gradients, and Prof. J. Satterly spoke on the surface tension and viscosity effects on a draining plate. Dr. R. W. Boyle presented several papers by his colleagues of the National Physical Laboratory on ultra-sonics and allied subjects. Prof. J. A. Gray gave the results of further experiments on the scattering of X-rays at small angles and on the scattering of β-rays. He also read a short paper on the absorption of γ-rays.

Several papers on geophysics were presented. Prof. A. S. Eve gave the theory of a new method of finding the vertical depth of a buried magnetic dike, which was followed by an experimental paper on the same subject by Prof. D. A. Keys. Prof. L. Gilchrist presented the results of field work, comparing the single and his multiple electrode variation of the single-probe method of geophysical prospecting, and indicating the desirability of the latter arrangement over the region investigated. The results of a torsion balance survey in eastern Canada over pyrite and chromite deposits were read in a paper by A. H. Miller.

In the sub-section of mathematics and astronomy, which met jointly with the members of the Royal Astronomical Society of Canada, papers on astrophysics were read by Dr. J. S. Plaskett, Prof. C. A. Chant, Meldrum Stewart, W. E. Harper, Miss A. V. Douglas, and others. An interesting feature of the joint meeting was an account of the new David Dunlap Memorial Observatory and telescope which have been given to the University of Toronto. The new telescope, which is of the reflecting type, will be the largest in Canada, and the observatory will be under the direction of the Department of Astrophysics of the University.

Papers in pure mathematics were presented by Prof. S. Beatty, Prof. J. L. Synge, Prof. L. L. Dines, Prof. N. R. Wilson, Prof. DeLury, and their colleagues. Among these may be mentioned "The Derivatives of an Algebraic Function", by Dr. Beatty; "Constructing Basis for an Algebraic Number Field", by Dr. Wilson; "On Sets of Functions Orthogonal to a Positive Function", by Dr. Dines.

A large number of papers were presented in the chemistry sub-section by Profs. Lash Miller, O. Maass, H. Hibbert, and R. H. Clarke, and their associates. Prof. M. C. Boswell and W. H. Hutcheon spoke on an apparatus for studying the conditions influencing the yield of methyl chloride in the action of chlorine on methane, and Prof. J. B. Ferguson presented a paper on the co-existent vapour and liquid phases in the system, normal hexane-methyl alcohol at 45° C.

A demonstration of the new optical meteorograph was given by Mr. J. Patterson, secretary of Section III., by which the temperatures and pressures may be indicated in the upper atmosphere at night by means of electric light flashes. Prof. A. Norman Shaw was elected president of the Section for the coming year.

In Section IV. (geological and mineralogical sciences) thirty-one papers were presented. The meetings of the Section opened with the address of the president, Dr. E. M. Kindle, on "A New Viewpoint on Palæontology", in which he explained the preparation of a printed card index illustrating and describing type fossils. The attention of the Section was mainly occupied with a symposium on batholiths, H. C. Horwood, J. S. DeLury, T. T. Quirke, E. L. Bruce, J. A. Dresser, S. J. Schofield, W. T. Wright, and D. R. Derry contributing.

Papers on the late glacial history of the Great Plains were read by W. A. Johnston and D. A. Nichols, and E. S. Moore described an old glacial valley on Michipicoten River, northern Ontario. Papers also dealt with the following subjects: "The Devonian and Siberian Rocks of Gaspe and Northern New Brunswick, and Topographic Deflections in the Gaspe Peninsula" (F. J. Alcock); "A New Lower Jurassic Fauna in the Rocky Mountains" (P. S. Warren); and "The Re-crystallisation of Gypsum, illustrated by Microphotos on Cinema Films" (G. M. Thomson). Other papers were read by titles and will appear in the transactions. Mr. W. A. Johnston was elected president of the Section for the coming year.

In Section V. (biological sciences) sixty-six papers were presented. The presidential address by Dr. Jas. Miller was on the subject of "The Glomerulus of the Kidney: An Anatomical and Pathological Study". As an historical review and a summary of recent work, the address, printed in the proceedings, will be useful. Botanical papers came first. Frère Marie-Victorin presented a series of papers by himself and co-workers, extending their important phytogeographical and taxonomic studies of the flora of the north-eastern part of Canada. Various new relic species were described.

F. E. Lloyd classified *Utricularia* species according to their trap mechanism. G. W. Scarth presented a paper by himself and A. B. Brown on the "Effects of Temperature on Stomata"; A. H. R. Buller showed that a yeast *Sporobolomyces* discharges aerial spores in the same manner as *Basidiomycetes*, and should probably be classed among the latter. He also described the phenomenon of puffing in the *Discomycetes*. Papers presented by W. P. Thompson were taken as read in his absence.

Anatomical, biochemical, pathological, and physiological topics were dealt with by the majority of the papers in this Section. Mention may be made of the following: Pierre Masson, "Sur les propriétés organogéniques des cellules de Schwann". J. G. Fitzgerald and co-workers were responsible for some seventeen papers on toxins, sera, etc. Among the more notable were: the account by N. E. McKinnon and Wm. Knowles of "A Concentrated Anti-Vaccinal Serum" which may prove to be of value; that by C. H. Best, H. C. Foster, and L. Irving on "The Fate of the Sugar which disappears under the Action of Insulin" (confirming and extending the work of Best, Hoet, Marks, and Dale); and that by A. F. Charles and D. A. Scott on "Acetylation of Crystalline Insulin". Hardolph Wasteneys presented, among others, an interesting paper by H. D. Jenner and H. D. Kay on "The Place of Mg in the Phosphatase System", also one by A. A. Fletcher and Florence Hargreaves on "The Colon Condition in Rats with Vitamin B Deficiency", and one with B. F. Crocker, entitled "A Note on the Equilibrium of Peptic Synthesis".

Several papers were presented by V. J. Harding, of which one by T. F. Nicholson on "The Effect of Large Amounts of Urea on the Acid-Base Equilibrium of the Dog" raised the unanswered question of whether urea can function as a base; and another by Harding and D. E. Selby described how yeast (which ordinarily will not hydrolyse galactose) can be trained to do so in three generations, and can be used accordingly in urine analyses.

Among the more significant of the papers presented by Dr. J. B. Collip was one by J. W. Allardyce and L. I. Pugsley on "A Comparison of the Effect of Vitamin D and the Parathyroid Hormone on the Calcium and Phosphorus of Serum and Urine". Dr. Collip summarised in another contribution the physiological and chemical properties of the placental hormones. B. P. Babkin, in a paper on "The Innervation of the Salivary Glands", described the different effect of parasympathetic and sympathetic nerves on these glands. Jas. Miller, F. R. Miller, and V. E. Henderson also presented papers.

On zoological topics only a few papers were presented, namely, one by C. McLean Fraser on the ecology of the cockle; two by E. Home Craigie (presented by B. A. Bensley) on the cerebral anatomy of the humming bird and of the wild Norway rat v. albino, respectively; and one by A. Willey, entitled "*Glossobalanus Berkleii*, a New Enteropneust from the West Coast". Dr. J. B. Collip was elected president of the Section.

The president of the Society for the ensuing year is Sir Robert Falconer, Principal of Toronto University, and the vice-president, Prof. F. E. Lloyd of McGill. It is hoped that the 1932 meeting will take place in Vancouver, but no definite arrangement has yet been made.

Conference of Empire Survey Officers, 1931.

THE second conference of Empire Survey Officers, convened by the Secretary of State for the Colonies, was held on July 8–28, and, as a result of a decision taken at the first Conference in 1928, was devoted mainly to the subject of cadastral and property surveys and land registration. At the same time, opportunities were taken for giving attention to other branches of survey.

The meetings were held generally at the Science Museum, placed at the disposal of the Conference by Sir Henry Lyons, representing the Board of Education; but meetings were held also at the War Office, Surveyors' Institution, University of Cambridge, Admiralty, the Thames (Port of London Authority), Nautical Almanac Office, Royal Observatory, Southampton (Ordnance Survey), Liverpool Observatory and Docks, York, and Hull. At the last port delegates were permitted by the Admiralty to observe hydrographical methods on two of H.M. surveying ships operating in the North Sea.

Of the Dominions, Canada, New Zealand, and Newfoundland were unfortunately unable to send delegates, and of the Colonies only fourteen were represented, the world-wide depression being mainly responsible. In practically all cases, delegates were either survey officers at home on periodic leave or for other reasons.

The pressing need for extensive revision of the

Ordnance large-scale maps of Great Britain was brought to notice by Sir Charles Close, sheets in some cases being forty years out of date. Methods of map reproduction at home and in the tropics were discussed at the Ordnance Survey, Southampton, where Brigadier H. St. J. L. Winterbotham, the initiator and president of the Conference, and Major Clough, gave a description of the latest methods and processes of map-making. Triangulation was discussed by Dr. de Graaff Hunter and Capt. Calder Wood; traverses by Mr. J. Clendinning; gravimetry and the training of European surveyors were treated at Cambridge by Sir G. P. Lenox-Conyngham, Col. Craster, Prof. F. Debenham, and others; while Sir John Flett gave a remarkably lucid lecture on geophysical surveying, and Drs. Jeffreys and Hunter dealt with the relations between geophysics and geodesy. Air survey was brought forward by Capt. M. Hotine, air photography by Flight-Lieut. J. Bussey, aeronautical maps by Squadron Leader P. H. Mackworth, and air survey as applied to cadastral mapping in India by Col. R. H. Phillimore; a paper on the airman-surveyor by Mr. P. E. L. Gethin provoked a lively discussion. Admiral H. P. Douglas, to whom the success of the Conference was due in no small measure, described hydrographical methods. A summary presentation of the present knowledge of tides in British waters was given by Prof. J. Proudman, following an admirable description of tidal instruments by Prof. A. T. Doodson; Comdr. E. C. Shankland lectured on the hydrology of the Thames estuary. Optical distance measurement was dealt with by Major R. L. Brown, and the possible improvement of the barometer was not ignored. Sir Henry Lyons described early methods of survey in Egypt and the Roman Empire. The Astronomer-Royal gave the results of the most recent experience on the reception of *W/T* signals, and Dr. L. J. Comrie gave a lecture on the *Nautical Almanac* and mechanical computation.

It will be seen that much ground was covered outside the main work of the Conference. Within this sphere there was an eloquent address from Sir John Stewart-Wallace on land registration in Britain. Papers on land survey were sent by Mr. F. H. Peters, Surveyor-General of Dominion Lands, Canada, by Mr. A. H. G. Dawson, Surveyor-General of Ceylon, and by Mr. W. F. N. Bridges for the Surveyor-General of Malaya, the latter being a complete account of the survey and registration in that Colony. Mr. Maxwell Edwards, Surveyor-General of the Transvaal, and Mr. W. G. Fairweather of Northern Rhodesia read papers on property surveys and registration in their respective spheres. Lieut.-Col. C. H. Ley sent a paper describing the somewhat difficult cadastral structure of Palestine; another came from Mr. C. O. Gilbert, the Director of Surveys in Kenya. Col. M. O'C. Tandy annotated a paper by Cols. Campbell and Gwynn on rectangulation surveys in India, which bear some relation to the system in the Prairie Provinces of Canada; the discussion was continued by Colonel MacLeod, Chief of the Geographical Section of the General Staff, whose organising ability contributed greatly to the success of the meetings, at which he often took the chair in the absence of the president. It is not possible to summarise all the work done by willing hands in the field of land survey, but it may be said that there were few of the difficulties in the Empire which were not ventilated. A most instructive exhibit of cadastral maps was arranged at the Science Museum by the spontaneous labours of Sir E. M. Dowson; this was by no means limited to the Empire, since France, Italy, Switzerland, and Egypt made generous contributions, often involving a considerable amount of work.

Other subjects discussed were topography, the training of native surveyors, the *Empire Survey Review*, the Field Survey Association, and the position of the licensed surveyor in Canada, Kenya, Trinidad, etc.

These first two conferences have owed their success largely to the efforts of Sir Cecil Bottomley and to Mr. E. B. Bowyer, chairman and joint secretary of the Colonial Survey Committee. The proceedings will be published by H.M. Stationery Office early next year. It was decided to recommend the convening of a third Conference in 1934.

Coloured Glass as a Deterrent to House Flies.

AN interesting series of tests with the object of finding whether rooms glazed with 'Calorex' are likely, by virtue of the special properties of the glass, to be freer from insects than rooms glazed with ordinary glass has recently been carried out at the Imperial College of Science and Technology under the supervision of Prof. J. W. Munro, on behalf of Messrs. Chance Brothers and Co., Ltd.

Calorex glass is of a pale greenish-blue tint, and is designed to afford protection from excessive solar radiation by strongly absorbing infra-red radiation whilst transmitting in a useful degree the radiation within the visible spectrum. The present experiments, which have been conducted with several types of insect, but mainly with flies, bees, and wasps, confirm and amplify observations made at the Building Research Station at Garston, Herts, and described by Mr. H. E. Beckett in NATURE.[1]

House flies (*Musca domestica*) exposed to sunlight in a box, one half of which was glazed with Calorex and the other with ordinary glass, showed a marked preference for the ordinary glass, the ratio of the numbers of insects in the two halves, averaged over several experiments, being about 9 : 4. These results were verified by other tests in which the insects were not enclosed within the box but were attracted to it by a suitable bait. Wasps and bees were found to behave in the same way as flies.

Much of the preference shown is ascribed to the inequality of temperatures beneath the two kinds of glass, the disparity in insect population being greatest when the maximum temperature differences were observed. Confirmatory evidence of a positive effect with temperature differences maintained by agencies other than radiation is not, however, chronicled.

That an effect can definitely be ascribed to the colour of the light which has passed through Calorex was demonstrated by an experiment in which bees were enclosed in a glass cylinder, one end of which was closed with Calorex and the other with ordinary glass. By interchanging the glasses an immediate reaction was obtained, the bees moving to the end covered with ordinary glass.

The effect of coloured light does not seem to be peculiar to blue light. Messrs. Pilkington Brothers, Ltd., from experiments conducted last year, have stated[2] that the house fly prefers white light to coloured light, and that red and yellow are the best deterrents, being considerably more effective than blue and green. On the other hand, it has been stated[3] that blue glass is completely effective.

The most extensive use of coloured glass for this purpose at present seems to be in meat stores. In such buildings yellow glass is unpopular on account of the sickly appearance which it imparts to the meat, and blue glass has been used with some success. In

Holland the use of blue glass has, moreover, been extended to cow-houses with beneficial results. The glass, although of a distinctly different tint from Calorex, appears to share with the latter to some extent its power of absorbing the infra-red radiation of the sun, so that temperature effects may be partly responsible for the positive results obtained. The value of yellow glass cannot, however, be ascribed to such an effect. More information is obviously required on this most practical problem.

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[1] NATURE, 125, 780, May 24, 1930.
[2] NATURE, 125, 529, April 5, 1930.
[3] NATURE, 125, 780, May 24, 1930.

University and Educational Intelligence.

Birmingham.—The vacancy caused by the retirement of Prof. F. W. Burstall from the chair of mechanical engineering has been filled by the appointment of Mr. Samuel Lees. Mr. Lees studied at Manchester College of Technology and St. John's College, Cambridge. He took the Mathematical Tripos and afterwards did research under the late Prof. B. Hopkinson, being elected to a fellowship of St. John's College in 1912. He was Hopkinson lecturer in thermodynamics at Cambridge (1919–29) and director of engineering studies at St. John's College (1924–29). Since 1929 Mr. Lees has been consulting engineer to Messrs. Silica Gel, Ltd.

Leeds.—The University has instituted a diploma in public administration, the course of study for which will commence in October 1931. The course will extend over two winter sessions.

Sheffield.—The Council of the University has decided to appoint a professor of electrical engineering. It is hoped to make the appointment in time for him to take over his duties in the early part of 1932.

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Mr. Sidney Weintroub, of St. John's College, Oxford, has been appointed an assistant lecturer in physics at University College, Southampton.

The Wilbur Wright memorial lecture of the Royal Aeronautical Society will be delivered on Wednesday, Sept. 16, at 9.15, in the Science Museum, South Kensington, by Mr. Glenn Martin, who will take as his subject "The Development of Aircraft Manufacturing".

The following scholarships for 1931 have been awarded by the Institution of Electrical Engineers: Duddell Scholarship (annual value £150; tenable for 3 years): C. H. W. Clark (Sevenoaks Grammar School); Silvanus Thompson Scholarship (annual value £100, plus tuition fees; tenable for two years): C. H. Lackey (Messrs. A. Reyrolle and Co., Ltd.); David Hughes Scholarship (value £100; tenable for 1 year): G. L. d'Ombrain (City and Guilds (Engineering) College); Salomons Scholarship (value £100; tenable for 1 year): S. H. Padel (Manchester College of Technology); War Thanksgiving Education and Research Fund (No. 1): grants of £50 each to F. J. Clark (East London College) and J. H. Wagstaff (University College, London); Thorrowgood Scholarship (annual value £25; tenable for 2 years): P. W. Ottley (Underground Electric Railway Company of London, Ltd.); Paul Scholarship (annual value £50; tenable for 2 years): W. T. Darwin (L.C.C. School of Engineering and Navigation).

Birthdays and Research Centres.

Aug. 16, 1863.—Prof. F. S. Kipping, F.R.S., professor of chemistry in University College, Nottingham.

Nearly thirty years ago the study of some organic derivatives of silicon was commenced, with the primary object of proving that compounds of the type $SiR_1R_2R_3R_4$ existed in enantiomorphously related, optically active forms. During the progress of this work, various interesting by-paths were encountered and, with the help of many students, some of these have been partly explored. The results have indicated that silicon analogues of many of the more important types of carbon compounds cannot be obtained, and that silicon is incapable of uniting with itself, with carbon, or with oxygen, by a 'double bond'. On the other hand, the formation of chains of silicon atoms, linked together directly or by an atom of oxygen, often takes place with unexpected facility, giving highly complex products, many of which cannot be isolated and identified.

Aug. 19, 1868.—Prof. W. Bulloch, F.R.S., Goldsmiths' professor of bacteriology in the University of London.

Ever since Lister (1869) introduced into surgery the principle of the antiseptic absorbable ligature in the form of catgut, this has always been a problem. Some years ago I was requested by the London Hospital authorities to investigate complaints regarding the sterility of samples of catgut sold in commerce. Much of the 'sterile' catgut was found not to be so, and the catgut sold by several manufacturers was found indeed to be uniformly (100 per cent) infected and presumably harmful. To remedy this so far as my own hospital was concerned, I carried out a systematic investigation of the methods of sterilising catgut, and this involved testing more than 30,000 ligatures. Two methods were found to be effective in producing sterile catgut. In conjunction with Messrs. Lampitt and Bushill, of the laboratories of J. Lyons and Co., a report was issued by the Medical Research Council, and the result was that surgical catgut was brought under the Therapeutic Substances Act, and the tests we had laid down were enforced. Two years' experience of the new conditions relative to the manufacture of surgical catgut in England and abroad has shown that at the present time the catgut is much better than was previously the case, and the risk of ligature infection in surgical operations has been greatly diminished.

In my leisure I devote my time to the study of the history of the sciences associated with medicine.

Aug. 19, 1874.—Prof. A. H. Reginald Buller, F.R.S., professor of botany in the University of Manitoba.

I am interested in the relations of fungi with various animals; and two species of Fungi Imperfecti, which attack and kill large numbers of larval nematode worms (*Strongylus* species, parasites of the horse) as these wriggle about in horse dung, are being investigated in my laboratory.

My chief occupation just now is the completion of the manuscript and the illustrations for another volume of my "Researches on Fungi". This volume, in part, will treat of *Pilobolus* and the ocellus function of its subsporangial swelling, *Sporobolomyces* regarded as a basidiomycetous yeast, *Tilletia tritici*, which causes the stinking smut disease of wheat, and *Sphærobolus stellatus*, a small gasteromycete allied to the puff-balls, which can shoot its ball of spores a horizontal distance of eighteen feet.

Aug. 19, 1885.—Prof. A. J. Clark, F.R.S., professor of materia medica in the University of Edinburgh.

We know something of the metabolism of the skeletal muscles, but practically nothing about the metabolism of cardiac and plain muscles. The latter group is, however, more important in certain respects than is the former.

The differences in function shown by the different types of muscles make it probable that their metabolic processes differ widely. Skeletal muscle is a very highly specialised tissue, whereas cardiac and plain muscles are somewhat less specialised. The metabolic processes of the latter group deserve, therefore, far more attention than they have hitherto received.

Societies and Academies.

Cracow.

Polish Academy of Science and Letters, May 4.—**I. Neyman** and **E. S. Pearson**: The problem of *k* samples.—**W. Goslawski** and **L. Marchlewski**: The absorption of ultra-violet radiations by certain organic substances.—**K. Dziewonski** and **St. Pizoń**: A new method of synthesis of dinaphthopyrone. Dibenzoxanthone can be obtained directly by the interaction of β-naphthol and carbanilide or thiocarbanilide.—**Mlle. Bron. Mlodzianowska**: The earliest stages of the development of *Cysticercus fasciolaris* of the larva of *Taenia taeniaeformis*.—**S. Skowron** and **T. Pawlas**: Observations on the influence of gonacrine on the organism.

June 12.—**St. Mrozowski**: The hyperfine structure of the resonance line of mercury (2).—**S. Szczeniowski** and **L. Infeld**: The effect produced by a cloud of electrons on the structure of the de Broglie wave.—**Mlle. A. Dorabialska**: Microcalorimetric measurements of the period of polonium. The period found by this method was 137·6 days.—**M. Hlasko**: The differences between the conductivity coefficients of strong electrolytes in the same solvents.—**M. Hlasko** and **W. Klimowski**: The conductivity of certain mineral acids and the mobility of the hydrogen ion.—**K. Dziewoński, W. Kahl**, and **Z. Olszewski**: Study of the compounds derived from naphthalic acid. The synthesis of 3, 4-dihydroxynaphthalic acid.—**E. Mnich**: The phosphorus compounds of plants (6). The solubility of the phosphorus compounds of bean flour and the faculty of phytine of combining with protein substances which it contains.—**Tymrakiewicz**: The stratigraphy of the peat bog situated near Dublany, Olesko, and Opaki. Three climatic periods were shown by pollen analysis.—**J. Jarocki** and **A. Demianowicz**: The presence of a Ponto-Caspian amphipod, *Chaetogammarus tenellus*, in the waters of the Vistula.—**L. Ejsmont**: The identity of *Proshystera rossittensis* and of *Tanaisia fedtschenkoi* with some remarks on trematodes with united cæca.—**J. Hirschler**: Observations concerning the reciprocal influence of insects.—**Z. Grodziński**: The development of the blood vessels in the pectoral fin of fishes belonging to the genus *Salmo*.—**F. Rogoziński**: Experimental rickets (3). The influence of ammonium chloride on the mineral metabolism of the rachitic rat.

Geneva.

Society of Physics and Natural History, May 7.—**Albert H. Du Bois**: Variations of the blood serum albumins under the influence of reticulo-endothelial blocking. In the rabbit, blocking the reticulo-endothelial system with 2 per cent Chinese ink by endovenous injection (1 c.c. per day) affects the proportion
of the blood serum albumins. The serin di
the globulin increases, and the ratio serin to
tends to be inverted. Moreover, the colloido-
pressure of the blood serum falls as a result of
of serin.—**Ch. Eug. Guye**: The lower limit of
chemical phenomena. A physico-chemical
menon is first defined as that of which the c
interpretation reduces in the final analysis to
space, time, and matter, ideas which have bee
lished by experiments on a macroscopic scale.
field of intra-atomic and quantic phenomena
ideas appear to lose all exact experimental m
and the question arises as to how far they
rightly applied in a field which is not their
origin. Planck's constant appears to limit p
chemistry on our scale; beyond this, all is m
It is a great temptation to find in this indefin
the origin or the causative principle of the organ
of life and thought. M. Guye recalls, moreo
this connexion, that when a material system c
only a small number of molecules (micelles, fil
virus, etc.) the statistical fluctuations then assu
siderable importance and the intimate nature
individual molecular actions ought to be made c
—**P. Balavoine**: A formula for the determinat
the alcoholic strength of brandy. The author g
simple formula for determining the alcoholic pe
age to 0·1 per cent in a liquid containing betw
and 70 per cent of alcohol, and not containing
than 10 grams of extract (syrup, etc.) per litre.

Sydney.

Linnean Society of New South Wales, April
Frank A. Craft: The physiography of the Shoal
river valley. (1) Tallong-Bungonia. A topogr
survey of the Tallong district reveals three
series of features—a peneplain level at 2200 fee
incomplete peneplain or series of very flat valle
2000 feet, and deep gorges which come within 350
of sea-level. From consideration of the land for
is concluded that the surface of the tableland
elevated to its present altitude by a series of up
of which the most recent has been largely respon
for the formation of the deep gorges.—**H. M. R. R**
Further notes on the orchids of the South Maitl
coalfields, with description of a new *Dendrob*
from Bullahdelah. The occurrence is noted
Calochilus cupreus Rogers in New South Wales,
its confusion with *C. campestris* R. Br. is discus
Several interesting teratological orchid forms
recorded, also a hybrid *Pterostylis ophioglosa* R.
× *Pt. concinna* R. Br. The identity of *Pt. Mitch*
Lindl. is considered, and a striking form at pre
included under *Pt. pusilla* Rogers is described
new variety. The new *Dendrobium* from Bullah
is closest to *D. speciosum* Sm. and *D. Kingia*
Bidw.—**H. L. Jensen**: Contributions to our knowle
of the Actinomycetales. (1) A case of heredit
variation in the genus *Actinomyces*. A soil mic
organism (probably identical with *A. polychrom*
genes Vallée) normally forms cells resembling cory
bacteria or mycobacteria. A variant, appearing
long, branched filaments of an entirely *Actinomyc*
like character, arises spontaneously in cultures of t
former type. Besides this, several other variants
produced, partly spontaneously, partly experimental
The bearing of these and similar phenomena on t
taxonomy of the genus *Actinomyces* and related gene
is discussed.

May 29.—**A. M. Lea**: On Baridiinæ (Curculionid
mostly from New Guinea. The paper consists of d
scriptions of sixty-seven new species of weevils fro
New Guinea (including a new genus), Aru, Fiji, Mal

a, Java, and Queensland.—**G. H. Cunningham**:
teromycetes of Australasia (11). The Phallales
Under the Clathraceæ are placed eleven
The family is rearranged, and divided into
ibes upon the nature of the receptacle of the
ation. A new family is represented by the
genus *Claustula* containing *C. Fischeri*. All
and species are redescribed, their relationships
nd known collections in existence in herbaria of
d are listed.—**Mary E. Fuller**: The life-history
phora ochracea Schiner (Diptera, Calliphoridæ).
per describes the morphology of the earlier
f the blowfly *Calliphora ochracea* Schiner, and
s some observations on the biology of the fly.
tural breeding habits of the species are not
, but in captivity it has been induced to ovi-
n fur covering meat. The hitherto unknown
have been obtained in quantity, and numbers
ts bred through, giving the complete life cycle.
. **Jensen**: A note on the systematic position of
cterium cœliacum Gray and Thornton. This
m agrees morphologically with the genera
acterium and *Corynebacterium*. The suggested
r of it to the genus *Flavobacterium* is therefore
stified.

WASHINGTON, D.C.

onal Academy of Sciences (*Proc.*, Vol. 17, No. 4,
15).—**Harvey Cushing**: (1) The reaction to
rior pituitary extract (pituitrin) when introduced
he cerebral ventricles. A patient recovering from
eration for a tumour on the brain offered himself
e investigation. Injection of surgical pituitrin
the lateral ventricle of the brain caused pro-
ed flushing (vaso-dilatation) and excessive
ing (except of the skin over the bone flap) with
of body temperature and metabolic rate. The
t is almost the reverse of that produced by intra-
ular or intravenous injections, which cause
ching of skin and mucous membranes (vaso-con-
tion) and prompt evacuation.—(2) The similarity
e response to posterior lobe extract (pituitrin)
to pilocarpine when injected into the cerebral
ricles. These substances have very similar effects,
esting a central autonomic stimulation chiefly
e parasympathetic division.—(3) The action of
pine in counteracting the effects of pituitrin and
ilocarpine injected into the cerebral ventricles.
ther given subcutaneously or previously injected
the cerebral ventricles, atropine appears com-
ely to counteract the effects of pituitrin and pilo-
pine injected into the ventricles.—**Wilder D. Ban-
t and S. F. Whearty, jr.**: (1) Activation by char-
. Chlorine and benzene in the presence of purified
vated charcoal form ring-substitution products.
) Aromatic substitution products with fluorine.
eous fluorine gives substitution products with
achlorobenzene.—**Wilder D. Bancroft and J. E.
tzler, jr.**: Reversible coagulation in living tissue
Following up previous work on the coagulation
nerve protein by drugs and its peptisation by
lium thiocyanate, it is suggested that, in the ab-
ce of organic ailments, morphine addicts might be
red by the use of this salt.—**R. E. Bowen**: Move-
nt of the so-called hairs in the ampullar organs of
ears. Ecker recorded movements of the hair cells
Petromyzon in 1844; similar movements, at very
rying rates, occur in the teleost *Ameirus nebulosus*.
Charles W. Metz and Helen Berenice Smith: Fur-
er observations on the nature of the *X*-prime (X')
romosome in *Sciara*.—**Tracy Yerkes Thomas**: On
e unified field theory (5).—**Jesse Douglas**: The
st area property of the minimal surface determined
an arbitrary Jordan contour.—**A. D. Michal**: Function space-time manifolds.—**A. A. Bless**: The composition of the interior of the earth. It is assumed that the temperature gradient in the crust extends to great depths; this leads to the view that dissociation of molecules takes place at great depths, and that the earth consists of the present crust with permanent gases, while the other elements form a core. It is also assumed that the composition of the earth as a whole is similar to that of the upper layers of the sun. The suggested ionisation of the core elements leads to a liquid core of high density, as required by seismic observations. The theory is put forward tentatively as a means of avoiding the hypothesis of a core of heavy metals, chiefly iron.—**W. V. Houston and C. M. Lewis**: Rotational Raman spectrum of CO_2. The microphotometer curves show a rotation band of equidistant lines. Even rotational states alone are present, and the moment of inertia is $70 \cdot 2 \times 10^{-40}$ gm. cm.^{2}.

Official Publications Received.

BRITISH.

Journal of the Royal Statistical Society. New Series, Vol. 94, Part 3. Pp. 359-486+xiii. (London.) 7*s.* 6*d*

Trinidad and Tobago. Minutes and Proceedings of the Sugar Cane Investigation Committee. Part 21. Pp. 269-331. (Trinidad: Government Printing Office.)

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 6, July. Pp. 261-304+xlii. (London.)

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield Vol. 13, 1930. Pp. 288. (Sheffield.) 7*s.* 6*d.*

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 6, June. Abstracts Nos. 960-1140. Pp. 187-222 (London: H.M. Stationery Office.) 9*d.* net.

South Australia: Department of Mines Mining Review for the Half-year ended December 31st, 1930. (No. 53.) Pp. 147+8 plates. (Adelaide: Harrison Weir.)

Royal Commission on the Civil Service, 1929–31. Report. (Cmd. 3909.) Pp. viii+252. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

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NATURE

SATURDAY, AUGUST 22, 1931.

CONTENTS.

PAGE
Scientific Aspects of the Unemployment Problem . 281
The Psychological Problem of Joan of Arc . . 284
Anthropology in Nigeria. By P. Amaury Talbot . 285
Mathematics for Actuaries and Others. By Dr. John Wishart 286
Palæolithic Man in Egypt. By A. S. W. . . . 287
Short Reviews 288
Matter and Radiation. By Prof. F. G. Donnan, C.B.E., F.R.S. 290
Southern Whaling 292
Obituary :
  Prof. Archibald Barr, F.R.S. 294
News and Views 296
Letters to the Editor :
  Magnetic Experiments on the Cosmic Rays.—Prof. Bruno Rossi 300
  Nuclear Moments of the Isotopes of Lead : Relative Values of the $g(I)$ Factors of Pb(207) and Tl —Prof. J. C. McLennan, F.R.S., M. F. Crawford, and L. B. Leppard 301
  Diamagnetism of Liquid Mixtures.—Dr. Hans Buchner 301
  Function of Water Vapour in the Dissociation of a Salt Hydrate.—B. Topley and M. L. Smith 302
  Magnetism of Colloidal Gold.—Dr. V. I. Vaidhianathan and Balwant Singh . . . 302
  Structure of the Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium.—J. A. A. Ketelaar 303
  Effects of Inadequate Feeding on Insect Metamorphosis.—Cedric Dover 303
  Excitation of the Green Auroral Line.—Prof. Joseph Kaplan 304
  The Slow Combustion of Methane and Ethane —Dr. E. Mardles 304
  Œstrus-Producing Hormones.—Dr. G. F. Marrian and A. Butenandt 305
  Segregation of Floral Characters in the Wild Oxlip.—Prof. F. E. Weiss, F.R.S. . . . 305
Research Items 306
Astronomical Topics 308
The Significance of the Relationship between Corals and Zooxanthellæ. By Dr. C. M. Yonge . . 309
New Physics Building at the National Physical Laboratory. By Dr. G. W. C. Kaye, O.B.E. . . 311
The Pulp-Wood Market in the United States . . 313
University and Educational Intelligence . . . 313
Birthdays and Research Centres 314
Societies and Academies 315
Diary of Societies 316
Recent Scientific and Technical Books . . Supp. v

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Scientific Aspects of the Unemploym Problem.

EVEN more perhaps than Dr. Miall's " H of Chemical Chemistry ", the progr of the recent jubilee meetings of the Socie Chemical Industry illustrates the remar extent to which, during the last fifty years science of chemistry has penetrated and transfo almost every section of industry, if not indeed public services. Examples are to be found i scientific papers presented at the meetings, w covered not only chemical industry generally such special sections of it as the dyestuff indu but also a discussion on fuel subjects which braced questions of fundamental importanc society in general as well to industry. Stri evidence of the widespread impact of science industry is to be found in the technical visits by members of the Society. These covered diverse industries as wallpaper manufacture, research laboratories of the General Electric Ltd.—which provide an outstanding example o industry created and continually expanded by application of scientific research—dry clean fine chemicals and drugs, gas, coke and tar, brew agriculture, foodstuffs, fuel research, the protec of metals against corrosion; while visits to National Physical Laboratory and the Chem Research Laboratory demonstrated the vital imp ance of scientific research in national life.

It is against such a background that the bearing of Sir Harry McGowan's president address to the Society of Chemical Industry, cussing the reaction of scientific and techni progress on the finance and economy of the mod State, is perceived. Scientific discoveries and th application in industry have dislocated the ma balance between industrial and agricultural p duction and have threatened the whole soc financial, and political structure of our civilisati Sir Harry McGowan uttered no idle warning wh he hinted at the possibility of our common civili tion perishing through our inability to control t forces which applied science primarily has create Under the influence of science, not only industry b also accepted views of trade and competition a changing their value, and policies such as free tra or protection acquire a new significance.

Sir Harry McGowan urged that the policy industrial co-operation which has developed notab in chemical industry under such forces should b extended into the more difficult field of internation co-operation—as indeed has already been done 'ew branches of industry, though with what s it is difficult as yet to say. As an aid to ontrol or development, Sir Harry McGowan ised a Minister of State devoted to the task omoting the co-ordinated reorganisation of industries, and beyond this an international cal council to provide chemical industry with ld-wide range. The effective rationalisation secured would stabilise development and co-ate or expedite research.

turn from the picture of industrial and inter-nal co-operation thus eloquently painted to fforts of Parliament during the past session pe with unemployment and the general in-al situation is to realise how far from com-urate with the rapidity of technological or tific advance in the last fifty years is the ence which representatives of science or of tific industry are able to exert on the direction ublic affairs. Examples of this have already the subject of comment in these columns. , the Royal Commission on Transport in its report made certain recommendations regard-oth road and rail transport which were intended sist the general economic development of the n. Neither in respect of the electrification burban services nor in the diversion of heavy ls traffic from road to rail have any adequate s been taken to give effect to the recommenda-s of the Commission, although both these re-mendations should encourage employment and recovery of the railways from their difficult ition. In the absence of a more scientific icy, it is still common for a heavy goods lorry do damage to a road in a few hours amounting several times the combined value of the lorry its load.

similar hiatus between knowledge and action sts in the fuel question. A really scientific sideration of the coal and fuel industries would viate considerably the difficulties in which the l industry finds itself. Lack of courage, how-r, remains the characteristic Government atti-de in 1931 as in 1926, and not even the grow- seriousness of atmospheric pollution or the ensity of the unemployment situation has driven rliament to examine the utilisation of our coal ources in the form of smokeless fuel or oil fuel a possible economic policy worthy of develop-nt. The fuel problem and the competition tween raw coal, gas, and electricity is still allowed develop along haphazard lines, without any tempt to plan and enact a scientific and economic tional policy. To this position no contrast could be more startling than the discussion on fuel subjects at the recent jubilee meetings of the Society of Chemical Industry, which was planned to elucidate definite answers to such questions as the probable effect upon the amount of coal raised, of the increasing use of oil, of the future development of the gas and electrical industries, of a large development of low temperature carbonisation, or of a general improvement of the standard of living. Only upon the considered answers to such questions can an adequate fuel policy be based, yet here again it is science and industry and not Parliament which is conducting the inquiry. The conference indeed took a sombre view of the prospects of any increased demand for coal, Dr. Lessing considering that a decrease in consumption is more probable, and even in the development of the hydrogenation process, prospects of an increased output of raw coal are not bright. Although international agreements might secure more lucrative prices, they are unlikely to affect the tonnage of coal raised. Lieut.-Commander Kenworthy's suggestion that scientific workers, economists, and business men should set up a representative body to examine the economic side of the coal problem was itself a confession that Parliament is not the instrument which will put coal mining on its feet. Essentially the plea was an admission that the fuel problem demands scientific treatment as an organic unit by the best brains of the country, unfettered by political ties.

When we pass to the direct contribution of the recent parliamentary session to the relief of unemployment, our present system of government shows to no greater advantage. For a sanctioned expenditure of up to £173,000,000 on emergency work for the relief of unemployment, work has been found for an additional 200,000 only, not allowing for any possible effects of discontinuing the safeguarding on gloves, lace, and cutlery. Such is the outcome not merely of this large expenditure of money but also of Parliament's endeavours to induce reorganisation of the coal, cotton, and iron and steel industries, Acts on housing, land drainage, and transport, and the expenditure of large sums on electrification, road improvement, and afforestation. There can indeed be no fairer comment on the situation than the recommendation of the Macmillan report that we should attack the task of capital development in England 'in a much more systematic and far-sighted manner than hitherto. An era of conscious and deliberate management must succeed the era of undirected natural evolution.

It is, of course, alleged by some that science itself causes unemployment, and that the increased production made possible by the mechanisation of industry under the influence of science is mainly responsible for our present difficulties. Superficial support may be found for such a view, but apart from the unescapable fact that industries such as the wireless industry—in which there is no unemployment—the electrical industry in all its branches, the automobile industry, the chemical industries, and aviation, which provide employment for millions of workers for whom otherwise there could be no industrial occupation, are the direct outcome of creative science and its application, the evidence of such industrial leaders as Mr. Henry Ford indicates that industrial leadership and continuous improvement in efficiency lead to industrial expansion and increased employment. The idea that there is only a limited amount of employment in the world has been revived in the present crisis, but remains a fallacy. The temporary unemployment due to displacement of workers during the genuine rationalisation of an industry, the permanent displacement of certain workers through the rise of a new industry such as the rayon industry, and the decline of the older textile industries, even though the final volume of employment is increased, tend to obscure the real issues, and the confusion is heightened by the failure of the industrialist either to foresee the problems and difficulties involved or to secure a minimum disturbance during the transition period.

The possibilities in the application of scientific method to the unemployment problem are indicated not only by the Macmillan report, which visualises a comprehensive re-building and re-planning policy for our larger towns and industrial centres, the re-planning and re-fitting of stable industries, and the electrification of railway systems, but also by the International Labour Office in its proposals for practical action on unemployment in Europe, which were recently submitted to the Commission of Inquiry for European Union. Without elaborating a definite scheme, the memorandum outlines such ideas as a definitely planned international road system to meet the probable requirements of rapidly increasing motor traffic and to provide connexions between the special roads for motor traffic which are at present being constructed everywhere independently in the most advanced countries of Europe; the co-ordination of regional systems of navigable waterways; the international distribution of electric power; and the concerted and uniform substitution on all European continental railways of a s
system of automatic coupling in place of the p
screw couplings, which are annually resp
for many fatal accidents. Schemes of thi
planned in advance as a definite programme
enable public works to be postponed f
boom period and carried out in a time of depr
They should thus be of direct value in re
the incidence of unemployment as well
encouraging the spirit of European co-ope
on which the Macmillan report laid such str

Any such schemes of development will no
to be considered in the light of the report c
May Committee on National Expenditure, wh
under consideration by the Cabinet. As we
already pointed out, this committee includ
one familiar with scientific progress and dev
ment, and research departments have clearly
singled out for drastic economies. It is ev
that the members of the committee still hol
the fallacy that research is a luxury becau
results cannot always and immediately be t
lated into pounds sterling on an annual repo
balance sheet.

The real difficulty to-day is that science ha
even yet come to take its right place in the dire
of both industry and national affairs. Bro
speaking, those industries in which scienc
associated with commercial and financial inte
in direct administrative control are the indus
which have proved most able to meet the pre
industrial depression. The comparative impote
of Parliament in the present industrial situa
is largely due to its lack of inherent scientific
technical knowledge, as well as to the absenc
such knowledge in those holding high adm
trative appointments in the Civil Service.
severer handicap has been imposed on G
Britain in the present crisis than the exclu
often deliberate, of technical and scientific m
administrative ability from responsible admini
tive posts in industry or in Government ser
Not until this defect is remedied in Parliamen
in Government service and industries genera
can we expect to see not merely effective and sci
tific reorganisation of our industries from the p
of view of the nation as a whole, but also the init
tion of the task of wise international co-operat
in a spirit of unselfishness and world service. Su
reorganisation and international co-operation w
open increasing opportunities for creative scien
to which alone in the changing face of indus
the worker can look for continued and adequ
employment.

'sychological Problem of Joan of Arc.

ial of Jeanne d'Arc. A complete translation ie Text of the Original Documents, with an oduction, by W. P. Barrett. (Broadway ieval Library.) Pp. viii + 352 + 12 plates. don: George Routledge and Sons, Ltd., .) 15*s.* net.

ERE can have been few historical events which have seemed more inexplicable than which made up the life of Joan of Arc. A it girl of eighteen profoundly affected the ies of nations. Such things seem impossible; hey occurred. The problem of Joan will ps never be completely solved. It may be possible to show that her history was y an unusual configuration of events, motives, personal characteristics which were each in selves neither unique nor startling. But Mr. ett's excellent translation of the documents ng to her trial enables even the layman to pt such an analysis.

ne of the leaders of the French, who followed may have been sceptical of her supernatural rs and have used her only on account of her nce with the people. Some of the ecclesiastics, burnt her, may have been genuinely concerned in upholding the authority of the Church and fending it against the dangerous and uncertain e of individual conscience. But rational ex- ations of Joan's effect upon her time in terms olitical motives and ecclesiastical theory can y solve half the problem. They leave the part ed by superstition and hysteria wholly un- ained.

oddesses or saints on one hand and demons itches on the other are both, anthropologically psychologically, aspects of the same idea. It ssible, as Miss Murray has argued, that Joan nated the goddess of a Dianic cult which had ved among the peasantry from neolithic s. But whether or not such a cult had actually ived, Joan was psychologically a demon to one ty and a goddess to the other. Now, modern chology has shown that these two ideas are jections of two aspects of the concept of the ther, one evil and terrifying, the other good and premely helpful, which survive in the unconscious om earliest infancy. From this fact these ideas rive their force.

To her enemies Joan was not only a political isance and a heretic; she was also a witch, nething infernally dangerous which must at all ts be destroyed. To her friends she was not only the creator of nationalism; she was a saint, perhaps even a goddess, who could not fail. There is a type of defensive nationalism, especially prevalent among the Latin races, which is clearly an expression of the Œdipus complex. To the unconscious, France became the persecuted mother, and the English and the Burgundians the violators from whom she was to be delivered. Joan, the Maid, gave this fantasy to the people As a saint or goddess she was also a symbol of the ideal mother, and therefore must have become identified with France. The fact that she was a virgin was important, as Voltaire observed, for, curiously enough, the unconscious generally likes to think of its mother as a virgin—one who has been threatened by the father but who has not yet yielded to him If she had been known to have given herself to any one man she would have lost her power over the rest. For the same reason the mother goddesses of antiquity were often unmarried—that is, they were either wholly chaste or universally promiscuous.

If Joan was the bad mother to the unconscious of her enemies and the good mother to the unconscious of her friends, to her own unconscious it seems probable that she was not a woman at all, but a rebellious son. The fantasy of nationalism is the fantasy of the son who, desirous of believing that his mother loves him only, imagines that she is the unwilling victim of his father from whom he will set her free. National leaders have been undoubtedly often inspired by such an unconscious fantasy; and when a woman displays the same symptom the suspicion at once arises that she may have unconsciously believed herself to be a man. Joan's transvestism was so persistent that it brought her to the stake. Therefore it can scarcely be rationalised as a protection against the soldiery among whom she lived. The loss of her male clothes or of her virginity might have destroyed the unconscious delusion of masculinity from which she probably derived much of her power.

Joan's voices appear to have been the projection of her own unconscious wishes. They told her to wear men's clothes and to deliver France. In them she implicitly believed, and so gained that confidence in her mission which inspired faith in her friends and fear in her enemies. Lastly, she had an intelligence of a high order, which must have helped to remove the doubts from those who might otherwise have thought her mad.

There have been many women with the Œdipus complexes of men which have been expressed in patriotic fantasies. There have been others who had voices which gave them an unnatural confidence, and yet others who have been intelligent. The combination of these three qualities in one person at a time when the political and mental life of the world enabled them to be effective were probably among the most important factors which went to make up the history of Joan of Arc.

Anthropology in Nigeria.

(1) *A Sudanese Kingdom: an Ethnographical Study of the Jukun-speaking Peoples of Nigeria.* By C. K. Meek. Pp. xxxiv + 548 + 64 plates. (London: Kegan Paul and Co., Ltd., 1931.) 25*s.* net.

(2) *Tribal Studies in Northern Nigeria.* By C. K. Meek. Vol. 1. Pp. x + 582 + 60 plates. (London: Kegan Paul and Co., Ltd., 1931.) 25*s.* net.

(1) THIS work on the Jukun of Northern Nigeria has been eagerly awaited by all those who were aware of Mr. Meek's study of this interesting people. Though these "studies were confined to a period of less than five months", no doubt he has been able to confirm and enlarge his knowledge from many sources in the last decade, during which he has had access to all the anthropological information collected throughout Nigeria. He has made excellent use of his opportunities, and the book may be regarded as authoritative and containing his considered opinion on the customs of the Jukun; in view of the haste with which the African, even in the Northern Provinces, is now shedding his old beliefs, it is unlikely that further researches will throw much additional light on them.

In an introduction of 21 pages, Mr. H. R. Palmer, formerly Lieutenant-Governor of the Northern Provinces of Nigeria and now Governor of the Gambia, discusses the affinities and history of the tribe. He would appear to place too much reliance on etymological similarities and on traditions and tales, some of which are probably of fairly recent Mohammedan provenance. Mr. Meek's treatment is more conservative, but, despite all, the origin of the Jukun is far from certain, though some facts give colour to their claim of a migration—at any rate, so far as the leading families are concerned—from Yemen, or Yeman, which to them includes all north-east Africa.

The Jukun kingdom was known as Kororofa, or Kwararafa, and was at the height of its power in the fifteenth to the seventeenth centuries, during which it is said to have captured Kano and Zaria, and to have penetrated into Bornu, Katsina, and even Gobir. Its capital, of the same name, was situated south of the Benue River, some three hundred miles south-south-east of Kano, and was abandoned a century ago, about the same time as the greater number of the towns were destroyed by the Fulani and Chamba. The tribe is now very small, numbering only some 25,000, living in scattered communities, mostly south of the Benue.

It is difficult to understand how this people, which to-day shows not the slightest warlike tendencies, could ever have formed a great confederacy, but no doubt their prestige was, to a large extent, due to moral and religious considerations, to the influence of their divine king. It is claimed that their power extended to the sea, but no evidence is given for this, and the far greater Aro theocracy, with its five million adherents, stood in their way.

Mr. Meek states that Calabar, the port to which the Aro exported most of their own—and probably the Jukun—slaves, "was known locally as Atakp or 'King of the Akpa' or Apa. For the Ekoi o these regions bore the same title as the Juk farther north". Akpa, however, is the na applied hereabouts to a large river, and it is un likely that it has any connexion with the Juku 'Apa', while the branch of the Ekoi settled here is called Kwa. Mr. Palmer (p. xix) and Mr. Meek (p. 16) are also incorrect in thinking that Dama "is a tribal name in the southern provinces"; according to the peoples of Ogoja province it was given to some of them by Hausa and others from the north.

The Jukun language is classified as belonging to the Sudanese group, which is enlarged to include semi-Bantu; out of 115 words, however, no less than 57 per cent are common to Bantu and Sudanese. Though little reliance can be placed on language to show the affinities of a people, this fact, together with their physical appearance as shown in the photographs, strengthens the belief that the mass of the people are of a Nigritic type; unfortunately the author took no somatic measurements.

The Jukun are still in the midst of changing from mother-right to father-right; there is no strict clan organisation and few traces of exogamy. The taboos as regards the use of personal names are stringently observed; even wives, who were wedded as virgins, may not thus address their husbands, though women who have previously been married can do so. The most interesting part of the book is that dealing with the divine king, who appears to be now regarded as an incarnation of the whole pantheon. His chief function is to secure plentiful harvests for his people, as he is the principal intermediary with the gods and ancestors on whom their growth depends; if he is out of favour with these, he is secretly killed. Apparently the normal reign of a Jukun king was about seven years, though a vigorous and popular man might live far longer.

Mr. Meek identifies both the Dindi (or soul) and the "spiritual guardian"—which seems to resemble what I have called the Over-Soul among the southern tribes—with the Egyptian *Ka*, but, even allowing for the considerable variation in the beliefs about this latter at different periods, there is a much larger content in the Nigerian idea, part of it unique. Heaven (*Kindo*) is regarded as "The House of Truth", and the earth-goddess Ama, who rules there, as a just and righteous deity.

The most interesting of the burial rites is the "releasing of the white grave cloth from the mouth", the purpose of which seems to be very similar to the Egyptian "opening of the mouth", [illegible] that the dead man may be able to speak in [illegible]ndo and inquire the cause of his death, which he will later declare to his living relatives at the ceremony of the Aku-Akwa, when the soul is formally requested to take up his abode in the bush and house shrines respectively.

According to the author, "A main cause for the firmness of the belief in the continuous existence of the dead is due to the conception of the necessity of the punishment of witches and sorcerers". The causality, however, is not apparent; the two beliefs, in survival and witchcraft, run in all probability side by side, as in most peoples, African and other.

A large—and, even in the reviewer's opinion, an excessive—portion of the book is taken up with comparisons of beliefs and practices in other countries, which will offend those scientists at home who consider that the field-worker should confine himself strictly to the people whom he is studying. Mr. Meek's assertions as to the close connexion of Jukun customs with those of ancient Egypt seem to be fully warranted. He is to be highly congratulated on the book, which is also well produced and illustrated, though some of the photographs might have been more appositely placed; few misprints have been noticed, but surely on p. 63 "the influence of the father's relatives is tending to decrease" should read "increase". The index is not so full as could be desired, which is the more regrettable, since the facts dealing with a single idea or custom are not always kept together.

(2) The second book under review, "Tribal Studies in Northern Nigeria", vol. 1, contains ethnographical notes on a large number of little-known peoples, dealing chiefly with their social organisation and languages. It is well for this information to be printed and made available for officials and scientists; fuller knowledge can be filled in as acquired. Perhaps the most interesting feature described is the sexual communism which is customary in some areas.

The Eket sacred lake, mentioned on p. 166, lies to the south-west, not to the north, of Calabar; this statement is referred to "The Golden Bough", where it is mentioned that the lake is near Eket in North Calabar. The illustrations are not so good as those in the Jukun book. An index will presumably be provided in the last volume.

P. AMAURY TALBOT.

Mathematics for Actuaries and Others.

(1) *An Elementary Treatise on Actuarial Mathematics.* By Harry Freeman. (Published for the Institute of Actuaries.) Pp. xiii + 399. (Cambridge: At the University Press, 1931.) 25*s*. net.

(2) *Some Recent Researches in the Theory of Statistics and Actuarial Science.* By Prof. J. F. Steffensen. (Published for the Institute of Actuaries.) Pp. vi + 52. (Cambridge: At the University Press, 1930.) 5*s*. net.

(3) *Probabilités et statistiques.* Par Dr. R. de Montessus de Ballore. (Leçons professées à l'Office National Météorologique de France.) Pp. ix + 211. (Paris: Hermann et Cie, 1931.) 60 francs.

(1) MATHEMATICS has been indebted to actuaries in the past for many valuable contributions in the fields of interpolation, finite differences, and statistical method. We have here an excellent treatise, by an actuary, on those branches of mathematics which are needed by the actuarial student. The author has held in mind the standard required to pass the examinations of the Institute of Actuaries, but has interpreted this standard in a broad way, with the result that we have chapters on elementary trigonometry, on functions and limits, and on differential and integral calculus, as well as those more especially required by the actuarial student, as are the chapters on differences, interpolation, approximate integration, and probability. The result is a model textbook. Proofs are clearly explained, and followed up by many illustrative examples, while the chapters end with a large number of well-chosen examples for solution by the student.

Apart from the needs of the student, we may anticipate that the research worker who has mainly relied in the past on Whittaker and Robinson's "Calculus of Observations" for the study of numerical mathematics will be able to supplement his reading with profit in the future from the text-book under review. The theory of statistics has not been dealt with, which seems a rather important omission, unless it is thought that this subject should preferably have a text-book to itself one of these days. It is not only on interpolation that many of our actuarial mathematicians have made important contributions to knowledge; papers frequently occur in the actuarial literature on points of statistical theory. The grounding that is furnished to the student on the subject of probability by the author, who is careful to avoid being dogmatic, should, however, be of great value to those who are going on to more advanced studies, as well as furnishing a ready tool for immediate use in life assurance calculations.

In the chapters on interpolation, importance is attached to the use of higher differences than the first, and to the study of the remainder term; and in this section reference is made to the fundamental work of Steffensen, made familiar to students in Great Britain through the English translation of his work on interpolation.

(2) Prof. Steffensen was invited in 1930 by the University of London to deliver a course of lectures, and he chose as his subject "Some Recent Researches in the Theory of Statistics and Actuarial Science". These lectures have now been published for the Institute of Actuaries by the Cambridge University Press. This is not a text-book in the accepted sense so much as a collection of notes, and it suffers a little from the heterogeneous character of the material with which the lecturer chose to deal. He has something to say on the place of mathematics in statistical and actuarial theory, and for the rest the book is a critical mathematical commentary on certain points of theory.

It is unusual to find an author setting out boldly to expose "errors due to neglect of the principle that theoretical assumptions should not contain contradictions". Interest in his section on "presumptive values of frequency constants" is shown by the way the matter was taken up and discussed by Dr. G. J. Lidstone in a recent issue of the *Journal of the Institute of Actuaries*. We feel that Prof. Steffensen has not been particularly illuminating in explaining the contradictions here, if indeed there are any. Other matters dealt with in the lectures are certain propositions in inequalities, and the theoretical foundations of various types of frequency functions.

(3) In "Probabilités et statistiques" we have a book of a different character. In his study of probability the author follows the traditional lines of Laplace, and his object is to reach the binomial distribution, of which he then gives the general theory. He applies this function to fit by means of moments a great variety of frequency distributions. The method has considerable success, but there are cases—as, for example, the distribution of barometric heights at Southampton—where the method proposed by the author is no more successful than were earlier efforts to fit Pearsonian curves. We wish that the author had used a sound test of goodness of fit in demonstrating the success (or non-success) of his formula; as it is, we are left in some doubt as to how his method compares with, for example, Pearson's Type I. distribution, to which there are strong resemblances. The work is largely the outcome of the author's own researches, and will be studied with profit by mathematical statisticians. JOHN WISHART.

Palæolithic Man in Egypt.

Prehistoric Survey of Egypt and Western Asia. Vol. 1: *Paleolithic Man and the Nile-Faiyum Divide; a Study of the Region during Pliocene and Pleistocene Times.* By K. S. Sandford and W. J. Arkell. (The University of Chicago Oriental Institute Publications, Vol. 10.) Pp. xv + 77 + 11 plates. (Chicago: University of Chicago Press; London: Cambridge University Press, 1930.) 22*s*. 6*d*. net.

THE Oriental Institute of the University of Chicago a few years ago began a prehistoric survey of Egypt and Western Asia under the direction of Dr. J. H. Breasted. It devoted attention first to the valley of the Nile and the Faiyum depression in the Egyptian desert, where the stone implements of prehistoric man have long been noticed lying on the surface. It assigned to two geologists, Dr. K. S. Sandford and Dr. W. J. Arkell, of Oxford, the task of discovering and mapping the deposits in which the various implements actually occurred. It has now published, as its first volume, a valuable, well-illustrated report on the results.

Drs. Sandford and Arkell are to be congratulated on having added a most important contribution to our knowledge of the history of the Nile valley in Lower Egypt during Pliocene and Pleistocene times, and so made it possible to understand the circumstances in which man first appeared in that region of Africa.

There are no traces of man in Lower Egypt during the Pliocene period, when the northern part of the Nile valley formed an arm of the sea and the Faiyum depression did not exist. The earliest stone implements are of the Chellean type and occur with characteristic Acheulean implements in an extensively preserved river-terrace in the Nile valley at from 70 ft. to 85 ft. above the present level of the river. The Chellean implements are more or less water-worn, while those of Acheulean type are as sharp-edged as if freshly made, so the former seem to have been derived from some still older deposit. Next, there are Mousterian implements of a rather late form found abundantly in a terrace about 25 feet above the existing Nile alluvium. The later terraces in the Nile valley, presumably containing the implements of Upper Palæolithic and Neolithic man, are actually buried by this alluvium and thus inaccessible to study.

Drs. Sandford and Arkell have fortunately overcome this difficulty by discovering that the terrace with Mousterian implements passes from the Nile valley through the Hawara channel into the Faiyum depression. It sinks a little towards the Faiyum, and seems to prove that in Mousterian times the depression was completely filled with a great lake which received water from the Nile. The whole country was then fertile and it was not until later Palæolithic times that desert conditions began, and they may not have reached their present state until the Neolithic period. In these later times the Faiyum lake began to shrink, leaving a succession of beaches as terraces marking the several shores as it gradually diminished to its present extent. The beaches, of course, away from the Hawara channel, are not obscured by later alluvial deposits, and so can be searched for any implements they may contain. A beach about 20 feet below the Mousterian level yields late Palæolithic stone implements of a peculiar local group which Vignard has named the Sebilian. Then follow beaches with Neolithic implements which have already been well studied and described by Miss G. Caton-Thompson and Miss E. W. Gardner.

The evidence on which the various conclusions are based is recorded in a series of remarkably concise chapters, which are illustrated by diagrammatic sections of the deposits and effective sketches of the different types of implements. Actual photographs of the country are also given in the plates. Dr. Breasted contributes a useful foreword, and the authors themselves add a summary which, with the aid of a coloured geological map, makes the whole work readily understood. A. S. W.

Short Reviews.

The Dynamic Universe. By James Mackaye. Pp. x + 308. (London: Charles Scribner's Sons, 1931.) 10*s.* 6*d.* net.

The complex structure of modern physics has caused many obscurities and inaccuracies to creep into the formulation of its epistemological presuppositions. Even the cosmological value of the principles and equations of relativity is difficult to extricate clearly from the mass of speculations, dimensional and non-dimensional, to which they have given rise. In undertaking a clarification of the confused conditions of theoretical physics, Prof. Mackaye has performed a very useful task; and this he does by providing critical answers to a number of pertinent questions such as the following: What is the cause of gravitation? Is matter a form of radiation? What is the cause of the Lorentz contraction? Why are not material bodies retarded in their motion through space? Has the theory of relativity superseded the law of causation? Is the acceleration of material bodies relative exclusively to other material bodies?

The variety of these questions shows the range and purpose of the author's inquiry. Yet, besides separating physics and metaphysics and explaining the one by the other, Prof. Mackaye has the ambition of presenting a cosmic theory dealing with the structure, and cause of change of motion, of material bodies. This attempt is based mainly on the radiation theory, which the author claims to fulfil the aspirations both of science and philosophy by reason of its unifying character. Although very suggestive, this portion of the book is less convincing, especially as the radiation theory in its present stage is a "rather blind groping for the truth". One might question also the author's final remark that "the explanation of nature's laws are physical, not metaphysical", in view of the fact that any explanation has to assume a number of constructive elements which are beyond the actual range of the particular theory seeking an explanation. The author, however, is himself fully aware of these difficulties, and the cautious presentation of his thesis should cause much useful thinking to philosophers and physicists alike.

T. Greenwood.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-Making Alloys, their Ores, Graphites, and Bearing Metals. By Charles Morris Johnson. Fourth edition. Pp. xix + 729. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 37*s.* 6*d.* net.

In the fourth edition of this book, we are presented with detailed descriptions of the methods of analysis of steel, steel works materials, etc. Instead of re-setting the third edition, the author has incorporated new and improved methods in eighteen appendices occupying 176 pages rather more closely printed than the rest of the book. The only other material alteration made is in the chapter devoted to the determination of tungsten in low tungsten steel and the analysis of slags containing chromium, tungsten, and vanadium; this has been rewritten and re-set. Otherwise, the third edition is given unchanged.

The book is essentially a laboratory handbook; the methods are described in very great detail, necessitating, therefore, considerable repetition and reference to methods which are not given in full until later in the book, the pages for reference not always being given. Considerable space is occupied by descriptions of apparatus designed by the author, such as electric furnaces, rheostats, and carbon dioxide absorption 'bulbs', which can be made in the laboratory. The methods are described as rapid methods; but it is rather surprising to find that more use is not made of the electrolytic process for the determination of copper, as this method, although not 'rapid' in itself, can be carried out while the determination of the other constituents in, for example, a bearing metal is taking place.

The last three appendices are devoted to details in the preparation of steel for microscopical examination and the results to be observed in normal and abnormal specimens. In a work of this description, such details must be of necessity rather scanty, but, coupled with references to original papers, they serve as a useful introduction to the subject.

Articulated Locomotives. By Prof. Lionel Wiener. Pp. xv + 628. (London: Constable and Co., Ltd., 1930.) 42*s.* net.

An articulated locomotive is a locomotive in which one or more of the driven axles are able to take up positions where they do not remain parallel to the others and may take angular positions in curves. Such locomotives, once rarely seen, are now found on many railways. The causes for this are the need for more powerful locomotives, the need for using heavy locomotives on lines with permanent way of insufficient strength, and the demand for locomotives of sufficient flexibility to negotiate curves of small radius. Well-known forms of articulated locomotives include the Fairlie, the Mallet, and the Garratt.

One landmark in locomotive history was the Semmering Contest in 1857, for it was then that most systems of locomotive articulation first appeared. Since then makers in all countries have produced articulated locomotives, and of these a great deal of information is given in the book under notice. One of Prof. Wiener's objects was to establish a clear system of classification of types. In addition to the descriptions, sketches, and illustrations of the engines, the book contains alphabetical lists of locomotives, railways and builders, and a chronological sequence of inventions connected with articulated locomotives.

Mechanics of the Gyroscope. By Prof. Richard F. Deimel. (Engineering Science Series.) Pp. x + 192. (New York: The Macmillan Co., 1929.) 17*s.* net.

This book is intended primarily for engineering students, but will be found of use also by students of applied mathematics and physics who are interested in the practical applications of the gyroscope. As regards scope and standard it occupies a position between the exhaustive treatises of Gray and of Klein and Sommerfeld on one hand, and Crabtree's elementary book on "Spinning Tops and Gyroscopic Motion" on the other. About thirty pages of the book are devoted to a rapid survey of dynamical principles, though this would scarcely seem to be necessary in view of the existence of a sufficiency of good text-books on this part of the subject. Then follow chapters on rotation under no forces (the free gyro), and on the spinning top and its motion on a plane and under constraint.

The book concludes with a discussion of applications to various types of gyro-compass and stabilisers used in ships and mono-rail cars. This discussion occupies about a third of the available space, and deals very fully with such topics as the stability of the gyroscopic apparatus and the methods used for controlling its oscillations and diminishing the errors to which it is liable. The free use of illustrations and tables taken from actual practice has enabled the author to produce a most interesting and instructive introduction to the theory and practice of gyroscopic motion.

Positivismus und reale Aussenwelt: Vortrag, gehalten am 12. November 1930 im Harnack-Haus der Kaiser Wilhelm-Gesellschaft für Förderung der Wissenschaften. Von Max Planck. Pp. iii + 35. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 1·80 gold marks.

This is a striking addition to the much-discussed pronouncements of physicists on the philosophical bearings of their new theories. Prof. Planck reveals himself as an idealist, having many beliefs in common with Sir Arthur Eddington and Sir James Jeans. His exposition of scientific method, and his views on the principle of causality and on the problem of free-will are a penetrating analysis of certain fundamental questions which are still a puzzle to the philosopher. Though Prof. Planck's message is hopeful, it is doubtful whether it should be taken as the final explanation of modern physics. T. G.

The World Mapped: being a Short History of Attempts to Map the World from Antiquity to the Twentieth Century. By Dr. I. J. Curnow. Pp. vi + 104 + 10 plates. (London: Sifton Praed and Co., Ltd., 1930.) 5*s.*

This is little more than an essay on an important and vast subject, nor indeed does its author make any further claim. It succeeds, however, in giving an outline of the subject, in which the principal developments are traced and illustrated by reproductions of early maps. The map-makers of antiquity have most notice, and perhaps the monks of the Dark Ages, and their fantastic maps merit a little less attention than they receive in Miss Curnow's allotment of space. This restricts a little the treatment of more enlightened ages. As a whole, however, the work is useful and may be recommended. It contains a short bibliography.

Matter and Radiation.*

By Prof. F. G. Donnan, C.B.E., F.R.S.

THE title of this lecture might suggest a discussion of the greater part of physical and chemical science. It is proposed, however, to confine the following remarks to a consideration of certain views and theories concerning the reciprocal inter-conversion of matter and radiant energy.

Some twenty-five years ago Jeans proposed, as an explanation of the enormous energy radiated by the stars, the startling hypothesis that matter might, under certain conditions, suffer a process of 'annihilation', whereby a proton and an electron might coalesce, and, disappearing as matter in the ordinary sense of the word, be converted into energy of radiation. The basis of Jeans's hypothesis was given by the special relativity theory of Einstein, which showed that matter and energy can be mutually related. Thus the energy corresponding to a mass m grams of matter was found by Einstein to be equal to mc^2 ergs, where c is the velocity of light in centimetres per second. Similarly, if E be the energy in ergs of a given quantity of radiation, its mass in grams is given by the expression E/c^2. We may express Jeans's idea by means of the equation $P+E=$ Radiation, where $P=$ proton and $E=$ electron. Now the mass of $P+E$ is equal to the mass of a hydrogen atom, and this is equal to the reciprocal of the Avogadro number N, the value of which is known to be $6{\cdot}06 \times 10^{23}$. Hence it is possible to calculate the energy of the radiation produced in the above reaction.

The development by Einstein of Planck's quantum theory enabled Jeans to carry this calculation one step further. If we suppose that the coalescence of P and E produces one quantum of monochromatic radiation (one 'photon'), we know that the energy of this quantum is given by the expression $h\nu$ where h is Planck's constant of action and ν the frequency of the monochromatic radiation. We can now write Jeans's hypothesis in the form of an equation, namely, $mc^2=h\nu$, and this equation enables us to calculate the value of ν, since $m=\frac{1}{6{\cdot}06 \times 10^{23}}$, $c=3 \times 10^{10}$, and $h=6{\cdot}5 \times 10^{-27}$. This calculation gives as a result $\nu=2{\cdot}2 \times 10^{23}$, the corresponding wave-length being $\lambda=1{\cdot}3 \times 10^{-13}$ cm.

Twenty-five years ago no radiation of this high frequency was known to science. Recent investigations on the so-called cosmic rays, which reach us from all parts of the heavens, have shown, however, that this radiant energy of cosmic origin contains frequencies equal to and greater than the frequency calculated above. Such results indicate, therefore, that some such hypothesis as that of Jeans is very probable, and that in the depths of space phenomena are occurring which are capable of producing photons of extremely high frequencies.

In the subsequent development of his theory of stellar radiation, Jeans has propounded the interesting hypothesis that in the interior of stars and nebulæ there exist very large and complex atoms which are much more massive than any known to us in the earth. In these 'super-radioactive' atoms Jeans supposes that electrons circulating near the atomic nuclei occasionally fall into the nuclei and, combining with the protons, produce the energy of stellar radiation as a resultant of the 'annihilation' of matter, that is, of electrons and protons. These actions are regarded by Jeans as independent of temperature and characteristic of the complexity and instability of the massive atoms. I do not intend to follow here the later hypothesis of Jeans, and propose to deal with the reaction $P+E=$ Radiation as a *chemical* reaction occurring between *free* electrons and protons. This reaction, if it be possible, is certainly the simplest and most fundamental of all chemical reactions and therefore worthy of the closest study.

We may observe two things about such a reaction. It evidently does not occur under any except very unusual conditions, as otherwise the material universe could not endure for very long. We may suppose that some very intense source of 'activation' is necessary, such as an extremely high temperature or possibly very high velocities of collision due to extremely high electric fields. The reaction is a very strongly exothermic one, so that the reverse reaction would be likely to occur only at excessively high temperatures. Given a system consisting of free protons and electrons, a proton-electron 'gas', we may therefore imagine the reversible equilibrium

$$P+E \rightleftarrows \text{Radiation}$$

as occurring in a closed space at a given temperature, and endeavour to obtain some idea of the temperatures which would be necessary. Only photons of frequency equal to or greater than $2{\cdot}2 \times 10^{23}$ could transform into a proton-electron pair. If the temperature were such that the *hohlraum* radiation were rich in frequencies of this high order, we might expect the possibility of such an equilibrium, assuming that this temperature was high enough to 'activate' the forward reaction. Given such assumptions, there are two very simple ways of calculating a possible temperature. The well-known formula $\lambda_m T=0{\cdot}3$ gives the wavelength λ_m of the radiant energy of maximum density in a closed space at a temperature of T degrees on the Kelvin thermodynamic scale. The frequency ν corresponding to λ_m being given by the equation $c=\nu\lambda_m$, we obtain the result $T=\frac{0{\cdot}3\nu}{c}$. If we now identify ν with $2{\cdot}2 \times 10^{23}$, it follows that

$$T=\frac{0{\cdot}3 \times 2{\cdot}2 \times 10^{23}}{3 \times 10^{10}}=2{\cdot}2 \times 10^{12}\ {}^{\circ}\text{K}.$$

Thus in a closed space at a temperature of the order of 10^{12} K, that is, one billion degrees, it would be possible for the reversible equilibrium $P+E\rightleftarrows$ Radiation to exist. Under these conditions matter, in the form of protons and electrons, would be constantly dissolving into radiant energy, and simultaneously radiant energy would be constantly giving birth to protons and electrons.

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* Digest of a lecture delivered to the Research Department of the Metropolitan Vickers Electrical Company on June 12.

Another approximate way of calculating the necessary high temperature is the following. We start with the well-known equation for the variation with the temperature of the equilibrium constant K of an ideal gas reaction, namely, $\frac{d\log K}{dT}=\frac{Q}{RT^2}$ where Q is the heat of the reaction. If Q does not vary with temperature, the integrated form of this equation is $\log K=\frac{-Q}{RT}+\text{constant}$, which we may write in the form $K=k_1e^{-Q/RT}$, where k_1 is another constant. In this form of the equation, Q and R refer to gram molecules. If we divide both these quantities by the Avogadro number N (that is, the number of molecules in a gram molecule) we can state the equation in a form referred to molecular magnitudes: $K=k_1e^{-q/kT}$, where $q=Q/N$ and $k=R/N$ (called the Boltzmann constant).

Now if q is an extremely large quantity, it is necessary that T should have a very great value if K is to possess an appreciable magnitude. We observe, for example, that $K=k_1/e$ if $q=kT$. Now although it is not possible in the present case to define the equilibrium constant K in the usual way, let us, nevertheless, apply the foregoing reasoning, and write therefore $q=mc^2=kT$, or $T=mc^2/k$. Since $m=1/N$ and $k=R/N$, this gives the result $T=c^2/R$. Recollecting that $c^2=9\times10^{20}$ and $R=8{\cdot}4\times10^8$ ergs, we get $T=10^{12}$ °K, which is approximately the same result as before.

We might have used the Planck radiation equation in these approximate calculations. We shall employ it now, however, for a somewhat different purpose. This equation gives the distribution of radiant energy E as a function of the wave-length, and we may write it for our present purpose in the form:

$$E_\nu=\text{const.}\frac{\nu^2}{e^{h\nu/kT}-1}.$$

In the present case

$$\frac{h\nu}{kT}=\frac{mc^2}{kT}=\frac{c^2}{RT}=\frac{10^{12}}{T},$$

so that we have

$$E_\nu=\frac{\nu^2}{e^{10^{12}/T}-1}.$$

For two different temperatures T_1 and T_2 and the same ν

$$\frac{(E_\nu)_{T_1}}{(E_\nu)_{T_2}}=\frac{e^{10^{12}/T_2}-1}{e^{10^{12}/T_1}-1}.$$

If we put $T_2=10^{12}$, $T_1=10^{10}$, we get

$$\frac{(E_\nu)_{T=10^{10}}}{(E_\nu)_{T=10^{12}}}=\frac{e-1}{e^{100}-1}=\frac{1{\cdot}7}{e^{100}}.$$

Hence, in comparison with the energy density of radiation of frequency $\nu=2{\cdot}2\times10^{23}$ at $T=10^{12}$, the energy density of this radiation at $T=10^{10}$ will be negligibly small. It follows, therefore, that the reverse reaction Radiation $\rightarrow P+E$ would be practically non-existent at $T=10^{10}$, though very marked at $T=10^{12}$. Thus if the temperature 10^{10} were high enough to activate strongly the forward reaction $P+E\rightarrow$ Radiation, matter (in the form of protons and electrons) would dissolve into radiation practically completely.

Quite recently, E. A. Milne has given an important theoretical treatment of the reversible thermodynamic equilibrium $P+E\rightleftarrows$ Radiation, employing for this purpose the quantum statistics of Fermi and Dirac. If n is the number of protons, or the equivalent number of electrons, present per cubic centimetre at statistical equilibrium, then Milne's result may be expressed in the form:

$$n=\frac{2^{\frac{1}{2}}}{h^3}[2\pi kT(m_e/m_p)^{\frac{1}{2}}]^{\frac{3}{2}}e^{-\frac{1}{2}\frac{mc^2}{kT}}$$

where h = Planck constant, k = Boltzmann constant, m_e = mass of one electron, m_p = mass of one proton, $m=m_e+m_p$. Employing the known values of the constants and changing to 10 as exponent base, Milne's equation reduces to:

$$n=0{\cdot}96\times10^{18}T^{\frac{3}{2}}\times10^{-\frac{2{\cdot}35\times10^{12}}{T}}.$$

The following short table gives a few of the results calculated by Milne by means of this equation.

T	n (No. of Protons per c.c.)	ρ_m (Grams per c.c.)	ρ_R (Grams per c.c.)
10^{10}	10^{-202}	$1{\cdot}65\times10^{-226}$	$0{\cdot}85\times10^{5}$
10^{11}	10^{11}	$1{\cdot}65\times10^{-13}$	$0{\cdot}85\times10^{9}$
10^{12}	10^{65}	$1{\cdot}34\times10^{10}$	$0{\cdot}85\times10^{13}$

In this table, ρ_m = density of matter and ρ_R = density of radiant energy. ρ_R is calculated from the equation $\rho_R=\frac{aT^4}{c^2}$, where a = Stefan's constant.

It will be seen that our former rough calculations are in qualitative agreement with Milne's results. Imagine hydrogen gas gradually heated up in an enclosed space. Then we have the following picture. As the temperature rises the molecules will be ionised and finally completely dissociated into atoms. With sufficient further rise of temperature the atoms will become ionised, and when this process is practically complete we shall have our proton-electron gas. We must now imagine that at some very high temperature the reaction $P+E\rightarrow$ Radiation sets in. Milne's results show that at $T=10^{10}$ this reaction will be practically complete. As the temperature rises still higher the reverse reaction, the 'birth' of matter from radiation, begins to be appreciable, and we see that at $T=10^{12}$ the equilibrium density of matter becomes equal to $1{\cdot}34\times10^{10}$ grams per c.c. The state of affairs at $T=10^{12}$ corresponds in fact to enormous densities for both matter and radiation.

We can never expect in our laboratories to attain to temperatures of this order of magnitude. Our only hope in this matter, as in so many other related problems of physico-chemical science, lies in the technical progress of electrical science. Only through the attainment and control of enormous voltages are we likely to obtain results equivalent to the very high temperatures discussed previously. Let us calculate, for example, the energy value of mc^2 in terms of electron-volts. We must write (where V = voltage and e = electron charge)

$$eV = mc^2 = \frac{c^2}{N} = \frac{9 \times 10^{20}}{6 \times 10^{23}} = 1 \cdot 5 \times 10^{-3}.$$

Now $e = 4 \cdot 8 \times 10^{-10}$ e.s.u. Hence $V = 0 \cdot 3 \times 10^7$ e.s.u. Since one electrostatic unit of voltage equals 300 volts, $V = 300 \times 0 \cdot 3 \times 10^7 = 9 \times 10^8$ or nine hundred million volts.

It does not follow, of course, that voltages of this enormous value would be necessary, since we only require electrical potential gradients sufficient to impart to protons and electrons the energies required for 'activation', that is, the energies required to overcome the repulsive forces which exist at very small distances. We might say, at a guess, that controllable voltages of the order of a hundred million volts would be likely to initiate an entirely new era in physico-chemical science. The future progress of this fundamental science lies, therefore, in the hands of the scientific electrical engineer. It is to be earnestly hoped that these advances will be made in England, the land where the electron and proton were discovered by Thomson and Rutherford, and the land where one hundred years ago Faraday discovered how to set electrons in ordered motion by moving magnetic fields.

If we turn back now to our enclosure in chemical and radiant equilibrium at a temperature of 10^{12} degrees, we know that there exists in such an enclosure a sufficient density of photons of frequencies equal to $2 \cdot 2 \times 10^{23}$ and upwards, that is, of photons which can transform into proton-electron pairs. Suppose that from such an enclosure there could escape a dense stream of radiant energy of frequencies lying between, say, $2 \cdot 2 \times 10^{23}$ and 10^{24}. Imagine a sufficiently dense stream of this type of radiation to escape into *cold* interstellar space, and perhaps there to encounter another similar stream. What might happen? Is it not extremely probable that matter would be generated? The reverse reaction radiant energy$\longrightarrow P + E$ does not *necessarily* demand a very high temperature. It would be enough if there existed a sufficient density of photons of frequency equal to or greater than $2 \cdot 2 \times 10^{23}$. Such a reaction would be, indeed, the most fundamental synthetic photochemical reaction. Now photons of such frequencies are known to be reaching our planet from all directions in space. It seems quite possible, therefore, that matter may be in process of generation in cold interstellar space, whereas temperatures such as 10^{12} could only be expected to occur in the hot cores of stars, as Milne has suggested.

Jeans and Eddington tend to emphasise the 'running-down' of the universe, the steady dissolution of matter into radiation. It seems likely, however, that, although the total effect may be such a running-down, there exist places in the universe where a 'running-up' may occur, even though this running-up be of a temporary nature. The universe is probably in a state of fluctuation. It is certainly large enough to permit very considerable local fluctuations, and such fluctuations are by no means incompatible with that general running-down process which the second law of thermodynamics seems to demand. It may be true that the universe, as a whole, is passing from a less probable to a more probable state, from a state of greater to a state of lesser organisation. This general drift, however, is quite compatible with intense local fluctuations in the opposite direction. The re-conversion of radiation into matter may be one of these.

Southern Whaling.*

IN "Southern Whaling" Sir Sidney Harmer reviews the present position of the whaling industry and summarises our knowledge, obtained largely as the result of commercial operations, of the biology of the great whales. The statistics, gathered with scrupulous care, show clearly the great concentration of modern commercial operations in the southern hemisphere, where on the average three-quarters of the annual world-catch of whales is obtained. Since hunting began in that region at the beginning of the present century, quite half of the world's catch has been made in the Antarctic, while African waters have contributed another quarter. Modern whaling operations, therefore, are conducted principally round the great ice barrier which surrounds the south pole.

Analysis of the species captured by the commercial vessels shows the great preponderance of finner whales in the catches, 90 per cent of which consists of the four species—Blue, Fin, Humpback, and Sei. Of these, the Blue and the Fin contribute on the average three-quarters of the total captures, so that the industry is largely dependent on the available stock of these two species. The annual world-catch of all species of whales has risen from 11,000 in 1919 to about 30,000 in 1929 and is still increasing, and the percentage of Antarctic Blue and Fin whales in the total world-catch has risen correspondingly from 63 to 85.

Recent researches into the life-histories of Blue and Fin whales have established that the period of gestation of these species is about a year, and that the young are born at the most every alternate year. Propagation, therefore, is slow. It has been noted that the percentage of sexually mature females in the catches is decreasing, while evidence has also been brought forward which points to a steady decline in the average length of whales captured in Antarctic waters in recent times. In connexion with the latter feature, it is to be remembered that, in whale hunting, the larger animals are deliberately selected. Now a decrease in the average length of a species inhabiting a self-contained area and subjected to intensive fishing operations is regarded as symptomatic of over-fishing, but in the case of Antarctic whales other factors—for example, seasonal movements, inter-area recruitment, and the possibility of variation in the routes of migration, about which little or nothing is known—have also to be considered, so that further research into these factors is necessary before it can be definitely stated that there is a serious decline in the stocks of whales over the whole Antarctic area. There appears to be justification, however, for the fear that the whale stock is being exploited detrimentally, and Sir Sidney Harmer expresses the opinion that the industry in Antarctic waters is rapidly approaching the peak, if indeed that point has not already been reached. New developments in pelagic whaling have vitiated methods of conservation of the whale stock hitherto adopted, so that conservation by international agreement or legislation would seem to be an urgent necessity both in the interests of the whales and of the industry.

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* "Southern Whaling." By Sir Sidney Harmer. *Proceedings of the Linnean Society of London*, Session 142, 1929–30.

The great rise in the whaling industry within recent years began with this new phase of pelagic whaling, that is, whaling without licenses outwith territorial limits, with parent ships of large size fully equipped with the latest appliances for the production of oil and guano. Unlike the earlier floating factories, these ships are self-contained and the whole carcase of the whale is hauled on board over a slipway, now most efficiently fitted at the stern. The parent ships are attended by several 'catchers', and harbours are not absolutely essential, as re-fuelling and re-storing can be done at sea from the 'carriers', while unloading of oil and guano can also be effected. This has been made possible by the use of whale carcases as 'fenders', while wireless, wireless direction-finding, and wireless telephony enable 'carrier' and mother-ship to establish contact without difficulty. The cruising radius of these large ships, in contrast to shore stations, is enormous, and it is not surprising that hunting for whales has been effected right round the fringe of pack ice which streams off the great ice barrier surrounding the south polar regions.

Sir Sidney Harmer is of the opinion that there is some relation between the distribution of whales and seasonal temperatures, and lays particular stress on a correlation between the September mean air-temperatures (for example, at South Georgia) and the order in which the Blue and Fin whales reach their maxima during the immediately succeeding whaling season in the same locality. Mossman[1] also states, "It is certain that the varying temperature of the South Atlantic caused by the fluctuating quantity of polar ice induces changes in the volume, direction and temperature of the great ocean currents". Temperature in itself is not considered a limiting factor in migrations, but it is taken as giving some indication of the melting of the ice which, with the interaction of the ocean currents, results in the growth of the plankton on which whales feed. Researches into the food of whales have so far elucidated that both Blue and Fin whales are plankton feeders and subsist in the Antarctic almost entirely on Euphausians; but, as Sir Sidney Harmer remarks, "The prevalence of these Crustaceans at any time does not produce an identical behaviour in the several species of whales", but that, "each species has its own times and seasons".

The question of the migrations of whales is one of prime importance, but the problem still awaits solution. There are undoubtedly breeding and feeding migrations, and the supposition that in the southern hemisphere a southward migration is for feeding and a northward for breeding is probably correct. Nothing, however, seems to be known of the migration routes or of the extent of the northward retiral.

The monthly statistics of the whales captured in the dependencies of the Falklands show clearly that the Blue and Fin whales reach their maxima during the summer months in the Antarctic and during the southern winter off the African coast. The composition of the stock fluctuates considerably in any one season (say at South Georgia), so that it is obvious that there are several lines of convergence on this particular area. Normally, at all sub-antarctic and antarctic localities, large and fat individuals are caught at the beginning of the season. Later, thin whales predominate, while towards the end of the season fat individuals may be again in evidence. It is presumed, therefore, that the lean whales have come from poor feeding grounds, probably in the warmer sub-tropical waters, and that the fat whales have experienced good feeding grounds nearer the polar ice or within the ice zone. A certain percentage of whales remains in sub-antarctic areas during the southern winter, and those captured have been found to be sexually mature or almost mature, but, naturally, operations during this period cannot be carried out except on a very limited scale, so that the relative frequency of whales in sub-antarctic waters during this period cannot be estimated.

Sir Sidney Harmer has submitted the figures as gathered by him from various sources to statistical treatment and has given a few tentative interpretations. No complete explanation is possible from the available data as to seasonal movements, but the suggestion is put forward that the central point of the main concentration of the Fin whale is farther north than that of the Blue whale, which latter is assumed to be (and probably is) an ice-loving species. The statistics show clearly that there are definite years when the Blue whales are in excess in the captures and others when Fin whales are more abundant, and that these phases seem to be correlated with the fluctuating ice conditions. The adoption, therefore, of the September mean temperature as a means of establishing correlation has been actuated by these occurrences. Blue whale years seem to correspond with low temperatures and heavy ice conditions, and Fin whale years with the reverse. With regard to breeding seasons, all available knowledge, chiefly from a study of fœtuses, is again reviewed, and the interpretation, with which there is general agreement, is that pairing and parturition take place outside the usual hunting grounds and seasons.

Since the publication of Sir Sidney Harmer's paper on "Southern Whaling", there has appeared "International Whaling Statistics" for the ten-year period 1919–1929, which has been published at Oslo by the Norwegian Government on the recommendation of the International Council for the Exploration of the Sea. This contains the figures from the whaling industry throughout the world, and is the first of a series which will constitute a complete study of the whaling industry for the last twenty years. The figures employed in Sir Sidney Harmer's paper show sometimes considerable differences from those of the "International Statistics", though, taken as a whole, this does not affect the general trend of the argument. Attention may be directed, however, to one particular series of figures. In Table 6 of Sir Sidney Harmer's paper, the tabulated data represent the whales captured during the season 1928–29 by all countries, and not, as stated, by Norwegian companies only. An interesting feature in the presentation of the data in "International Statistics" is the average production of oil per whale. The oil production is here given in the form of Blue whale equivalents on the following basis: one Blue whale = 2 Fin whales = 2½ Humpbacks = 6 Sei whales. Previously a production of 75 to 80 barrels of oil per whale was considered a good average, but nowadays this has risen with the improved methods of extraction to more than a hundred. The more complete utilisation of the whale carcases by pelagic whalers is all to the good, but has added to the investigator's difficulties in that recent oil production figures are not comparable with those for earlier years, while the effect on oil production of any variations in condition or of decrease in the average size of the whales is also masked. The efficiency of modern 'plant' has also resulted in an improvement in the quality of the oil produced, and it is now possible to put the higher grades of oil direct on the market in a more or less colourless and odourless condition.

An interesting effect of the intensive whaling operations in the Antarctic is that exploration has incidentally received a new impetus, as it did in the early days of sealing, for example, of Weddell, Biscoe, and Enderby, and new discoveries of land are likely to be achieved. Scientifically, also, the exploration of new areas will extend our knowledge of the distribution and frequency of these finner whales.

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[1] Mossman, R. C. "The Climate and Meteorology of Antarctic and Sub-Antarctic Regions" *Journal of the Scottish Meteorological Society*, 3rd Series, vol. 18, No. 35, 1918.

Obituary.

PROF. ARCHIBALD BARR, F.R.S.

BY the death of emeritus Prof. Archibald Barr, on Aug. 5, in Glasgow, the engineering profession loses one of its ablest representatives in Great Britain.

Prof. Barr was born in Paisley in 1855. He was educated at Paisley Grammar School and the University of Glasgow, where he graduated in engineering science in 1876. Thereafter he spent eight years as assistant to Prof. James Thomson in the University of Glasgow, when he was called to the chair of mechanical engineering in the Yorkshire College (now the University of Leeds), where he spent five years and equipped and organised the engineering laboratory, making it one of the most up-to-date in the country at that time. In 1889 he was recalled to Glasgow as regius professor of civil engineering and mechanics in the University, in succession to the earlier holders of the chair—Lewis Gordon, Macquorn Rankine, and James Thomson.

Dr. Barr might then have settled down to the comparative ease of an academic life, but he found at Glasgow inadequate lecture rooms and a poorly equipped laboratory in the basement, and he had the vision to see that the science teaching of the future must develop along experimental lines; he therefore threw himself with characteristic energy and purpose into the work of arousing interest and collecting funds with which to build and equip an engineering college worthy of Glasgow as one of the most important centres of engineering activity in Great Britain. The result was the James Watt Engineering Laboratories, opened in 1900. Here he continued, until 1913, to lecture, to supervise laboratory instruction and research, and to inspire an ever-growing staff and body of students with the determination to understand the fundamental principles of engineering science and to apply these to the manifold problems that confront the engineer in the daily practice of his profession. In 1889, when he went to Glasgow, there were thirty-six engineering students at the University; when he resigned the chair in 1913, this number had increased to more than two hundred.

Dr. Barr did not confine his activities to the University, but undertook consulting work in the testing of engine and boiler plants, and contributed to the papers and discussions of the leading engineering and scientific societies in Glasgow and London. He served at different times as president of the Institution of Engineers and Shipbuilders in Scotland, the Royal Philosophical Society of Glasgow, and the Scottish Aeronautical Society; he supervised the first motor car reliability trials held in Scotland, in 1901; was convener of the engineering section of the Glasgow International Exhibition in 1901, and chairman of the committee which organised the first aviation meeting held in Scotland, at Lanark in 1910; while from 1921 until his death he was chairman of the governors of the Royal Scottish National Institution, at Larbert, for the care of mentally defectives.

The year after Prof. Barr's appointment to the chair of engineering at Yorkshire College, Dr. William Stroud went to the college as professor of physics. These two young men became close friends, and the partnership proved most fruitful of results. Prof. Barr brought to it his gifts of mechanical invention and organising ability; Prof. Stroud, his flashlight penetration to the scientific core of a problem. In 1888 they decided to carry out a research on the mechanical equivalent of heat, but immediately thereafter they chanced upon an advertisement by the British War Office calling for a range-finder to measure ranges for gunfire, and in three weeks' time the essential features of the modern instrument had taken experimental form. For some years they worked at the development of the instrument, Prof. Barr making many of the parts with his own hands, and himself adjusting them from a platform on the roof of his house in Glasgow. In 1892 the first naval range-finder was built and tried on board H.M.S. *Arethusa*, and at once demonstrated its value to the Service; from that time the demand for such instruments steadily increased. In 1895 a small workshop was opened in an old stable, and later, another old building was occupied in the same neighbourhood. In 1904 the first part of the present factory building of Barr and Stroud, Ltd., was opened at Anniesland, on the western outskirts of Glasgow, with about a hundred workmen. It grew by 1914 to a factory with 900 men, supplying naval and military instruments to the British Government and nearly every foreign Power; while during the War, the main building was extended and two new buildings added to provide room for more than 2000 workers.

Prof. Barr took the keenest interest in all the problems of manufacture and factory development, visiting the United States in 1896 to learn something of their machine methods, and installing the first American milling machine to come to Scotland, two years later. He initiated the scheme of welfare work in the factory, sick benefit, recreation clubs, dining hall, and the use of the premium system in encouraging output.

The extended use of the range-finder on board ship made it imperative to control the fire of the guns; in 1905, Prof. Barr invented a step-by-step motor for signalling electrically from range-finder to gun, and from that date onwards many instruments were designed and patented which have gradually developed into the intricate fire-control system of the modern warship. An electrically operated torsion-meter for measuring the power developed by large prime movers was developed in 1912.

The War inevitably involved the firm of Barr and Stroud in greatly increased production of its usual work, and in this activity Prof. Barr took his share, but he also developed a number of instruments for military and naval use—the torpedo depth recorder, the rangetaker-tester, a bomb-dropping sight for aircraft, the submarine periscope—and took a keen interest in the manufacture of optical glass by improved methods. After the War, the attention of his firm was necessarily turned towards civilian work, and he perfected Dr. E. E. Fournier d'Albe's optophone for enabling the blind to read ordinary type, and a series of instruments for producing contour maps from photographs taken from an aeroplane, by which means survey work in new and unexplored countries has been very greatly simplified.

Prof. Barr was elected a fellow of the Royal Society in 1923, was a member of the Institutions of Civil and of Mechanical Engineers and the Institute of Metals, and was made doctor of laws of the University of Glasgow in 1914.

Prof. Barr will be remembered by his many students for his clear, direct, convincing explanations of the fundamental principles underlying any problem. He was not content to teach engineering as a mere branch of applied science, but aimed to develop in his students the power of thinking out for themselves the laws of science on which the particular work of the moment was based. He was a ready and lucid speaker, and drew upon a fund of humour and wide human sympathies which enabled him to command the interest and constant attention of his classes and to get into close touch with his students individually outside the lecture room. From boyhood he showed inventive talent, and all his life his mind was occupied with the solution of a long series of mechanical problems; while to the development of his patents on a manufacturing scale he applied an integrity which would not brook the least lapse from workmanship of the highest class. He brought to the management of his business a well-balanced judgment, a rapidity of thought that enabled him to come to a sound conclusion quickly, a clearness of mind by which he distinguished the commercial and financial aspects of a problem from the practical and scientific, and a sympathy with his fellow-workers and employees which has found expression in a workshop and organisation where every facility for the well-being of those engaged in the work is provided. His death will be deeply felt by the members of his family, his daughter and two sons (his wife died three years ago, and his second son was killed in France in 1915), by his business associates, and by a wide circle of friends and past students.

WE regret to record the death of Mrs. Howes, widow of the late Prof. G. B. Howes, who succeeded Huxley at the Royal College of Science. Mrs Howes died in Kenya Colony, at the home of her daughter, Mrs. Rae, on July 4, aged seventy-nine years. Forty years ago she made the home of her husband a resort for the younger school of biologists, and did much to forward the cause of modern biology.

WE regret to announce the following deaths:

Prof. W. E. Dixon, F.R.S., University lecturer in pharmacology at Cambridge and formerly professor of pharmacology in King's College, London, on Aug. 16.

Prof. J. W. Hinchley, professor of chemical engineering in the Imperial College of Science and Technology and secretary of the Institution of Chemical Engineers, on Aug. 13, aged sixty years.

News and Views.

THE results of the explosions made by the German Greenland Expedition to determine the thickness of the Greenland ice-cap have been awaited with much interest, owing to their widespread geographical and geological bearing. Two theories have been advanced as to the structure of Greenland. According to one theory, it is a high plateau capped with ice, and the rapid flow of the Greenland glaciers is due to their steep gradient. According to the rival view, Greenland, like Ireland, is a saucer-shaped land, consisting of a rim of mountains with the central hollow filled by ice, which flows outward over the surrounding highlands. Carvill Lewis adduced Greenland in support of the assumed covering of the Irish Sea by a dome of ice which then flowed over the Welsh mountains to the height of 1300 ft. Croll claimed that the Greenland ice was as thick as its height above sea-level, in support of his view that the ice at the south pole is 24 miles thick. Croll's estimates of the thickness of the Greenland ice-cap were declared impossible, in accordance with Lord Kelvin's calculations as to the maximum possible thickness of ice.

THE German Greenland Expedition under the late Prof. Wegener has now tested the thickness of the ice by artificial earthquakes, and the results have been announced by a telegram published in the *Times* on Aug. 13. The largest single charge fired was 74 kgm. of dynamite: 25 explosions were made, and the resulting waves observed. The control station was on lat. 72° N., midway between the eastern and western coasts, and therefore at the geographical centre of Greenland. The height there is 9800 ft. above sea-level. From the time taken for the return of the explosion-wave reflected from the base of the ice-sheet, it is calculated that the ice is 8800 ft. thick. The rock floor, according to this result, is only 1000 ft. above sea-level. The ice 38 miles inland, at the height of 6000 ft. above sea-level, is from 2300 ft. to 3000 ft. thick, so that the rock floor is there about 2000 ft. higher than in the interior. These experiments tend to support Croll's view that Greenland is saucer-shaped, and that the internal ice-cap is much thicker than has been claimed as physically possible. To what degree the explosion-wave results are trustworthy will be considered when the details of the experiments and calculations are available; but the ice is obviously much thicker than was expected on the conception that Greenland, like Labrador, is a high plateau with a marginal mountain range.

THE subjects to be dealt with by Section G (Engineering) of the British Association during the London meeting have been broadly chosen from three separate points of view. That the meeting marks the centenary of the Association is shown by the presidential address by Sir J. Alfred Ewing, which is, at the same time, the Bramwell Trust Lecture. In this Sir Alfred will deal with the position of prime movers in 1931. Prof. Elihu Thomson will speak on "Pioneering in Electrical Engineering Fifty Years Ago", and Sir Robert Hadfield will describe "Faraday's Work in Ferrous Metallurgy". To reflect the activities of the Association in all parts of the British Commonwealth, papers are to be given by: General C. H. Mitchell (Canada), "Engineers' Contributions to Canada's Development"; Mr. A. L. Egan (South Africa), "Methods of Improving the Kata Conditions of Atmospheric Air in Deep-level Mines". Lastly, since the Association is meeting for the first time in London, the special engineering interests of that city are to receive attention. London is, practically speaking, the centre of many activities in the sphere of aeronautics. The research work in this sphere at the National Physical Laboratory and at the Royal Aircraft Establishment, South Farnborough, will be touched upon by Mr. E. F. Relf and Mr. R. McKinnon Wood, who will respectively describe the new wind tunnels at these two establishments. Col. the Master of Sempill will give a paper on "Motorless Flight". These three papers are correlated with demonstrations: the wind tunnels by the visit to the National Physical Laboratory, and "Motorless Flight" by the gliding demonstrations to be given at Feltham Air Park on Sunday, Sept. 27.

FURTHER subjects to be discussed in Section G of the British Association which are connected more or less closely with London are: "Acoustical Problems of Broadcasting Studios", by Mr. Noel Ashbridge, of the British Broadcasting Corporation, and "London Tunnelling Problems", by Mr. H. H. Dalrymple-Hay. These papers, too, are combined with appropriate visits and demonstrations. Apart from these three special aspects, other important subjects of a general nature are included in the programme. Dr. W. Rosenhain will speak on "Metals and Alloys in relation to Engineering Progress", and Prof. F. C. Lea will present a paper on "The Effect of Temperature on some of the Physical Properties of Metals", these dealing with the metallurgical side. Sir David Milne-Watson, on "The New Gas Industry", will refer to some aspects of the important national question of fuel utilisation. Mechanical and manufacturing engineering are represented by Prof. E. G. Coker's paper on "Force Fits and Shrinkage Fits"; civil engineering by Prof. C. F. Jenkin, who will describe his "Earth Pressure Investigations"; while Prof. Julius Hartmann (Copenhagen) with his paper on "Jet Rectifiers" will deal with an important aspect of modern electrical engineering.

A CORRESPONDENT, writing from Loughborough on Aug. 6, mentions having seen a fully-grown cuckoo about his house for several days; on the above date it was perched on some railings along with about twenty sparrows, and being fed by a wagtail. Such an appearance of the yearling cuckoo is quite to be looked for at this time of year, but the fact that it has been deemed worthy of notice is worth recording, as it shows that the great difference in habits between the young cuckoo and the adult is not generally known. The old bird is notoriously secretive in its ways—so much so that it is literally only 'a wandering voice' to 99 per cent of those who know of its existence. But the yearling exposes itself quite freely, is easily approached, and may be seen almost anywhere; in two summers a specimen was seen perched on the top of the Small Waders' aviary which used to be behind the Lion House in the Zoological Gardens. As the build of the cuckoo—long-winged and short-legged—is that generally characteristic of birds which hunt in the open, the behaviour of the yearling is more in accordance with what one would expect from its structure than is that of the adult. Evidently, however, during the bird's progress towards maturity and its travels to and sojourn in the south, it finds it expedient to conceal itself, and retains the habit; possibly the chief elimination the species suffers is by the persecution of birds of prey, which compels individuals to this change of customs, as the cuckoo appears not to suffer from starvation in spring or to be compelled to board ships when on passage—common misfortunes with others of our migrants. The wagtail above alluded to had, no doubt, reared the cuckoo, and the sparrows would have been attracted by their curiosity at a strange bird, often popularly mistaken for animosity, which they rarely display.

A REPORT by Miss D. A. E. Garrod on work on the British School of Archæology in Palestine during the past season appears in *Man* for August. Miss Garrod herself has been engaged in excavating the Mugharet-el-Wad, the largest of the Wady-el-Mughara group of caves, close to the rock basins which were uncovered in the previous season. A series of mesolithic burials has been found with circlets of beads of bone and shell still in place on the skeletons. The better preserved one, which has been removed in one piece, will go to the Palestine museum as an exhibit. On the skull are the remains of a cap strung with dentalia shells, while the lower jaw is full of bone pendant beads. The skeleton lay in a contracted position with one arm across the body. Of the other excavations, Mugharet-el-School is being carried out by Mr. Ted McCown. He has found an interesting Mousterian industry, and at the end of last May brought to light the skull and lower jaw of a young child, three to four years old (see NATURE, June 6, p. 865). The end of a child's humerus was revealed in the hard block of Mousterian breccia. This has now been sent whole to Sir Arthur Keith, in the hope that it may be found to contain the whole skeleton. At Mugharet-el-Tabou is a purely Mousterian deposit of great depth. Its great interest at the moment consists in the fact that it contains well-preserved fauna associated with the Mousterian—at present little known for this region. At Mugharet-el-Kabara, Mr. Turville Petre is excavating Zichron Jakob, a cave ten miles from Wady-el-Mughara. A mesolithic horizon has produced bone sickle handles with carved animal heads at the top, many bone harpoons, and various pieces of carved bone and stone, some of which, it is hoped, may be on exhibition later in London.

THE farming industry in Germany is far from flourishing at the present time. Instead of this preventing the development of new industrial material, it seems, judging from the large number of new agricultural devices shown at the recent show in Hanover, to be acting as a spur to further improvements. In the *Electrician* for July 31, R. Borlase Matthews describes some of the novel machines shown at this agricultural exhibition. Manufacturers are providing machines likely to reduce the costs of production, and the farmer is doing everything to increase the cultivated area and farm the land more intensively, so as to lower the total cost per unit produced. The number of new implements shown was nearly two hundred, and there were 5300 machinery exhibits, numbers which far surpass anything seen at shows in Great Britain. Electrically operated apparatus was very much in evidence, large scale demonstrations being given of equipment suitable for dairying, poultry-keeping, etc. An ingenious device known as the 'rain-cannon' is used for watering fields. It consists of a jet mounted on a cylindrical pressure tank. The upper portion of the tank is filled with air, which is compressed by the water until there is equilibrium. When this is attained, a valve situated in the nozzle opens an orifice. Owing to the sudden release, the air pressure ejects the water in a powerful jet to a considerable distance and at the same time moves it round slightly. This method is a great improvement on the old sprinkler and pipe-line methods. A small rain-cannon requiring only a pressure of two or three atmospheres to work it was a very popular exhibit. Pneumatic transport methods for transporting hay from the barns are coming into use owing to their convenience. A device was shown which supplied concentrated feed to the horses in stables twice a day. It was entirely automatic, requiring charging only once a week.

IN the *University of Colorado Studies* for April 1931 there is an interesting paper by Prof. Kenneth Field on the effects produced by interconnexion of electric light and power supply companies. The tendency in America is for the small companies to unite and form large companies. For example, twenty large companies control more than fifty per cent of the total supply. Just as with the 'grid' in Great Britain, the economies arise from the decrease in the consumption of fuel per unit power generated, the more economical maintenance that can be attained, and what may be described as the substitution of capital for labour. In large steam stations, evaporators for distilling water can be used to prevent scale-forming materials from entering the boilers, and this reduces the maintenance costs. Mechanical stokers, coal and ash handling machinery, coal bunkers, etc., considerably reduce the manual labour required. When water is available for condensing purposes, steam generating stations are located at the coal pits, and thus the cost of transport is lowered. Savings in reserve capacity are facilitated by making temporary service from distant plants possible. During a recent drought in North Carolina, industries in that State which were dependent upon electric light and power were kept in operation by energy received through interconnexion with the Southern Company, operating in South Carolina. This company had no surplus power, but obtained from the Georgia Company the equivalent of the power which it passed on for use in North Carolina. In turn the Georgia Company received from the Alabama Company the equivalent of the energy it gave to the Southern Company. In effect, therefore, the North Carolina industries were kept going by electricity generated in the State of Alabama. The power was not actually transmitted, but the effect produced was the same as if it were.

A NEW scientific journal which marks an important stage in the geological survey of China has appeared under the name of the *Soil Bulletin*, published for the University of Nanking and the China Council of the Institute of Pacific Relations by the Geological Survey of China. Two numbers have appeared to date, the first in December 1930 and the second in March 1931; and both make contributions of interest to a subject which has received little scientific attention. Soils have distinctive morphological characters, and their classification on the basis of their own features, rather than from the point of view of their origin, is more likely to be of value to the agriculturist. A preliminary reconnaissance of a portion of the soils of China was carried out by Prof. C. F. Shaw in 1930, and this revealed the presence of nine soil regions. Of these, three are large areas of primary soils and six are composed exclusively of secondary soils. It was found that the geological origin of the soil material was subordinate to climate in determining the broad general soil regions, but within the regions it was of much importance. Mode of formation has had a dominant rôle in determining the characteristics of those regions which are composed mostly of alluvial sediments, though both climate and geological origin have naturally also had much influence.

AT the Congrès International du Bois et de la Sylviculture, which was held in Paris on July 1–5, an International Association of Wood Anatomists was formally constituted. This was the outcome of an informal meeting of wood anatomists which was held at Cambridge on the occasion of the fifth International Botanical Congress, in August 1930. At that time it was not found possible to do more than appoint a committee to consider the question of organisation and to report to the next conference, which was provisionally fixed for July 1931, in Paris. The Committee's report included a draft constitution, which was finally adopted at an open meeting held on July 4 last. The Committee was then empowered to enrol members and to carry on the affairs of the Association until such time as the statutory Council shall have been appointed. The secretary to the Committee is Prof. S. J. Record, Yale University School of Forestry, New Haven, Connecticut, United States, and the British representatives on the Committee are Mr. E. H. B. Boulton, Department of Forestry, University of Cambridge; Dr. L. Chalk, Imperial Forestry Institute, Oxford; Mr. B. J. Rendle, Forest Products Research Laboratory, Princes Risborough, and Mr. M. B. Welch, Technological Museum, Sydney, Australia.

IN 1911 an International Hygiene Exhibition was held at Dresden, and in 1930 a second International Exhibition was the appropriate occasion for the opening of a permanent museum of hygiene in that town. Since the first exhibition, almost revolutionary changes have taken place throughout the whole field, so that the 1930 exhibition presented quite a different picture from its predecessor. Its sections included the hospital, physical culture, occupational hygiene, psychic life and hygiene, woman and child, care of health, nourishment, clothing-hygiene, and sanitary and dwelling conditions. The aim of the Museum, organised as a registered association, is to convert the greatest possible number of people to a systematic and continuous care of their health, not merely by imparting instruction, but also by influencing them to think hygienically for themselves. Various sections are devoted to press and publication propaganda, teaching apparatus, lantern-slides, travelling exhibitions, health service, and so on. An illustrated article in the *Museums Journal* for July gives in some detail an account of this important institution.

AN explanatory circular (1208) has been issued by the Ministry of Health respecting the *Memorandum* (153/M.C.W.) on birth control issued in March. It is emphasised that local authorities have no general power to establish birth control clinics as such. Under the Maternity and Child Welfare Act, 1918, facilities for birth control advice at a centre are limited to married women already in attendance as expectant or nursing mothers in whom further pregnancy would be detrimental to health. Under the Public Health Acts, gynæcological clinics may be established and contraceptive advice may there be given to married women in attendance for a similar reason. It is considered undesirable that a gynæcological clinic should be established at a maternity and child welfare centre; such a clinic should be provided in separate premises or at a hospital. Contraceptive advice should not be regarded as falling within the scope of the normal duties of the medical officers of a local authority, who should be free to undertake or to decline it.

THE further issue in the Ministry of Agriculture's new series of bulletins includes one (No. 13) on "Home-grown Feeding Stuffs" by Dr. H. E. Woodman, the object of which is to indicate how the farmer's own produce may best be used in the rearing of stock. From a comparison of the relative cost of some home-grown and purchased feeding stuffs, it is evident that it may pay the farmer better to retain his own potatoes and corn for home consumption rather than to sell them and have to purchase maize meal. A general description follows of the composition, feeding value, and uses of a large variety of common home-grown foods, such as cereals, hays, forage crops, silage, potatoes, and sugar beet by-products, and rations suitable for different types of stock are supplied. In conclusion, a comparative table is drawn up showing the composition and feeding values of various winter forage crops and pasture grass, from which it is evident that kales in particular should prove satisfactory substitutes for pasturage. Copies of the bulletin may be purchased direct from the Ministry of Agriculture, 10 Whitehall Place, S.W.1, price 8*d.* post free.

The Indian Journal of Veterinary Science and Animal Husbandry is the title of a new quarterly journal the first part of which has recently been published for the Imperial Council of Agricultural Research, New Delhi, India. The annual subscription, including Indian postage, is Rs. 5, or 8*s.* 3*d.*, which should be sent to the secretary of the Imperial Council. The aim of the journal is to encourage practical investigations of economic value, and actual notes of practical experiences and clinical observations, rather than abstruse articles on research, are what are required, though reviews and abstracts of current work will be included. This first part contains an article by H. Cooper on anti-rinderpest inoculations, and other papers and abstracts on diseases and infections of cattle and other animals.

It is announced that Lord Ilchester and Prof. J. Stanley Gardiner have been elected trustees of the British Museum in succession to Lord Ullswater and Lord Chalmers, who have retired.

After consultation with the Lord President of the Council and the president of the Royal Society, the recently formed Agricultural Research Council has appointed Sir William Dampier to be secretary of the Council. Mr. E. H. E. Havelock, of the Development Commission, has been appointed assistant secretary.

The nineteenth annual meeting of the Indian Science Congress will be held in Bangalore on Jan. 2–8, 1932, under the presidency of Rai Bahadur Lala Shiv Ram Kashyap. The following have been elected sectional presidents; agriculture, Mr. G. N. Rangaswamy Ayyangar; mathematics and physics, Prof. Ganesh Prasad; chemistry, Prof. P. R. Ray; zoology, Prof. D. R. Bhattacharyya; botany, Dr. Haraprasad Chaudhuri; geology, Mr. Percy Evans; medical and veterinary research, Lt.-Col. A. D. Stewart; anthropology, Mr. J. P. Mills; psychology, Prof. N. S. N. Sastry. Further information can be obtained from the General Secretary, 35 Ballygunge Circular Road, Calcutta.

The Association of Special Libraries and Information Bureaux will hold its annual conference at Lady Margaret Hall, Oxford, on Sept. 18-21, under the presidency of Mr. H. T. Tizard. Some problems of professionalism will form the subject of a lecture by Prof. A. M. Carr Saunders, and Mr. B. M. Headicar will discuss practical methods of arrangement, indexing, and routine in the business library and information bureau. Other subjects included in the programme are "International Abstracting and Indexing" by Sir Frederick Nathan, "Films as a Medium of Information in Education" by Mr. F. A. Hoare, and "Agricultural Economic Information" by Mr. J. P. Maxton. On Sept. 20, Sir Francis Goodenough will give a short address on the Report of the Board of Education Committee on education for salesmanship.

A great earthquake was recorded in the observatories of Great Britain on the evening of Aug. 10. At Kew, the first impulses occurred at 9 h. 28 m. 21 s. p.m., G.M.T. The records indicate that the origin was about 4000 miles north-east by east of Kew, or near the Altai Mountains in Mongolia, and this position is confirmed by reports that it was about 2100 miles from Bombay. An earthquake on Aug. 16 which shook the city of El Paso and was widely felt in Texas and New Mexico was recorded as a small disturbance at Kew Observatory. The first impulses at Kew occurred at 11 h. 52 m. 4 s. G.M.T., and the records indicated that the epicentre was about 5300 miles away. Among other recent earthquakes, one of the most interesting occurred on July 18, in the Mississippi valley (*Daily Science News Bulletin*, Science Service, Washington, D.C., July 20). Its centre was close to New Madrid, the scene of the great earthquakes of Dec. 16, 1811, and Jan. 23 and Feb. 7, 1812.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mechanical engineering at the Technical College, Bradford—The Principal, Technical College, Bradford (Aug. 25). A principal of the Neath Mining and Technical Institute, and an assistant at the Caerphilly Mining and Technical Institute and Junior Technical Day School, with good honours degree in science—The Director of Education, County Hall, Cardiff (Aug. 25). A laboratory steward at the Technical College, Coatbridge—The Director of Education, Lanarkshire House, 191 Ingram Street, Glasgow (Aug. 26). A county librarian under the Durham County Education Authority—The Director of Education, Shire Hall, Durham (Aug. 27). Chemical laboratory assistants at the Royal Arsenal—The War Department Chemist, B.47, Royal Arsenal, Woolwich, S.E.18 (Aug. 29). An assistant librarian in the University of Birmingham—The Secretary, University, Birmingham (Sept. 5). A demonstrator of biology at St. Bartholomew's Hospital Medical College—The Dean of the Medical College, St. Bartholomew's Hospital, E.C.1 (Sept. 10). An assistant at the College of Estate Management for lecturing on town planning and road-making—The Secretary, College of Estate Management, 35 Lincoln's Inn Fields, W.C.2 (Sept. 14). A Milroy lecturer at the Royal College of Physicians for 1933—The Registrar, Royal College of Physicians, Pall Mall East, S.W.1 (Sept. 21). A handicraft instructor under the Lincolnshire (Holland) Education Committee—The Director of Education, High Street, Spalding. An assistant in the development section of the British Non-Ferrous Metals Research Association—The Director, British Non-Ferrous Metals Research Association, Regnart Buildings, Euston Street, N.W.1. An engineering draughtsman under the Air Ministry—The Secretary (S.1), Air Ministry, Kingsway, W.C.2.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Magnetic Experiments on the Cosmic Rays.

BOTHE and Kolhörster [1] were the first to show that the cosmic rays manifest themselves to us as highly penetrating corpuscular rays. Direct experimental data on the nature as well as on the energy of these rays are still lacking; they might be obtained by experiments on the magnetic deflection if a sufficiently large and intense magnetic field could be reached.

I have attempted to overcome the difficulty of producing such a field by making use of the magnetic induction in a mass of magnetised iron.[2] Some preliminary experiments using the method of triple coincidences between the impulses of three Geiger-Müller tube-counters to define and analyse the beam of corpuscular rays, only show that these rays are not deflected in iron to an extent comparable to the deflection which electrons of 10^8 *e*-volt would be subjected to. The experiment was repeated later by Mott-Smith,[3] with the same method but with greater precision; the results were again negative and the energy of the corpuscular radiation, presumed to be electronic, was given as 2×10^9 *e*-volt as an approximate minimum value.

A fresh and more extensive series of measurements of the deflection of the corpuscular rays in magnetised iron have been recently undertaken by me, using an improved and more sensitive arrangement (which has already been briefly described[4]) on a principle suggested by Prof. Pucciante.

Figs. 1 and 2 represent the apparatus used in a first experiment in plan and in vertical section. The core of the magnet consists of two iron plates *A* and *B*, 2·8 cm. × 13 cm. × 38 cm., four millimetres apart; the two armatures *C* and *D* close the magnetic circuit. The wire carrying the magnetising current is wound round the plates in a single layer of seven turns per centimetre; with a current of five amperes the induction field inside the iron (measured with a ballistic galvanometer) is 16,200 gauss; the induction lines are closed without emerging from the core, and pass through it, as indicated by the arrows, clockwise or counter-clockwise according to the direction of the magnetising current. Above and below the magnet are two tube counters, each of 2·5 cm. internal diameter and of an effective length of 25 cm.; their axes are horizontal and parallel to the direction of magnetisation.

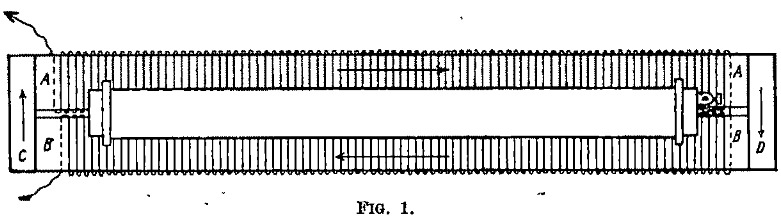

FIG. 1.

The experiment was carried out by counting the coincidences between the impulses of the two counters, alternately reversing the direction of the magnetising current. Since the two plates are inversely magnetised, the corpuscles are deflected in contrary directions, according as they pass through the first or the second plate. It is consequently easily seen that the corpuscles which have passed through the first counter (if negatively charged) are concentrated in the second or are repelled from it according as the induction lines are counter-clockwise or clockwise. An increase in the frequency of the coincidences in the former case and a diminution in the latter is therefore to be expected. If the corpuscles are positively charged, the conditions are reversed.

Perhaps the performance of the apparatus will be better understood by explaining that the effect of magnetising the plates is to alter the angular aperture of the beam subtended by the lower counter from any point of the upper (see Fig. 2). The effect which may be expected from a beam of corpuscles all of the same energy can be represented approximately (provided *R* is not too small and the loss of energy in the iron is neglected) by the formula: $\frac{\Delta N}{N_0} = \frac{140}{R}$, where *R* is the radius of curvature of the path of the corpuscles which penetrate the plate perpendicularly to the induction lines, N_0 is the frequency of the coincidences when the field is zero, ΔN is the difference between the frequency of the coincidences with the field in alternate directions. For electrons or protons of 10^{10} *e*-volt the above formula gives, for example, $\frac{\Delta N}{N_0} = 0{\cdot}068$.

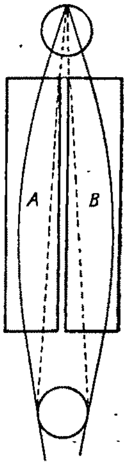

FIG. 2.

The result of the measurements was as follows:

Field clockwise:
In 197h 34m . . . 21·534 coincidences.
Field counter-clockwise:
In 197h 34m . . . 20·756 coincidences.

$$\Delta N = 778 \pm 200 \quad \frac{\Delta N}{N_0} = \frac{778 \pm 200}{\frac{1}{2}(21{\cdot}534 + 20{\cdot}756)} = 0{\cdot}037 \pm 0{\cdot}01.$$

(The chance coincidences, amounting to 1205 for each series of measurements, have been deducted from the above figures.) The difference is therefore 3·7 times greater than the mean error, and it may be considered as being very probably true. It will be noted that its sign is that proper to a beam of positive particles.

In order to test whether this effect was actually due to the deflection of the penetrating corpuscular rays, which pass through the iron, the experiment was repeated with a magnet similar to the former, but of greater size. If the above assumption is correct, an effect three times larger was to be expected. The result of the measurement was as follows:

Field clockwise:
In 108h 9m . . . 5·261 coincidences.
Field counter-clockwise:
In 108h 9m . . . 5·157 coincidences.

$$\Delta N = 104 \pm 105 \quad \frac{\Delta N}{N_0} = \frac{104 \pm 105}{\frac{1}{2}(5261 + 5157)} = 0{\cdot}02 \pm 0{\cdot}02.$$

It is seen that the difference is within the limit of the experimental error (twice as great as in the former experiment) and does certainly not reach the expected value. The little effect found in both experiments may be due to the deflection of positive secondary particles of lower energy, generated inside the iron. Safely, however, one can only say that the primary corpuscular rays are not deflected, by passing through the iron to such a great extent, as electrons or protons of 10 or 20 milliards *e*-volt would be, provided the effective magnetic field is identical with the induction field. (In the latter experiment, for example, it was from electrons of 10^{10} *e*-volt that an effect of 20 per cent was to be expected.)

A fuller description of the experiments, with a more exhaustive discussion of the results obtained, will be published later.

BRUNO ROSSI.

Physical Institute, University of Florence,
Arcetri, Italy, July 10.

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[1] W. Bothe und W. Kolhörster, *Zeit f. Phys.*, **56**, 751; 1929.
[2] B. Rossi, *Rend. Lincei*, **11**, 478; 1930.
[3] L. M. Mott-Smith, *Phys. Rev.*, **37**, 1001; 1931.
[4] B. Rossi, *Phys. Rev.*, **36**, 606; 1930.

Nuclear Moments of the Isotopes of Lead: Relative Values of the $g(I)$ Factors of Pb(207) and Tl.

As a continuation of the programme that was initiated with the analysis of the hyperfine structure of Tl II,[1] the hyperfine structure of Pb III was investigated. The important Pb III lines [2] in the visible region were examined by means of a concave and an echelon grating. The structure and intensities of the patterns were interpreted consistently by attributing $I=0$ to the two even isotopes Pb(206) and Pb(208), and $I=\frac{1}{2}$ to the odd isotope Pb(207). This interpretation is in agreement with Kopfermann's[3] deductions based on the structure of Pb I and II lines and with Schüler and Keyston's[4] inference based on intensity measurements of the lead line λ4058.

The observed H.F.S. of Pb(207) III is similar in regard to relative separations to that of Tl II. The magnitudes of the separations in Pb(207) III, however, are much smaller than those of Tl II. The separation of the $6s7s'\ {}^3S_1$ of Pb(207) III is only 2·25 cm.$^{-1}$ as compared with the 4·97 cm.$^{-1}$ separation of the corresponding state of Tl II.

From these separations of the ${}^3S_1$ states of the two spectra, the values of the interaction constants of the $6s$ electrons of the $6s7s$ configurations of Pb(207) III and Tl II can be evaluated.[5] A comparison of these values shows that the $g(I)$ factor of the Tl nucleus is about four times that of the Pb(207) nucleus.

This result is especially significant. Up to the present the observed I values have been explained consistently on the assumption that only spinning protons contribute to the resultant moment of the nucleus.[6] The simple assumption that each proton contributes $\frac{1}{2}h/2\pi$ to the resultant was sufficient to explain the known facts. On this simple theory, the resultant moments of the nuclei of Tl and Pb(207), for both of which $I=\frac{1}{2}$, would be due to one unneutralised spinning proton. The $g(I)$ factors of the two nuclei, then, would be expected to be the same, since there is no evidence to indicate why different spinning protons with the same mechanical moments should have widely different magnetic moments. Contrary to this expectation, experiment shows that the $g(I)$ of the Tl nucleus is about four times that of the Pb(207) nucleus. The obvious conclusion is that the moment of at least one of the nuclei is composite and not due simply to a spinning proton. This conclusion invalidates the simple rule that each proton contributes $\pm\frac{1}{2}h/2\pi$ to the resultant, and necessitates endowing some of the protons in at least one of the nuclei with some property in addition to spin.

Our knowledge of extra-nuclear electronic structure suggests orbital motion. This model is not extreme, since the dimensions of a proton relative to a complete nucleus are of the same order as the dimensions of an electron to the atom. Such a model has the possibilities of explaining not only resultant I values, but also the nuclear $g(I)$ factors, even if the latter are negative.

J. C. MCLENNAN.
M. F. CRAWFORD.
L. B. LEPPARD.

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[1] McLennan and Crawford, in Press.
[2] Smith, *Phys Rev.*, vol 34, p. 393; 1929.
[3] Kopfermann, *Naturwiss.*, **19**, p. 400, 1931.
[4] Schuler and Keyston, *Z. f Phys.*, **68**, p. 174; 1931.
[5] Pauling and Goudsmit, "Structure of Line Spectra", chap. xi.: McGraw-Hill, New York, 1920.
[6] Bartlett, *Phys Rev.*, vol. 37, p. 327; 1931.
[7] Page and Watson, *Phys Rev*, vol. 35, p. 1584; 1930.

Diamagnetism of Liquid Mixtures.

WITH regard to the discussion in NATURE by Trew and Spencer[1] and Ranganadham[2] on the diamagnetism of liquid mixtures, I should like to communicate the following data based on measurements carried out by me.

I find that the deviations from the susceptibility for the mixture calculated from the proportions of the components for acetone-chloroform is only 2 per cent. I find no trace of paramagnetism. Trew and Spencer believe that the paramagnetism they find for this mixture is probably attributable to the formation of dimethyltrichloromethyl carbinol (in German, Trichlorbutylalkohol tertiär), which their measurements show to be *paramagnetic*. I find this substance to be *diamagnetic* ($\chi=-0{\cdot}65\times10^{-6}$, and with water of crystallisation present $\chi=-0\ 67\times10^{-6}$). Further, for this substance I have obtained values of $\chi=-0{\cdot}64_5$ and $\chi=-0{\cdot}66\times10^{-6}$ respectively from calculation following Pascal's rule. Again, the density of this substance according to Trew and Spencer is 0·66, whereas I find it to be 1·5, and these authors state that the substance is pale yellow, while all chemical references agree that it is white, a fact which I have observed myself. I find in agreement with previous work that the melting-point is 96·5° C. (97° C.?) and 76° C. in the case where water of crystallisation is present. Two samples of dimethyltrichloromethyl carbinol where investigated, one from Kahlbaum, the other made by Frl. Karin Meyer; the two showed identical properties.

The capillary ascension method of Quincke was employed using field strengths of 8200, 3850, 1800, and 1300 gauss; the last of these gave only qualitative results since the sensibility at this field strength was not sufficiently great. In view of the present results, the possibility of explaining Trew and Spencer's measurements (at 640 gauss) by an anomalous dependence on the field strength is thus probably excluded. For the dimethyltrichloromethyl carbinol a Weiss (bifilar) balance method was employed to determine the susceptibility using a field of 8500 gauss.

It should also be noticed that the density curve for acetone and chloroform, given by Trew and Spencer in their original paper, shows that dimethyltrichloromethyl carbinol could not have been present in this mixture, for if it had been, a large density anomaly would have appeared.

The use of Pascal's theoretical values, by means of which Trew and Spencer have attempted to support their results, appears to me to be misleading. For example, the single exception in agreement between theory and measurements quoted by Trew and Spencer, namely, acetone, is precisely the substance for which the large deviations are found to occur. Further, a closer inspection of Pascal's results shows that the deviations between calculated values and experimental observations of other authors are systematic, that is, the greater the halogen (Cl, Br) content of a compound the greater these deviations become.[3] My results, $\chi = -0{\cdot}58 \times 10^{-6}$ for acetone and $\chi = -0{\cdot}485 \times 10^{-6}$ for chloroform, are within the limit of error of previous measurements recorded by other authors.

HANS BUCHNER.

Institute of Physics,
University of Munich,
July 26.

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[1] *Proc Roy. Soc.*, **131**, 1931, p. 209, and NATURE, **128**, 1931, p. 152.
[2] NATURE, **127**, 1931, p. 975.
[3] Pascal, *Ann. de Chim. et Phys*, **19**, p. 67; 1910.

Function of Water Vapour in the Dissociation of a Salt Hydrate.

IN measuring the influence of the gaseous product upon the velocity of dissociations of the type

$$\text{Solid}_1 \longrightarrow \text{Solid}_2 + \text{Gas},$$

we have found an interesting effect with the reaction:

$$MnC_2O_4.2H_2O \longrightarrow MnC_2O_4 + H_2O,$$

which goes on slowly in a vacuum at 76°, at which temperature the dissociation pressure is approximately 135 mm.

The reaction rate under otherwise constant conditions is sensitive to quite small concentrations of water vapour. Plotted against a linear scale of water vapour pressures, the quotient

$$\frac{\text{Rate in vacuum}}{\text{Rate at } pH_2O}$$

(shown in the diagram as 'rate') at first falls sharply; this appears to be the normal behaviour of salt hydrates. But with increasing water vapour pressures the rate passes through a minimum at about 10^{-1} mm. (that is $<10^{-3}$ of the dissociation pressure) and then rises, to pass through a maximum of the same order as the rate in vacuum; thereafter it falls again along a more gentle curve eventually to zero at the dissociation pressure. So far as we know at present, this minimum and maximum is a unique case.

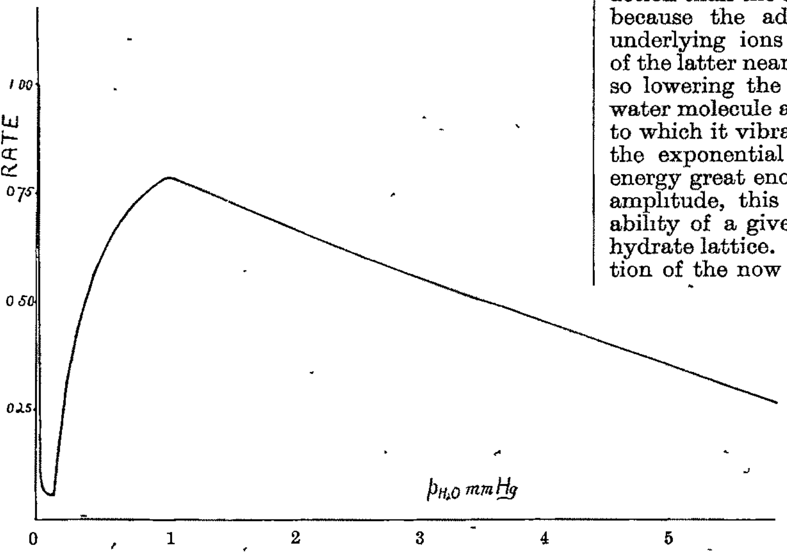

FIG. 1.

In rough outline the following picture might provide a qualitative explanation of the effect: the reaction is experimentally of the usual 'interface' type, that is, dependent upon the presence of the anhydrous phase. It possesses a large temperature coefficient, so that the rate-governing process is subject to a considerable activation, presumably in vibrational degrees of freedom. In our view, two stages are involved:

$$\text{Salt hydrate} \rightleftarrows (\text{Anhydrous salt} + H_2O \text{ adsorbed in interface}) \rightleftarrows \text{Anhydrous salt} + H_2O \text{ (gas)}.$$

Water molecules in the hydrate lattice adjoining the anhydrous phase require a smaller vibrational energy to enable them to break out of the lattice because of the attraction exerted by the ions on the opposite side of the reaction zone; hence the reluctance of the reaction to take place in the absence of the second solid phase.

Water vapour in the gas phase establishes an adsorption equilibrium in the interface zone between the two solids rapidly in comparison with the slow chemical reaction. The net rate of decomposition is now decreased (*a*) because it is the difference between two opposing rates, (*b*) because a fraction of the interface is blocked for decomposition by the adsorbed molecules already present.

As the two-dimensional density of adsorbed molecules increases (with the arbitrarily maintained partial pressure) a stage will be reached in which the gaps in the adsorption layer are more or less surrounded by other adsorbed molecules. We suppose that these gaps may be much more effective in promoting the reaction than the corresponding area not so surrounded, because the adsorbed molecules polarised by the underlying ions virtually carry the attractive field of the latter nearer to the hydrate side of the interface, so lowering the force constant between the hydrate water molecule and the rest of its lattice, with respect to which it vibrates in the reaction zone. Because of the exponential factor governing the chance of an energy great enough to give the molecule an assigned amplitude, this may increase enormously the probability of a given molecule breaking loose from the hydrate lattice. At the same time, the mutual attraction of the now rather numerous adsorbed molecules polarised by oppositely charged ions will decrease the probability of a given molecule contributing to the reverse reaction by passing from the adsorbed layer back to the lattice. The combined effect is to cause the net rate to rise again, and clearly it must pass through a maximum and fall again more slowly as the gaps available for the forward reaction become filled up and the number of molecules in a position to contribute to the reverse reaction is still further increased. Ultimately the two opposing rates become equal at the dissociation pressure.

The initial rapid fall with very small fractions of the dissociation pressure explains the well-known difficulty of approaching the equilibrium in many salt hydrate systems experimentally.

B. TOPLEY.
M. L. SMITH.

Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College,
London, W.C.1, July 3.

Magnetism of Colloidal Gold.

IN three previous notes in NATURE[1] it has been pointed out that the diamagnetism of graphite, antimony, and bismuth decreases with particle size. This was most striking in graphite and less in antimony and bismuth. In a later communication on the same subject[2] I adopted two methods of colloidalisation of bismuth—Bredig's method and mechanical colloidalisation. In Bredig's method I obtained an abnormally low value, due to the powder containing a mixture of oxide and the metal, as was pointed out by me. In the case of bismuth, S. S. Bhatnagar[3] contends that he obtains a large amount of oxide by mechanically colloidalising bismuth, and part of the decrease of diamagnetism that I obtained by that method is also due to oxidation.

We have recently investigated carefully prepared gold sols avoiding all possibilities of oxidation. The sol was prepared by the method of Zsigmondy for the preparation of gold sols, by reducing dilute solutions of gold chloride ($HAuCl_4$) by formaldehyde. The particle sizes are 10-40 $\mu\mu$ as mentioned by him. The sol was always kept in an atmosphere of hydrogen and never allowed to come in contact with the atmosphere. It was coagulated, washed, and dried in a high vacuum desiccator. From a large quantity of the sol about 20 mgm. were obtained as precipitate.

Its susceptibility was then determined in a high sensitivity Curie balance, the substance being sealed in a thin capsule and a correction being applied for the susceptibility of the latter. The specific susceptibility, χ, obtained was $0{\cdot}0804 \times 10^{-6}$, the value for gold in the massive state being $0{\cdot}15 \times 10^{-6}$ (I.C.T.).

As Gerlach has explained[4] the phenomena observed by Honda[5] on the decrease of diamagnetic susceptibility of copper and silver on cold working as due to the small percentages of the amorphous substance dispersed in the main body of the elements, it is possible that in a sol a very small percentage is in an amorphous state. An alternative suggestion is that a small percentage is in a crystalline structure different from cubical (copper, silver, and gold are cubical in structure), as the sols of gold and silver are known to exhibit magnetic double refraction. The well-known X-ray spectrograms of colloidal gold and that of crystals by Debye and Scherrer, however, show that both give similar line spectra, but in the former case the lines are more diffuse. While more work is necessary to decide completely between these explanations, it is certain that diamagnetism in gold and possibly also in many other substances depends on crystalline and block structure.

V. I. VAIDHIANATHAN.
BALWANT SINGH.

Dept. of Physics, F.C. College,
Lahore, June 29.

[1] Sir C. V. Raman, NATURE, **123**, 945; 1929. V. I. Vaidhianathan, NATURE, **124**, 762; 1929, and **125**, 672; 1930.

[2] *Ind. Jour. Phys.* **5**, 559; 1930.

[3] *Ind. Chem. Soc. Jour.* **7**, 975; 1930.

[4] NATURE, **127**, 556; 1931.

[5] NATURE, **126**, 990; 1930.

Structure of the Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium.

UNTIL recently very little was known about the structure of these trifluorides.[1,2] An examination by the powder method was made of aluminium and iron trifluorides, forming a part of an investigation on the structure of the trihalogen salts of aluminium, iron, and chromium. The diagrams so obtained proved that the trifluorides mentioned in the title are all isomorphous, as was already known of the four latter compounds.

The hexagonal elementary cell contains three molecules:

AlF_3 : $a = 4{\cdot}93$ A., $c = 6{\cdot}25$ A., $c/a = 1{\cdot}265$
FeF_3 : $a = 5{\cdot}20$ A., $c = 6{\cdot}66$ A., $c/a = 1{\cdot}28$ [2]
CoF_3 : $a = 5{\cdot}06$ A., $c = 6{\cdot}63$ A., $c/a = 1{\cdot}31$ [2]
RhF_3 : $a = 4{\cdot}88$ A., $c = 6{\cdot}81$ A., $c/a = 1{\cdot}39$ [2]
PdF_3 : $a = 5{\cdot}05$ A., $c = 7{\cdot}08$ A., $c/a = 1{\cdot}40$ [2]

Contrary to Ebert,[2] I found that these structures are not purely rhombohedral, for with chromium *Kα* rays it was possible to discern undoubtedly 200 near 003 (111 rhombohedral). The space group proved to be D_3^1 with metal on

one onefold position : 000, and on
one twofold position : $\frac{1}{3}\,\frac{2}{3}\,u_1$; $\frac{2}{3}\,\frac{1}{3}\,\bar{u}_1$; with $u_1 = \frac{2}{3}$.

The fluorine ions on :

(1) one threefold position :

$$u_2\,u_2\,\tfrac{1}{2} \;;\; 0\,\bar{u}_2\,\tfrac{1}{2} \;;\; \bar{u}_2\,0\,\tfrac{1}{2} \;;\; \text{with } u_2 = \tfrac{2}{3},$$

(2) one sixfold position :

$$xyz \;;\; y - x,\ \bar{x},\ z \;;\; \bar{y},\ x - y,\ z \;;$$
$$yx\bar{z} \;;\; \bar{x},\ y - x,\ \bar{z} \;;\; x - y,\ \bar{y},\ \bar{z},$$

with $x = \frac{1}{6}$, $y = \frac{5}{6}$. $z = \frac{1}{6}$.

These five parameters will differ very little from the above rational values. The intensities calculated with these parameters are in good agreement with those observed.

In the case of aluminium trifluoride, u_1 is perhaps 0·70 rather than $\frac{2}{3}$.

The structure consists of alternating planes of metal and fluorine ions, the latter being close-packed around the first.

The distance between two fluorine ions is somewhat smaller than that calculated with a radius of 1·33 A., namely: $AlF_3 = 2{\cdot}46$ A., $FeF_3 = 2{\cdot}60$ A., $CoF_3 = 2{\cdot}53$ A., $RhF_3 = 2{\cdot}44$ A., $PdF_3 = 2{\cdot}52$ A. This is in remarkable agreement with the observation in some trifluorides of the rare earths by Oftedahl,[3] who found 2·47 A. in lanthanum trifluoride.

The metal ions are arranged on a nearly cubic rhombohedron, the fluorine ions (2) are on the middle of the six polar edges; only the fluorine ions (1) are not on the middle of the other edges.

A full report will be given in the *Z. für Kristallographie*. A communication on the various structure types for compounds of the type MF_3 will also follow. I am indebted to Dr. H. J. Verweel for a part of the experimental work.

J. A. A. KETELAAR.

Laboratory for General and
Inorganic Chemistry,
University of Amsterdam,
July 14.

[1] A. Ferrari and A. Schurillo, *Gazz. Chim.*, **59**, 927; 1929.

[2] F. Ebert, *Z. Anorg Chem.*, **196**, 395; 1931.

[3] I. Oftedahl, *Zeit. Phys. Chem.*, B, **5**, 272; 1929.

Effects of Inadequate Feeding on Insect Metamorphosis.

SOME years ago H. S. Pruthi pointed out[1,2] that moulting in insects is not the result of growth, but is "primarily concerned with metabolism". He found that intermittent starvation of the larvæ of *Tenebrio molitor* extended the duration of the larval period and increased the number of moults, the size and weight before pupation of the older larvæ being the same as in the younger ones. Partially starved larvæ of *Pieris brassicæ* also showed an increased number of moults, the size and weight before pupation being the same as in normally fed caterpillars used for control experiments. Pruthi therefore concluded that if "moulting is simply to allow growth, there is absolutely no necessity for extra moults", and expressed the opinion, based on observations detailed in his paper,[1] that if larvæ are starved before the commencement of the metamorphic processes pupation is delayed, while if they are starved after maturity pupation is accelerated. On the other hand, as he himself shows, several workers contradict the theory that inadequate feeding, quantitatively or qualitatively, delays metamorphosis.

My own limited experience supports those who take this view. In the case of *Orgyia turbata* Butler (Corbett and Dover[3]), on which observations were made by the Government Entomologist, F.M.S. and S.S., and his staff, it was found that a heavy mortality occurred among caterpillars fed on *Crotolaria* (a plant to which they were not accustomed), but that those which survived completed the larval period sooner and with less moults than those fed on *Mimosa*, the favourite food-plant of the earlier instars. It seems, therefore, that diminished metabolic activity, consequent on an unpalatable food-supply, accelerates the completion of the larval period, probably because there is a lesser accumulation of waste nitrogenous and carbonaceous matter, the elimination of which, as suggested by Eisig and Sharp[4], is assisted by ecdyses. Moreover, "a quick life-cycle would increase the possibility of the larvæ surviving the disadvantages occasioned by unhealthy food". These opinions are of interest, not only because they partially contradict the views of Pruthi and others (while supporting the fundamental hypothesis that moulting is more intimately connected with general metabolism rather than with growth), but also because they suggest that "an insect which has once gained a foothold on a plant which is commonly supposed to be unpalatable may be more numerous than on more favoured food-plants", at least during the initial stages of adaptation.

How can the difference between the above observations and those of Pruthi be explained? The answer probably lies in the fact that in all his partial starvation experiments starvation was intermittent, while in the case of *Orgyia turbata* fed on *Crotolaria* the food-supply was apparently unpalatable, and was not partaken of so freely as was *Mimosa*: there was a reduction in the quantity of food taken, but there were no periods of starvation followed by normal feeding. The interpretation of Pruthi's results, therefore, appears to be that a comparatively lengthy period of starvation, followed by an equal period of normal feeding, disturbed the metabolic rhythm to the extent of retarding growth. The increased number of moults observed in his intermittently starved larvæ can be explained by Eisig and Sharp's theory, for the nature of the feeding permitted to them must have resulted in an excessive accumulation of waste products which ecdyses helped to eliminate. If these explanations are accepted, it will be seen that Pruthi's results are brought more into line with the proposition that, in many cases, an unpalatable and reduced food-supply accelerates the completion of the larval period. The problem is, however, a controversial one, and is of both biologic and economic interest. Further investigations should therefore be of value.

CEDRIC DOVER.

[1] Pruthi, *Brit. Jour. Exp. Biol.*, 8, 1; 1925

[2] Pruthi, NATURE, Dec. 26; 1925.

[3] Corbett and Dover, *Malayan Agric. Journ.*, 15, 7; 1927.

[4] Sharp, "Camb. Nat. Hist.", Insects, 1, p. 163; 1901.

Excitation of the Green Auroral Line.

THIS note will be of special interest when compared with my paper on the light of the night sky, published in a recent number of the *Physical Review*, and with my report before the Pasadena meeting of the American Physical Society, in which I reported the first effectively complete reproduction of the aurora spectrum. On many of the spectra which were photographed during the progress of the above-mentioned experiments, it was thought that there were definite, though weak, indications of the presence of the green auroral line. The failure of the green line to appear with considerable intensity in these experiments was never considered to be serious, since there was ample evidence for the occurrence of collisions between excited nitrogen molecules and metastable oxygen atoms in the states which are involved in the emission of the green line. Since the state on which the green line originates is metastable, it is not at all surprising that the line was either absent or missing in these experiments.

In my most recent experiments, on raising the pressure from 10^{-3} mm. to about 5 mm. by admitting oxygen to the tube in which the auroral spectrum was reproduced at the lower pressure, it was found that, so far as the excitation of oxygen was concerned, the tube behaved very much as it did at the lower pressure. Now at 10^{-3} mm. it was often possible to obtain a large decomposition of oxygen molecules into atoms, without the appearance, however, of the arc spectrum of oxygen. The presence of atoms in great numbers was indicated by the incandescence of small bits of oxide (as in atomic hydrogen) and also by strong heating of small patches of the tube wall. Now the production of oxygen atoms, under conditions where no arc lines (other than the green line) are produced, arises both in the aurora and in the night sky. Because of the marked resemblance between the low-pressure tube and the high-pressure tube, a photograph was taken of the spectrum of the high-pressure tube and a fairly strong excitation of the green line was observed. Other plates showed that when the arc lines of oxygen increased in intensity the green line decreased in intensity, which indicates that the process by which the green line is excited in these experiments is one which does not excite the arc spectrum. Such a process is discussed in some detail in my paper on the light of the night sky.

It is believed that the process of excitation of the green lines is the same in both the high-pressure and the low-pressure tubes, but that at high pressures the green line is emitted because collisions with the wall or with nitrogen molecules are less probable in view of the diluting effect of the added oxygen. It is also possible that the lifetime of the metastable oxygen atom which emits the green line is less at high pressures than at very low pressures in view of the close proximity of excited atoms and molecules.

It is important to note that the green line was excited in the present experiments without the use of rare gases. Practically all other laboratory reproductions of the green line have been made with the help of rare gases. Fuller discussion of the present work will show that the present excitation of the green line and the rest of the auroral spectrum is probably the one that occurs in Nature, and furthermore, it is a phenomenon in which only oxygen and nitrogen are involved. For that reason the present experiments should have a direct bearing on the problem of the origin of auroral displays.

JOSEPH KAPLAN.

University of California at Los Angeles,
July 18.

The Slow Combustion of Methane and Ethane.

THE observations referred to by Prof. W. A. Bone in NATURE of Aug. 1 (p. 188) with regard to the source of alcohols in the combustion products of paraffin hydrocarbons were based on experimental evidence accumulated in Great Britain and other countries from the point of view of the peroxide mechanism of combustion; compare, for example, in the case of methane, the work of Wartenburg and Sieg,[1] who concluded that methane first forms the moloxide $CH_4(O_2)$. It is interesting to note that the earlier supporters of the peroxide theory of oxidation had discovered the presence of alcohols in the oxidation products of hydrocarbons, but it was considered that these alcohols had been derived directly from the peroxides or from the esters[2] and not at all from a primary hydroxylation process.

The particular view that oxygen first enters the –CH group with its labile hydrogen, to form an alkyl hydrogen peroxide, was arrived at in 1926, after a consideration of the results obtained in a research on the slow oxidation of a large number of fuel vapours in air.[3] Attempts to isolate organic peroxides were unsuccessful,[4] but now, after five years, it has been discovered by Dumanois, Mondain-Monval, and Quanquin that alkyl hydrogen peroxides are present, not only in the combustion tube, but also in the petrol engine.[5]

An intensive study of the oxidation of ethane and methane in air with and without the addition of inhibitors, carried out by myself (an account of which has been submitted for publication), has provided further evidence in favour of the Engler-Bach peroxidation theory of combustion. The experiment of endeavouring to isolate the moloxide or the activated methyl hydrogen peroxide from methane has not been attempted, since it is considered that at the temperatures of the experiment, namely, above 600° C., any organic peroxide would have an extremely short life, and if any organic peroxide were isolated, then, as Staudinger points out, it would not be the primary one, but a derivative or degraded form of it. The peroxidation theory of combustion is not essentially based on the isolation and identification of organic peroxides, but rather on the characteristic behaviour of inhibitors and surfaces and on the phenomena of autoxidation and autocatalysis.

It would be interesting to know how Prof. Bone would explain by the hydroxylation theory the autoxidation of benzene vapour to phenol or of aniline vapour to tars at low temperatures, facts recorded in the literature of hydrocarbon combustion.[6]

E. MARDLES.

Imperial College of Science,
S.W.7.

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[1] *Ber.* **53**, 2192; 1920. A short bibliography of the subject of the oxidation of fuel vapours is given in *R. and M.* (Air Ministry), 1374; 1930

[2] Grun, *Ber.*, **53**, 987; 1920: Kelber, *Ber.*, **53**, 1567; 1920.

[3] Callendar and others, *Engineering*, *R and M.* (Air Ministry), 1062; 1926.

[4] Mardles, *J.C.S*, 872; 1928.

[5] *Comptes rendus*, **19**, 158; 1931. *Ann. des Comb. Liquides*, **5**, 915; 1930.

[6] Mardles, *J.C.S.*, 872; 1928. Gill, Mardles, and Tett, *Trans. Far. Soc.*, **24**, 574; 1928. Brunner, *Helvetica Chemica Acta*, **13**, 197; 1930.

Œstrus-Producing Hormones.

RECENTLY, Doisy and his co-workers (1931) have reported the isolation from the urine of pregnancy of a crystalline substance possessing œstrus-producing activity, which is distinct from the active substance theelin, previously described by them. The latter substance, to which they gave the formula $C_{18}H_{21}(OH)_2$, was shortly afterwards isolated by one of us (Butenandt, 1929)[1] and by Dingemanse and co-workers[2] (1930). It was shown afterwards (Butenandt, 1930) that this substance is represented by the formula $C_{18}H_{22}O_2$, and that it behaves either as a hydroxy ketone or as a dihydroxy alcohol.

There is no doubt that the second substance isolated by Doisy and his co-workers,[3] to which they give the formula $C_{18}H_{21}(OH)_3$, is identical with that fully described earlier by one of us (Marrian. 1930)[4]. Although Prof. Doisy refers to the triol previously isolated, there is no suggestion in his papers that it had been characterised as a trihydroxy substance of the formula $C_{18}H_{21}(OH)_3$. His view that the substance described by one of us is a mixture of both active substances is apparently based solely on a difference between the *uncorrected* melting points. The evidence of the analytical data, which clearly shows this supposition to be untenable, is ignored.

A year ago when the presence in urine of two distinct œstrin-producing substances was clear to us, we were considerably puzzled over the relationship between them. The suggestion was tentatively advanced (Marrian, 1930) that the substance $C_{18}H_{22}O_2$ on treatment with hot alkali took up the elements of water to form $C_{18}H_{24}O_3$. This supposition was afterwards shown to be incorrect (Butenandt, 1930), since the former substance proved to be unchanged by such treatment. At the same time it was shown that both substances occur together in urine, and that by distillation in a high vacuum with potassium bisulphate, $C_{18}H_{24}O_3$ could be converted into $C_{18}H_{22}O_2$. Prof. Doisy has made no adequate reference to this work, and has advanced the earlier view, which has been shown to be untenable.

G. F. MARRIAN.
A. BUTENANDT.

London and Göttingen,
July 23.

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[1] Butenandt, *Naturwiss.*, **17**, 879; 1929. *Deutsch. Med. Woch.*, **55**, 2171; 1929 *Zeit. fur physiol. Chem*, **191**, 140; 1930. *Abh. d. Ges. d. Wissensch. zu Gottingen*, 1931 *Math phys.* Kl. iii. Folge, Heft 2.

[2] Dingemanse *et al*, *Deutsch. Med Woch*, **56**, 301, 1930

[3] Doisy *et al.*, *Proc. Soc. Exp Biol. Med.*, **28**, 88; 1930. *J. Biol Chem.*, **91**, 641, 647, 653, 655, 1931.

[4] Marrian, *Chem. and Ind.*, June 20; 1930. *Biochem Jour.*, **24**, 1021; 1930.

Segregation of Floral Characters in the Wild Oxlip.

DR. C. J. BOND[1] finds that in hybrids between the primrose (*Primula vulgaris*) and the cowslip (*Primula veris*) the earliest flowers were formed singly on long peduncles of the primrose type, while the later ones were arranged in the umbelliferous type as in the cowslip. He asks whether these two types of inflorescence are also found in the true oxlip (*Primula elatior*).

I have cultivated this latter plant, originally obtained from Cambridgeshire, for many years, and have never seen any of the plants producing flowers singly on peduncles as in the primrose. They were always produced on a common erect scape. In Switzerland, too, where I found them last May, this was the sole method of flower-bearing. This fact, therefore, would support the more generally held opinion that *Primula elatior* Jacq. is a true species and quite distinct from the hybrid between the primrose and cowslip, from which it differs in other characters also.

In hybrids of my own raising, between the primrose and the true oxlip (*Primula elatior*), I have, however, often noticed the phenomenon described by Dr. Bond for hybrids between primrose and cowslip. I have also seen the two types of flower-bearing in hybrids which I have raised from *Primula elatior* crossed with *Primula Juliae*. In this case also the single pedunculate flowers preceded those borne on a common scape, which was usually comparatively short. It would appear, therefore, that in crossing some species of *Primula*, one of which produces its flowers singly and the other bearing numerous flowers on a common scape, neither type of inflorescence is completely dominant, but that both types may occur in succession. As this condition occurs also in the cultivated form known as Mrs. McGillivray, it would point to this plant being a hybrid, probably with *Primula Juliae* as one of the parents.

F. E. WEISS.

Pittance Farm, near Cranleigh,
Surrey, July 27.

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[1] NATURE, May 9, p. 708.

Research Items.

The Roman Neanderthal Skull.—A description of the Neanderthal skull found at Saccopastore, near Rome, as first announced to the Société romaine d'Anthropologie on June 1, 1929, is given by Prof. Sergio Sergi in *L'Anthropologie*, t. 41, Nos. 3-4. It is one of the best preserved of the Neanderthal skulls, and the condition of the base affords an exceptional opportunity of appreciating its characteristics. The cranial capacity is 1200 c.c., which makes it the smallest known of the Neanderthal skulls. This fact, combined with its refinement in character, suggests that it is the skull of a female, and, judging from the state of the sutures and dentition, it is that of a young woman. The position of the foramen, which is farther forward than in the Chapelle-aux-Saints skull, in which, however, the position may be due to faulty orientation and reconstruction, indicates that the head was carried as erect as in modern man. The cephalic index is approximately 78·4. The horizontal contours of the Saccopastore and La Chapelle skulls, taken in the plane of the lambda, coincide in a surprising manner. The horizontal perimeter is, at the maximum, 520 mm., La Quina being 515 mm. Near the lambda is a complex system of wormian bones, a common phenomenon in Neanderthal skulls. The significance of this feature has hitherto been overlooked; but it points to instability in the occipital region over the inion, which is here in course of evolution. In norma lateralis the whole peribregmatic region shows flattening, the frontal inclination (74°) and occipital (70·5°) being comparable to that of the Gibraltar skull. In a posterior segment the skull shows a certain degree of roundness, contrasting with the bun-like projection of the occiput in La Chapelle and La Quina. The face and its features are very large. In its general dimensions and its morphology the skull is nearest to the Gibraltar skull. The associated fauna point to a dating at the Riss-Würm Interglacial.

Milk Diets for Rats.—We have received the first number of the fourth volume of *The Journal of Nutrition* (Messrs. Baillière, Tindall, and Cox). This journal, which is produced in the United States, was started in 1929, and has established itself as a scientific periodical dealing with many different aspects of the nutrition of animals and human beings. Among the original contributions are papers by J. Waddell, H. Steenbock, and E. B. Hart on the effects of milk diets on rats. On whole cow's milk supplemented with copper the animals suffered from anæmia, and growth and reproduction were subnormal although third-generation animals were secured. When iron was also added to the diet, no anæmia occurred, but growth and reproduction were still subnormal. The females matured late and the reproductive cycles were prolonged. Small amounts of manganese or iron improved the ovulation rhythm. No evidence of lack of vitamin E was observed. The males suffered from testicular degeneration, which also was not due to deficiency of vitamin E. It was also found that addition of iron to an ordinary stock ration prevented the animals from utilising the vitamin E in the diet or possibly destroyed its vitamin E content. D. L. Hussemann and R. A. Hetler found that vitamin B_2 is probably more essential for successful lactation in the rat than vitamin B_1, although both are required.

Incubation of the Mexican Jacana.—The share taken by the respective parents in the incubation of the eggs of shore-birds still requires much investigation. Alden H. Miller contributes new facts concerning the breeding activities of the Mexican jacana (*Jacana spinosa*) observed at Lake Olomega, Central America (*Condor*, vol. 33, p. 32; 1931). Scrutiny of the marsh at a distance of 50-75 yards revealed the presence of nests, which were betrayed when the adult birds quietly ran or sneaked away. In every case it was the male bird which was flushed from the nest, and although in some instances the females were near by, they were little disturbed by an intruder at the nest, in contradistinction to the males. It is the author's impression that females were more often seen about nests containing fresh or slightly incubated eggs than about eggs heavily incubated or where there were young. He decides that the male jacana performs most if not all of the incubation, and that it also cares for the young. Females take relatively little interest in eggs and young, although they are decidedly active in courtship. Another interesting observation was that the demonstrations indulged in by the incubating birds were much less frantic than the demonstrations of birds accompanied by young, and that 'broken wing' antics were seen only in cases where the eggs were hatching or where young were following the male parent.

Nitrogenous Excretion in Invertebrates.—Prof. H. Delaunay contributes to *Biological Reviews* (Camb. Phil. Soc., vol. 6, July 1931) a useful summary of recent work on excretion in invertebrates. He directs attention to the three main types of excretory organs —(*a*) those which open to the exterior, for example, nephridia, malpighian tubes of insects; (*b*) those in which excretory substance accumulates, for example, the branchial heart of cephalopods; (*c*) the atrocytic organs or cells which shed into the fluid in some cavity the solid or liquid which they produce, for example, the chloragogen cells of oligochætes, the pericardial cells of insects. An account follows of recent observations on excretion, beginning with the Protozoa. In *Paramecium* and *Spirostomum* nitrogen is excreted as urea, but in *Didinium* in ammoniacal form. In *Spirostomum*, the fluid withdrawn by means of a micropipette from the contractile vacuoles contains so small an amount of urea that it would appear that these vacuoles serve simply to expel the excess of water from the cytoplasm, and that the nitrogenous waste passes out by osmosis from the entire surface of the organism. In leeches, ammoniacal nitrogen forms the major part of the excretion, and this appears to be true also for earthworms. The absence of uric acid in the concretions and extracts of nephridia appears to be general (but Willem has stated that in the concretions in the excretory organs of *Arenicola* urate of sodium is present). On the contrary, uric acid preponderates in the excretory material of insects. The author reviews the conditions in cœlenterates, sponges, echinoderms, molluscs, crustacea, insects, and araneids, and then passes to a comparative study of the different nitrogenous excretory products.

Methylene Blue Stain for Yeast Cells.—The hitherto unsuspected factors producing anomalous results in the staining of yeast cells with methylene blue have already been indicated in Nature (**126**, 491; 1930), and the necessity for revision of the technique is further demonstrated by the work of Fink and Weinfurtner, recorded in the *Wochenschrift für Brauerei* (48, 159; 1931). Portions of a 0·4 per cent suspension in distilled water of fresh pressed yeast were added to five times the volume of solutions of certain sugars. It was shown by plate-culture experiments that, after 30 minutes, most of the cells were still alive, although the methylene blue test indicated that only 10 per cent had survived compared with 95 per cent in a blank experiment. It is clear that in order to take the stain so readily the permeability of the walls of the yeast cell must have undergone a considerable increase in excess of that which normally occurs when yeast is suspended in distilled water. This increase is attributed to the sugar used, cane sugar, dextrose, lævulose, and galactose being approximately equal in effect, whilst maltose produces a smaller increase in permeability. The increase seems to be related to the fact that the sugars are non-electrolytes, since addition of potassium chloride in 0·1 *N* strength inhibited it completely: that is, the original impermeability of the walls was restored, the living cells being less susceptible to the stain than the dead cells. Revision of technique, therefore, will have to allow not only for the *p*H value of the medium, but also for the fact that in the absence of electrolytes and in the presence of sugars methylene blue will readily enter the cell and afterwards inhibit its growth.

Germination of Damaged Seeds.—How much a seed can be damaged without seriously affecting the resulting plant has been a matter of controversy since the inception of seed testing, and the question has been recently investigated by the British Association of Commercial Seed Analysts. New seed of species of *Brassica* may be damaged in a variety of ways; the testa may be lost or cracked, or the seed may be partially sprouted or attacked by weevils, and yet show a germination of seventy-five to a hundred per cent. Yearling seed, however, gave less satisfactory results. In the case of timothy, although badly damaged seed was of little value, that which was only slightly eaten showed a fifty-six per cent germination, and it seems possible that a satisfactory line of demarcation may be drawn between good and useless seed. As regards leguminous seeds, lucerne is the least susceptible to damage, more than eighty per cent germination being recorded, except in those cases where fracture had occurred at the junction of the cotyledons and radicle. Trefoil, alsike, and white clover, with seeds damaged in a similar manner, gave distinctly lower germination. The most striking results, however, were obtained with maple peas, even severely damaged seeds giving a seventy-eight per cent germination, of which fifty-six yielded mature plants. Soil tests carried out with new swede seeds, the testas of which were either entirely or partially missing, showed even up to ninety-seven per cent germination, failure only occurring where injury to the radicle was excessive. It would seem, therefore, that some revision in the use of the term 'impurities' in the case of such seeds is necessary.

Granites of Eastern Australia.—A valuable summary of the ages, distribution, and petrological characters of the granites of eastern Australia has been published by Prof. E. W. Skeats in the *Proc. Roy. Soc. Victoria*, 43, 1931, pp. 101-118. Pre-Cambrian granites appear to be limited to the western part of the area, thus lending support to the hypothesis that the growth of Australia has been, on the whole, from west to east. Cambrian intrusions are found in west Tasmania and central Victoria; those of the Lower Devonian are widespread from Tasmania to south New South Wales; those of the Upper Devonian range from Victoria to central New South Wales; Lower Carboniferous granites occur in Victoria and Queensland; and Permo-Carboniferous and Triassic (or post-Triassic) examples are found in north New South Wales and Queensland. The loci of granitic intrusion thus seem to have migrated northwards during the periods mentioned. Judged by the association of *lit-par-lit* intrusions with fluxion gneisses and highly folded and metamorphosed sediments, there were only two important periods of mountain-building, the first in the Pre-Cambrian and the second at a time doubtfully referred to the Lower Devonian. Most of the remaining granites are thought to have been intruded under conditions of tension.

Air Pollution at Pittsburgh.—A paper, from the *Pittsburgh Record* June–July 1931, by H. B. Meller, head of the Air Pollution Investigation of the Mellon Institute of Industrial Research, gives the results of a year's study of 'sootfall' in Pittsburgh, 1929–30, and comparisons with previous studies, 1912–13 and 1923–24. Within the period, Pittsburgh had increased its population from 534,000 in 1910 to 680,000 in 1930, with some 20 per cent increase of area. 'Sootfall' represents the deposit caught in 'containers' exposed in different parts of the city, eighteen in 1930, eleven on the previous occasions. They were changed monthly, and, in the last study, an additional set daily. The catch for the year ranged from 2319 tons per square mile at Woods Run to 553 at Mt. Washington. If the catchment is on the same lines as in the corresponding study in Great Britain, Mt. Washington would be rated as a *C* station and Woods Run as a treble *D*. The scheme of analysis is, however, not quite identical. In Pittsburgh deposits are classified into: combustible 36 per cent, ash 47, and iron oxide 17. British records count insoluble (tar, carbon or soot, and ash) 60 to 40 per cent and soluble (loss on ignition and ash) 40 to 60 per cent according to site, in town or country, and no special account is taken of iron oxide. Tar counts in Great Britain at about 1 per cent; at Pittsburgh 1·3 per cent at a railroad signal bridge and 5·1 per cent at a car-parking garage. In the conclusions, the triple problem is summarised as the elimination of smoke, dust, and sulphur; for the first two the solution is in sight, for the last "there is now no satisfactory process".

An Application of Thyratrons.—It is often necessary in radioactive work to count voltage pulses, such as those which are produced by amplifying the disturbances produced by single α-particles. Several circuits involving thyratrons which can be used for this purpose are described by Dr. Wynn-Williams in the July number of the *Proceedings of the Royal Society*. The thryatron is a grid-controlled arc tube, and has the property that a heavy anode current cannot flow so long as there are not merely thin positive ion sheaths on the grid wires. Essentially it is an inertialess relay system, with the relay action for starting controlled by the potential of the grid. Other means, such as interruption of the anode current mechanically, have to be employed to extinguish the arc current, and in earlier devices for counting with thyratrons, the speed of counting had been limited by the inertia of the extinguishing device. This difficulty is largely obviated on the circuits described in the present paper by using a number of thyratrons, so disposed that the lighting of the arc in one automatically puts another into a condition in which it is sensitive, and so gives the first a longer time to be reset by the mechanical quenching device without the recording system as a whole failing to record some of the pulses, if they follow one another rapidly. It has been found possible to record impulses separated by so little as 1/500 sec., and a system has been described, but not tested, in which the 'dial' recording numerically the total number of pulses is itself a system of thyratrons, containing no mechanical parts whatever.

Nitrogen Contents of Barley and its Wort.—The difficult task of summarising and interpreting the unfinished experiments of the late Prof. Schryver and of correlating the results of subsequent workers, including himself, has been ably accomplished by L. R. Bishop in a recent paper in the *Journal of the Institute of Brewing* (**37**, 345; 1931). The accumulated data provide some interesting generalisations. In particular, the soluble nitrogen compounds of a wort produced by mashing an English malt account for from 30 to 40 per cent of the total nitrogen present in the original dry barley, fluctuations in this proportion corresponding with variations in the conditions of malting and mashing. The temperature of mashing is of particular importance, and the methods recently devised for the determination of the various forms in which nitrogen may occur have enabled a distinction to be drawn between ammonia-, amide-, and amino-nitrogen, which remain almost constant in amount, and peptide-nitrogen, which is produced in maximum quantities by mashing at 50° C. It is interesting to note that the results confirm and amplify those obtained by H. T. Brown in 1909 in connexion with the relation of mashing-temperature and total permanently-soluble wort nitrogen. The wort carbohydrates also were shown to follow similar regular variations, the 'apparent maltose' giving a sharp maximum at 60° C., and dextrins and other constituents a less marked maximum at 70° C. These conclusions have a practical as well as a theoretical interest, since it is hoped that investigations at present in hand will show exactly which types of nitrogen compound best fulfil the feeding requirements of the yeast. When this link is supplied, a big step will have been taken towards deciding the optimum nitrogen content of the barley and predicting the best malting and mashing conditions.

Astronomical Topics.

New Bright Comet, 1931 *c*.—Mr. P. M. Ryves, who is a fellow of the Royal Astronomical Society and a member of the British Astronomical Association, residing at Zaragoza, Spain, telegraphed to the U.A.I. Bureau at Copenhagen that he had discovered a comet of magnitude 5·5 approaching the sun. The following positions of Aug. 10 and 12 (which are probably only approximate) were obtained by him; that of Aug. 14 was obtained by Prof. G. van Biesbroeck at Yerkes Observatory, after receiving the announcement of the discovery:

	U T	R A. 1931 0	N. Decl. 1931·0	Mag.
Aug.	$10^d\ 3^h\ 30^m$	$7^h\ 43^m\ 0^s$	23° 48′ 0″	—
,,	12 4 0	7 52 0	23 19 0	5·5
,,	14 9 29·1	8 4 32·53	22 45 46	4.0

The comet is visible in the morning twilight; an attempt was made to deduce an orbit from the above material, but the first two positions are probably not sufficiently exact for the purpose. The perihelion distance is likely to be small, and the comet may become visible in daylight, like the great comet of 1882 and Skjellerup's comet of 1927. Comets near the sun are difficult to observe, since the sky is too bright to see comparison stars. Positions obtained by reading the circles of equatorials are better than nothing.

Comets.—*Harvard Card*, No. 159, contains a suggestion from Mr. L. E. Cunningham that the comet recently detected by Herr Reinmuth on plates exposed on Mar. 4 and 5, 1902, is probably identical with comet 1925 II (Schwassmann-Wachmann 1). This is the remarkable comet the orbit of which lies wholly between those of Jupiter and Saturn. The daily motion accords exactly, while there is a discordance of 11^m in R.A., 1½° in Decl. These discordances are not unduly large, considering that the elements used were not definitive, and that the motion has been carried back twenty-five years, without applying perturbations. The comet would have been near aphelion in 1902, and as Reinmuth gave the magnitude as 12·0 it must then have been passing through one of its bright outbursts, of which two have been observed in the last two years. If the identity is confirmed, the early observation will be of great use in improving the elements of the comet.

Prof. M. Kamienski (assisted by E. Rybka) continues in *Pub. Warsaw Observatory*, vol. 6, his exhaustive researches on the motion of comet Wolf I. He deals here with the apparition of 1918–19. The observations are numerous and extend from July 11, 1918, to April 1, 1919. The comet was unexpectedly bright, reaching mag. 9½ in November. The observations agree very closely with his previous calculation for the first five months, then the observed R.A. falls behind the calculated one, the amount reaching 19″ in the final group. Prof. Kamienski hopes to remove these discordances by a recalculation of the planetary perturbations from 1884 to 1919.

Stellar Rotation.—Dr. E. A. Kreiken contributes a paper on this subject to the May number of *Mon. Not. Roy. Ast. Soc.* The stars discussed are mainly eclipsing variables and spectroscopic binaries. There are strong reasons for believing that in these close pairs tidal action makes the periods of rotation and revolution equal to each other. Theoretical reasons lead Dr. Kreiken to the formula:

$$\log \text{period} = 1{\cdot}5 \log \text{diameter} - 0{\cdot}5 \log \text{mass} + \text{constant}.$$

This formula differs in one point only from a formula derived empirically by Elvey (*Astro. Jour.*, **71**, 4; 1930). Elvey omitted the term depending on mass. The constant term is evaluated from stars of different classes; the value −0·28 is found from eclipsing variables, −0·04 from spectroscopic binaries with small eccentricity. It gradually rises as the eccentricity increases, and reaches +1·58 for spectroscopic binaries with eccentricity greater than 0 60. This accords well with theory, since period and eccentricity are presumed to increase as the stars grow older.

Dr. Kreiken has not yet used rotation periods derived from the contours of spectral lines: but he hopes to discuss them in the future. He tests his formula on the rotations in the planetary system, but some of his conclusions seem untrustworthy. He assumes that tidal friction in the solar system is inappreciable, and takes the rotation periods of Mercury and Venus as only a few hours. But observations of surface markings make it nearly certain that Mercury rotates in the same time as its revolution, 88 days; while spectroscopic observations make it highly probable that the rotation period of Venus is at least several days. Moreover, following some conclusions of Jeans about the sun's interior, Kreiken takes its rotation period as one sixtieth of 26 days. It does not seem fair to do this for the sun, as the values for the stars presumably are those of their surfaces.

The Significance of the Relationship between Corals and Zooxanthellæ.

By Dr. C. M. YONGE, Marine Biological Laboratory, Plymouth.

BOTH by the publication of his book, "Coral Reefs and Atolls", and by a recent contribution to NATURE,[1] Prof. J. Stanley Gardiner has materially added to the debt which all interested in problems of corals and of coral reefs already owe him. As a result, however, of work on the physiology of corals carried out during the course of the Great Barrier Reef Expedition, I am unable entirely to agree with Prof. Gardiner's conclusions in one important matter. He suggests that corals obtain supplies of carbohydrate from their contained zooxanthellæ, and also that the oxygen produced by the latter as a result of photosynthetic activity is of *vital* importance to the animals. My own conclusions as to the significance of the relationship between corals and zooxanthellæ are somewhat different, and, since this work—the result of the combined labours of Mrs. Yonge, Mr. A. G. Nicholls, and myself—is now largely completed, I am able to put them forward with confidence and no longer tentatively as in previous contributions to NATURE.[2, 3, 4] Moreover, it has proved necessary to publish this work in a series of six large reports,[5, 6, 7, 8, 9, 10] and a short summary of the results obtained is, therefore, not without some justification.

The zooxanthellæ of the Madreporaria are yellowish brown spherical bodies varying in diameter from 6μ to 14μ. Each contains a granular nucleus, one, and occasionally two, pyrenoids around which an amyloid assimilation product accumulates, and vacuolated cytoplasm which contains many oil droplets. The whole is bounded by a stout cellulose wall. They increase rapidly by division into two, but there is no evidence of the formation of spores, nor were they ever found in centrifuged water samples, while all attempts at culturing them outside the body of the animal failed. Unlike the green *Chlamydomonas* present in *Convoluta roscoffensis*, which, as shown by Keeble and Gamble,[11] occur free in the sea and form spores, the zooxanthellæ can live only within the tissues of the coral and are transmitted direct from parent to offspring by way of the planulæ. They are thus definitely degenerate. Within the tissues they occur only in the endoderm, most plentifully in the superficial regions. They are invariably contained within tissue cells, very frequently in wandering cells which convey them from place to place, and their absence from the ectoderm and mesoglœa may be due to the mechanical difficulties of transporting such relatively large objects through the dense material of the mesoglœa.

Although zooxanthellæ never occur in the ectodermal glandular margin of the mesenterial filaments, they may, especially under certain conditions, be very numerous in the 'absorptive' region which lies at the base of this. Degenerating zooxanthellæ are always most abundant in this region, although they may occur anywhere in the endoderm, but always in small numbers in a healthy coral. Boschma[12, 13, 14] has based his views, that zooxanthellæ are digested by corals, on the presence of these degenerating algæ in the 'absorptive' zone, but clear evidence was obtained that this region, as well as being the sole absorptive area, is also the only site of excretion. It is thus the only region of the coral where interchange between the interior of the tissues and the exterior takes place. Degenerating zooxanthellæ present are in process of *excretion* and not digestion.

The pyrenoid of the zooxanthellæ contains chlorophyll which, in the presence of light, forms the amyloid assimilation product (not apparently true starch), utilising carbon dioxide and producing oxygen. Experiments with corals in sealed jars showed that the hydrogen-ion concentration of the water rises appreciably after nine hours in darkness, owing to the accumulation of carbon dioxide, whereas in the light the hydrogen-ion concentration remains constant, because the carbon dioxide is utilised by the zooxanthellæ. In *Dendrophyllia*, a deep-water coral which has extended its vertical range and is not uncommon on the surface of reefs, there is a similar rise in hydrogen-ion concentration in both light and darkness. In common with all deep and cold water corals, *Dendrophyllia* possesses no zooxanthellæ. The carbohydrate formed as a result of photosynthesis is in part converted into oil and stored in that form, as in diatoms and other algæ. Protein synthesis, which involves the utilisation of nitrogen and also of phosphorus and sulphur, was followed by estimations of the phosphorus exchange between corals and the surrounding water. Whereas *Dendrophyllia* excretes large quantities of phosphorus in the same way as any other animal, the reef-building corals which contain zooxanthellæ do not. On the contrary, they frequently remove phosphorus from the surrounding water, even when this has been greatly increased by the addition of phosphate. The zooxanthellæ are thus capable of utilising much more phosphorus than is normally produced by the katabolic processes of the corals in which they live. The same is probably true of nitrogen and possibly of sulphur.

The abundance of zooxanthellæ is thus dependent upon two factors, light and the presence of nutrient substances, carbon dioxide, nitrogen, phosphorus, and sulphur, the latter in turn depending on the metabolic state of the coral. It proved possible to demonstrate experimentally the effect of these limiting factors. In the case of light, comparison between reef-building corals from the surface of the reef and from depths of 7 or 9 fathoms revealed that the former had approximately double the population of zooxanthellæ, while individual colonies from the reef surface which had grown on the under-side of boulders in the absence of light were found practically devoid of zooxanthellæ. The results of an experiment whereby corals were kept in a light-tight box in the sea for 152 days showed that the animals could survive this treatment without obvious harm, but that practically all the zooxanthellæ had died and been extruded at the end of this period. In all cases they were ejected by way of the 'absorptive' zone. Reef-building corals deprived of zooxanthellæ in this way excreted large quantities of phosphate of about the same order of magnitude as *Dendrophyllia*. Sections of such corals revealed that, in place of the zooxanthellæ, there were great numbers of wandering cells with granular contents, and it would therefore appear that these cells normally contain zooxanthellæ, but in the absence of these they resume their original function of excretion. Such wandering cells are a constant and conspicuous feature in the histology of corals, such as *Dendrophyllia* and *Balanophyllia*, which never contain zooxanthellæ.

The metabolic activities of corals were lowered in three ways: by starvation, by heating, and by deprivation of oxygen. In the case of starvation, a series of experiments were set up in which corals were starved (in filtered sea water) and fed (with freshly caught zooplankton) under parallel conditions. In all cases it was found that starved Madreporaria quickly show a great reduction in the bulk of their tissues, and that this is shown equally whether zooxanthellæ are present or not. Almost immediately after starvation begins, zooxanthellæ are expelled in large numbers—some, but by no means all, dead, and practically all intact—and this continues until almost all are extruded. There is no evidence whatever of any digestion of the zooxanthellæ by the corals, or of any transference of material, such as the fat which Keeble and Gamble showed was passed from the *Chlamydomonas* to the *Convoluta*, from the plants to the animal. *Chlamydomonas*, however, possesses *no* cellulose wall. It was conclusively proved that Madreporaria obtain no nourishment whatever from their contained zooxanthellæ, and also that the latter are not even necessary for the initial development and early growth of the newly settled larvæ.

Precisely the same results, so far as the zooxanthellæ are concerned, were obtained when corals were heated to 36° C. for two hours or placed for some days in water almost devoid of oxygen. As in the starved animals, the zooxanthellæ were ejected in great numbers by way of the 'absorptive' zone of the mesenterial filaments, and then passed out through the mouth in mucus strings. The same process was observed in Nature during the summer months when corals on the reef surface were subjected to temperatures of above 35° C. over low-water in the day time, and as a result were almost completely denuded of zooxanthellæ, which gradually multiplied again until, at the end of about three months, the usual content of zooxanthellæ was regained. Here again the extruded zooxanthellæ were intact and apparently alive and healthy when extruded.

In every case, as a result of starvation, heating, or deprivation of oxygen, the metabolic activities of the coral were reduced, and, as a result, the amount of nitrogen, phosphorus, sulphur, and carbon dioxide produced by them was greatly reduced. This lack of the necessary inorganic food materials of the zooxanthellæ is clearly the cause of their expulsion, which is effected by the wandering cells which convey them to the 'absorptive' zone where they are expelled. It is difficult to explain what impels the wandering cells to do this, but it may possibly be the abnormal raising of the hydrogen-ion concentration in the tissues. There is certainly, however, a mechanism here whereby the population of zooxanthellæ is maintained at the level which the metabolic state of the coral, that is the amount of available food, permits. When the population falls below this level, it quickly reaches the maximum possible, owing to the very rapid multiplication of the zooxanthellæ.

Unlike the zooxanthellæ, which are apparently unable to live apart from the animals and are definitely degenerate in so far as they have lost the power to form spores, the reef-building corals can, and, where light is absent, invariably do, live without zooxanthellæ, like all deep and cold water corals. To an individual coral colony the association with zooxanthellæ is *not* essential. Nevertheless, the vast majority of reef-building corals and practically all the Cœlenterata on the reefs possess them, and there can be no doubt that they play an important, probably a vital, rôle in the economy of marine life on a coral reef. This work on the physiology of corals has indicated what the significance of the association may be.

Before proceeding to this, however, the question of oxygen production by the zooxanthellæ must first be discussed. In the presence of light, the zooxanthellæ, as a result of photosynthetic activity, produce oxygen. Exact determinations showed that whereas the oxygen content of enclosed volumes of sea-water in which corals were kept for nine hours in the light might be doubled or even trebled, in the dark it fell to one half, or much less, during a similar period. Corals could be kept in an enclosed volume of water for several week without suffering from lack of oxygen, owing to th presence of this closed system. A series of experiments, carried out over twenty-seven hours continuously, showed that only over the middle of th day, between the hours of 10 A.M. and 3 P.M. approximately, does oxygen production by the zooxanthella exceed oxygen consumption by the coral and th zooxanthellæ. Over twenty-four hours there wa always a drop in oxygen content, showing that th production of oxygen by the zooxanthellæ canno completely supply the wants of the coral. Mr. A. P Orr found that the oxygen tension in pools on the ree surface at low tide at night fell as low as 17·8 per cen saturation, whereas under similar conditions by da it might rise as high as 230·4 per cent. As soon a the sea covered the reef, however, normal condition again prevailed.

In spite of these facts, the benefit derived by th corals from this supply of oxygen is almost certainl more apparent than real. It was found that coral can survive exposure to water of less than 10 per cen oxygen saturation for several days, and that they ca respire equally well in water less than 50 per cen saturated as in water fully saturated with oxygen Under normal conditions, except in sheltered lagoon and other regions where coral growth is slight, the would never be exposed to such conditions; for wate movements around the exposed areas of reefs wher coral growth is invariably most prolific are alway great, and the constant mixing of the water ensure a continuous supply of oxygen. Finally, were th zooxanthellæ absent, the great quantities of nutrien salts excreted by the corals and other Cœlenterat which contain zooxanthellæ would permit of a muc greater growth of phytoplankton, with a consequen increase of oxygen in the water. The zooxanthella are really imprisoned phytoplankton which produc oxgyen within the corals instead of in the sea-wate There is no satisfactory experimental evidence indicating that the oxygen produced by the zooxanthella within the corals is essential to these animals or tha they would not flourish equally well in its absence.

An examination of the feeding mechanisms of mor than forty genera of Madreporaria revealed that coral are carnivores with highly specialised feeding mechanisms for dealing with zooplankton of all sizes. Thi was abundantly confirmed by a study of their digestiv enzymes. Protein alone can be digested extracellularly in the cœlenteron, but only to polypeptides digestion being completed intracellularly where amino acids are formed. Fat also can be digested intracellularly, but very slowly: while the only carbohydrat which can be digested, and that very slowly, is tha found in animal tissues, namely, glycogen. Extract of the mesenterial filaments showed no digestiv action on zooxanthellæ or on any carbohydrate o plant origin. The Madreporaria are thus amongs the most highly specialised carnivores in the anima kingdom, being capable only of digesting anima matter with its constituent proteins, fats, an glycogen.

It is improbable that the small quantities o glycogen and fat which can be digested suffice for th energy requirements of the corals, in spite of thei relatively low needs. It will be necessary, therefore to break down proteins by deaminisation, with consequent accumulation in the tissues of the nitrogen phosphorus, and sulphur split off from the protei molecules in this process. This need for the formation of carbohydrate from protein would explain th remarkably dense population of zooxanthellæ in al healthy reef-builders. If the animal is to functio with maximum efficiency it must rid itself of thes end products of metabolic activity. The excretor system consists of wandering cells, and though these rid the body of excrement quickly enough for the needs of an individual coral colony, it may well be quite otherwise in the case of a large population.

Coral reefs only maintain themselves owing to their remarkable powers of growth in the face of innumerable adverse factors, of which the power of the sea and the action of diverse boring organisms are the most potent. It is essential, therefore, that they should function with the utmost efficiency, and their powers of growth could not but be impaired were excretory products to accumulate in the tissues. But they possess in the zooxanthellæ the means whereby all excrement is automatically removed practically the moment it is formed (unlike photosynthesis, protein synthesis in plants proceeds in darkness as well as in light), and which increases as the tissues grow and the excretion of nitrogen, phosphorus, and sulphur increases. Coral reefs as a whole are largely a closed system, obtaining their food certainly from the zooplankton in the sea, but adding to the dissolved nutrient substances only when they die or expel surplus zooxanthellæ. It appears by no means improbable that the Madreporaria have attained their present great importance in the economy of marine life in tropical waters owing to the aid given to them by their contained zooxanthellæ. In their absence the corals would have been unable to overcome the disadvantages inherent in the simplicity of their structure and of their metabolic processes.

The association between corals and zooxanthellæ is, therefore, essential to the plants, certainly not to individual coral colonies, but probably an indispensable factor in the necessarily exceptional powers of growth and repair possessed by the marine communities known as coral reefs.

[1] Gardiner, NATURE, **127**, 857; 1931.
[2] Yonge, NATURE, **123**, 89; 1929.
[3] Yonge, NATURE, **123**, 765; 1929.
[4] Yonge, NATURE, **124**, 694; 1929.
[5] Yonge, "Studies in the Physiology of Corals", I. Feeding Mechanisms and Food. *Sci. Repts.*, G. Barrier Reef Expedition, Brit. Mus., **1**, 13; 1930.
[6] Yonge and Nicholls, II. "Digestive Enzymes". *Ibid.*, **1**, 59; 1930.
[7] Yonge, III. "Assimilation and Excretion". *Ibid.*, **1**, 83; 1931.
[8] Yonge and Nicholls, IV. "The Structure, Distribution and Physiology of the Zooxanthellæ". *Ibid.*, **1**, 135; 1931.
[9] Yonge and Nicholls, V. "The Effect of Starvation in Light and in Darkness on the Relationship between Corals and Zooxanthellæ". *Ibid.*, **1**, 177; 1931.
[10] Yonge, Yonge and Nicholls, VI. "The Relation between Respiration and the Production of Oxygen by Zooxanthellæ". *Ibid.*, **1** (in preparation).
[11] Keeble and Gamble, *Quart. Jour. Micr. Sci.*, **51**, 167; 1907.
[12] Boschma, *Proc. Akad. Wet. Amst.*, **27**, 13; 1924.
[13] Boschma, *Biol. Bull.*, **49**, 407; 1925.
[14] Boschma, *Proc. Akad. Wet. Amst.*, **29**, 993; 1926.

New Physics Building at the National Physical Laboratory.

By Dr. G. W. C. KAYE, O.B.E.

BUSHY House at Teddington, which was erected about 1715 by the first Earl of Halifax, a president of the Royal Society and a pupil of Newton, played a not inconsiderable part in the life of the Royal Family of Great Britain. It was, however, destined to fill, after two centuries, an even larger rôle in the life of the nation. In 1900, after many preliminaries, Bushy House was selected as the future home of the National Physical Laboratory, and in 1902 the Laboratory was formally opened by the present King (then Prince of Wales).

Since that date, under the directorship first of Sir Richard Glazebrook and now of Sir Joseph Petavel, a great part of the extensive grounds of Bushy house has been gradually covered by a large collection of buildings devoted to the requirements of the various departments of the Laboratory. During the last few years, these buildings have overflowed on to land acquired for the purpose in the proximity of Bushy Park. But for more than a quarter of a century, physics, the most comprehensive department of the Laboratory, which indeed gives its name to the whole, continued to be inadequately accommodated partly in Bushy House and partly in a number of converted dwelling-houses on the outskirts of the grounds.

Plans for a new physics building were first got out in 1924, and a design prepared by Mr. F. A. Llewellyn, of H.M. Office of Works, was exhibited at the Royal Academy in 1927. The proposed building had a frontage of 295 feet with wings 135 feet in length, forming three sides of a rectangle. The construction of the central portion of the building was begun in January 1929, and the formal opening by Sir F. Gowland Hopkins, president of the Royal Society and chairman of the General Board of the Laboratory, took place on June 23 last.

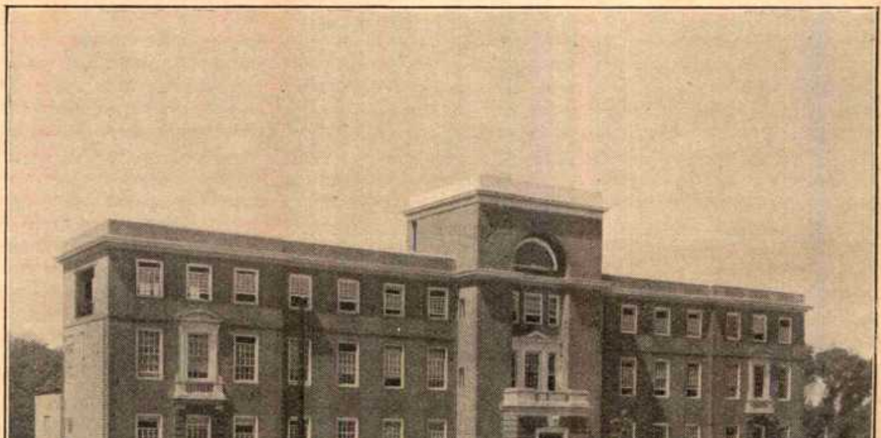

FIG. 1.

The site of the building, which abuts on Bushy Park on two sides, enjoys immunity from traffic noises and vibrations. The structure is mainly of heavy brickwork, which was preferred to a steel-frame building on the score of transmission of noise and tremor. The outer walls are of Crowborough bricks with Daneshill brick and Portland stone dressings.

As will be seen from Fig. 1, the completed portion of the building (of which the frontage is 180 feet) is mainly of three stories, with a central tower. Each storey is wholly on one level. There is a small basement for special purposes. Behind the main block are workshops, industrial laboratories, store-rooms, boilers, etc., all of one storey and semi-isolated from the main building. A large door in the rear of the building is provided with a crane and permits the ready unloading of heavy equipment and stores direct from lorries.

The building is planned on a system of units, all partition walls being non-structural, to facilitate rearrangement of rooms should the necessity arise. In general, the rooms measure about 18 ft. from back to front, the length being either 10 ft., 20 ft., or 30 ft. The heights of the rooms are 16 ft., 14 ft., and 12 ft. on the ground, first, and second floors respectively. In all cases the floors are of concrete, covered with thick cork carpet. Vertical wooden battens are provided at about 3 ft. intervals throughout the walls and ceilings to facilitate the erection of equipment and apparatus. Windows can be quickly darkened by lightproof blinds. Joinery throughout the building is of stained and polished British Columbian pine, except in the entrance hall and landings, where teak has been used.

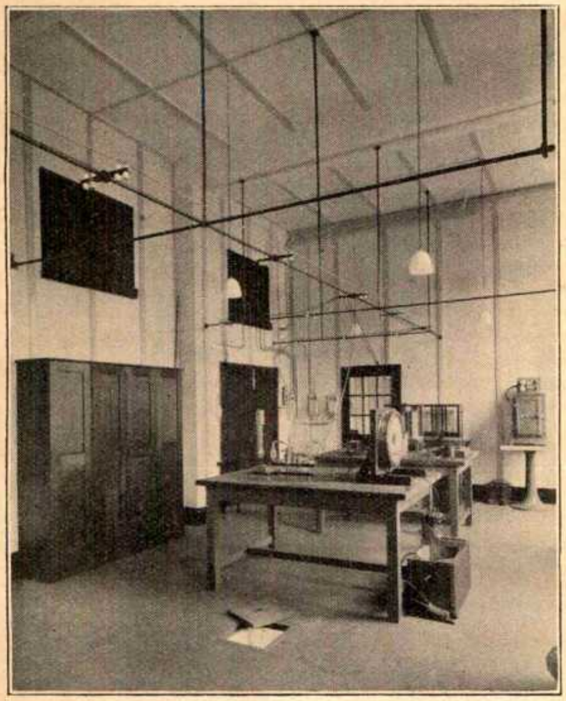

Fig. 2.

The whole of the service mains (electricity, gas, water, etc.) are located in spacious horizontal ducts over the corridors. These ducts, which permit a man to walk along them, communicate with each other by vertical ducts and with the various rooms by doors at 10 ft. intervals. The distribution of the several services to the experimental tables is completed in each room by the aid of an overhead light steel tubular framework provided with insulators for electric cables, and clips for piping, etc. Thus all the services can be brought immediately above a particular apparatus, the lay-out being much facilitated by the use throughout of movable tables rather than of fixed benches. The freedom so gained is enhanced by the provision of sinks let into the floors and provided with loose wooden covers. The usual sinks are, of course, also provided. Many of these details are shown in Fig. 2, which illustrates one of the laboratories.

The electrical services, which are clearly identified by a colour scheme of labels, include 230-volt A.C. at 50 cycles, 240-volt D.C., 110-volt D.C., and 110 volts from a 400-ampere-hour battery. The mains leading from the ducts in the various rooms are connected to 30-ampere switch fuses on the walls, though in the industrial laboratory provision is made for heavier currents.

A system of small service trolleys (of the dinner-waggon type), which can be readily transported about the building, provides sets of accumulators giving low voltage D.C. for steady current work. Experience has shown that this meets the present-day requirements of the Department more satisfactorily than the usual system of split-voltage battery mains. The trolley system is also extended to sets of high-voltage light-current accumulators, and to heavy, costly, or specialised instruments which are only occasionally required by a particular experimenter.

Access to the different floors and the flat roof (which is designed to permit open-air experimental work) is gained by a staircase and passenger lift in the central tower, which also contains an experimental well 70 ft. deep provided with observation platforms.

As at present arranged, the ground floor of the building is devoted largely to investigations on heat: for example, hygrometry, thermal conductivity of metals, refractories, building materials, etc., specific heats of gases, low-temperature research, work for the Engineering Committee of the Food Investigation Board, including a wind tunnel for measuring the exchange of heat between brine-cooled pipes and air passing outside them. There is also a large 200-kilovolt constant-potential generator for operating X-ray tubes used for purposes of 'dosage' and intensity measurements.

The first floor contains the administrative offices, library, etc., and laboratories devoted to investigations in atomic physics, including work on single metal crystals.

The second floor is given over largely to researches on sound: for example, the measurement of noise, the absolute measurement of sound, the calibration of microphones, and the acoustics of buildings. There are large, heavily lagged enclosures to facilitate such work. On this floor also is housed the photographic section of the Laboratory and the departmental drawing office. The end rooms on this floor can have one side opened wide to the outer air should the necessity arise.

The basement affords accommodation for constant-temperature rooms, a reverberation chamber for measurements of acoustical coefficients of absorption, and equipment for photographing sound pulses and water ripples. There are store-rooms in the basement for housing records and special equipment and material, such as radium. The Laboratory, it will be recalled, is responsible for the custody, distribution, and testing of radium for the National Radium Trust and Radium Commission. Facilities are also provided in the basement for projecting cinematograph films.

The part of the building already constructed will house the Heat and General Physics Section of the Physics Department, with part of the radiology and sound work. It is hoped during the next few years that sanction will be obtained for the erection of the wings, so that the remainder of the Radiology Section and the temperature standardisation work can be transferred from the dwelling-houses and other buildings in which they are at present accommodated. The quadrangle will be completed by the Acoustics Building, the erection of a section of which has recently been approved.

The Pulp-Wood Market in the United States.

UNDER the arresting headline "Russia seizes Canada's Market", the *Monetary Times* of Toronto (Jan. 2, 1931) discusses the position of the pulp-wood market, a position which is not without interest for Europe. In 1924, under the heading "The Mistaken Idea that Canada has a Monopoly in Wood", the Canadian Pulpwood Association in a memorandum to the Royal Commission on Pulpwood wrote: "Contrary to the prevailing idea, it must not be overlooked that if the American is forced to turn away from Canada for raw materials, he will find that we have not by any means a monopoly. For instance, wood from Russia, in large quantities, is already freely quoted, by substantial concerns, for delivery at Atlantic seaports. If the U.S. operator has the Canadian door shut in his face, he will naturally consider it to his interest to encourage forestry conservation and development intensively in the United States to ensure independence as far as possible."

The memorandum went on to point out that research would be stimulated, that so far as possible existing American hardwoods would be utilised, and that already there had been a remarkable development in the use of the long-leaf southern pine in the kraft industry. In short, that there was a possibility that, in the attempt to take advantage of America's extremity by the threat of pulp-wood export restrictions, Canada might find that she had jeopardised a valuable trade connexion in paper products, encouraged her chief customer to develop her own resources, whilst unconsciously encouraging her trade with other countries.

To-day these predictions are coming true. America has been busily engaged in investigating every source of pulp-wood supply, an absolute necessity to her, owing to her enormous consumption of pulp. One of the new sources of supply has proved to be Russia. This year, Russian shipments of the highest quality of wood, amounting to some 300 cords, are being delivered in the eastern States at the same price as Canadian wood. Further, Canada gave transportation preference to the Russian wood; for the latter, landed at the Canadian ports of Sorel or Three Rivers, was for a time carried to the United States by Canadian railways at lower freight rates than these railways gave to Canadian wood for precisely the same movement.

The other possibility predicted, that America would undertake research with the object of endeavouring to make use of materials of her own not previously utilised for the pulp trade, has also been verified by the already mentioned development of the long-leafed southern pine in the kraft industry; and there is another interesting outcome. Dr. C. H. Herty, former president of the American Chemical Society, recently announced to the Atlanta Chamber of Commerce that he had succeeded in producing high grade newsprint paper from southern slash pine, cooked in the same digester and under the same conditions as spruce. The importance of this research work becomes evident when it is understood that there are vast reserves of this timber in the southern States, and that this variety of southern pine had always been regarded as the least capable of producing regular newsprint.

The above description of the present position in the pulp industry in the New World carries some important lessons for Europe. It displays the close and accurate study made of world-wide forest resources and the thorough knowledge of the pulp-wood industry which exists on the other side of the Atlantic. It also throws a strong light on the attitude taken up and ideas expressed since the War in some quarters in Britain upon the small influence the Russian coniferous forests were capable of exerting on the markets.

University and Educational Intelligence.

LONDON.—The degree of D.Sc. has been conferred on the following: W. Youngman, for a thesis entitled "Further Studies in the Cytology of the Hibisceæ", with two subsidiary contributions; S. E. Hollingworth, for a thesis entitled "The Glaciation and Physiographic Development of the Eden Catchment Basin West of that River, and the Drumlins of Edenside and the Solway Basin", with two subsidiary contributions; Lin. L. Lee (Rothamsted Experimental Station), for a thesis entitled "The Influence of Geology and Climates on Soil Types" (*Jour. S.-E. Agric. Coll.*, June 1931); A. N. Puri (Rothamsted Experimental Station), for a thesis entitled "Studies in Soil Colloids" (*Memoirs of Dept. of Agriculture*, 1930; *Soil Science*, 1930–31); A. J. Maslen (Chelsea Polytechnic), for a thesis entitled "The Structure of *Mesoxylon Platypodium* and *Mesoxyliodes*" (*Annals of Botany*, July 1930); L. R. Underwood (Imperial College—City and Guilds College and East London College), for a thesis entitled "The Combustion of an Oil Jet in an Engine Cylinder".

THE following fellowships for the year 1931–32 have been awarded by the Salters' Institute of Industrial Chemistry and approved by the Court of the Salters' Company: J. L. Sweeten (St. Catherine's College, Cambridge) and Norman Stuart (Imperial College, London). Fellowships have been renewed to: D. L. Hodge (Imperial College, London), D. J. Branscombe (University College, Exeter), J. Hofton (Caius College, Cambridge), and H. G. Simpson (East London College). The Salters' Institute has also awarded one hundred and thirteen grants-in-aid to young men and women employed in chemical works, to facilitate their further studies.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the year 1931–32: Dr. B. K. Blount, a fellowship of £300, tenable for two years, at the University of Oxford; Mr. Ragnar Ericson, a Swedish fellowship of £300, tenable for two years, at the Imperial College, London; Dr. George Karagunis, a Greek fellowship of £400, tenable for one year, at University College, London; Dr. J. Lens, a Netherland fellowship of £300, tenable for two years, at University College, London; Dr. Y. Urushibara, a Japanese fellowship of £400, tenable for two years, at University College, London. The Trustees have renewed the following fellowships for the year 1931–32: Mr. W. R. Angus (British fellow), University College, London, and Dr. James Bell (Glasgow fellow), University College, London.

Birthdays and Research Centres.

Aug. 23, 1869.—Dr. R. T. Gunther, curator of the Lewis Evans Collection of Historic Scientific Instruments in the University of Oxford.

I am especially interested in the discovery of ancient scientific instruments and specimens, and in their preservation for illustrating the history of the natural sciences. It has been only too frequently a common experience in the laboratories of our universities that with every change in the directorate a quantity of unique apparatus of great scientific interest has been scrapped. It is with the view of checking the wastage of apparatus of special historic or artistic value that the Lewis Evans Collection has been founded. Incidentally, the benefaction of Dr. Evans has led to the restoration (in part) of the Old Ashmolean, the oldest museum of natural history in Britain, and quite recently to the discovery of some of Edward Lhwyd's type specimens of British fossils, long believed to have been irretrievably lost.

Aug. 23, 1886.—Prof. W. Stiles, F.R.S., Mason professor of botany in the University of Birmingham.

In the near future I hope to see considerable development of our knowledge of the physiology of plants and the application of this knowledge to various plant industries, including agriculture, horticulture, and food storage.

My own researches have dealt mainly with problems of cell physiology, particularly with those of absorption of substances by living cells, and the passage and movement of substances from cell to cell in the organism. While continuing work on this subject, I am also engaged on an investigation of the relation between the chemical and physical constitution of substances and their toxic action on plant cells and tissues. Latterly I have turned my attention to the very fundamental questions of respiration and photosynthesis by plants, and am investigating these processes by methods specially developed for the purpose.

Aug. 24, 1880.—Dr. A. D. Imms, F.R.S., chief entomologist at the Rothamsted Experimental Station, Harpenden, Herts.

My duties involve keeping abreast with many aspects of entomology. At the same time, the writing of a comprehensive text-book on the subject has absorbed much time and energy during the past few years. The modern trend of the subject, as with other branches of zoology, is towards its biological and physiological aspects. An entomologist well trained in physiological technique has a wide field in front of him. On the biological side, more exact methods of study of insects in relation to their environments are likely to yield results of both fundamental and economic significance. At the same time, there is a shortage of scientific taxonomists of broad outlook, specialists in the parasitic groups of Hymenoptera, for example, being especially few and far between. My own investigations deal chiefly with parasitism, its effects upon the hosts concerned, and the differential influence of environmental factors on host and parasite.

Aug. 25, 1844.—Sir Thomas Muir, C.M.G., F.R.S., formerly Superintendent-General of Education in Cape Colony.

Firmly believing that in the advancement of science every little addition counts, I continue to work at quite minor problems, leaving them to be suggested by my own casual reading or to be brought to my notice by fellow-students from near or far. Fairly often I am able to pay such a correspondent back in his own coin with interest, and so I derive now and again the pleasant satisfaction of seeing a more vigorous brain dealing effectively with a worthier type of work.

I thus welcome the present occasion as giving me the chance of influencing by suggestion a much wider circle of workers: and I select as a subject urgently requiring attention the determinantal properties of oblong arrays. Naturally the first business would be to search out and tabulate the already known results from those of Bézout in 1779, all the while noting contrasts, analogues, and possible generalisations. Even such preliminary labour would in every case reward the worker: and thoughtful afterstudy would almost certainly give something of value to us all.

Aug. 26, 1863.—Mr. Edward Heawood, Librarian to the Royal Geographical Society.

My special studies for many years have been the history of exploration and early maps. At the moment I am chiefly interested in the beginnings of topographical survey and mapping in England and the early history of paper-making and the paper trade. Both these subjects, especially the latter, have so far been more or less neglected. Many early maps, for example the English version of the world-map of 1544 generally known as Sebastian Cabot's, or John Norden's map of Kent of about 1595 (among many others), remain to be discovered, and a systematic search in old libraries might bring some at least to light. Practically no information is available on early paper-making in Great Britain, but the subject is of importance in connexion with the dating of old documents or other bibliographical problems.

Aug. 26, 1873.—Prof. W. A. Osborne, professor of physiology and dean of the faculty of medicine in the University of Melbourne.

Two problems of gel behaviour interest me at present. (1) Fresh defibrinated blood diluted with a twofold volume of water is laked and is transparent. Addition now of sodium chloride to restore the original osmotic pressure brings back opacity and reflection of light. (2) The cornea in contact with solutions not iso-osmotic with blood behaves as a gel, allowing rapid diffusion of chlorides but slow diffusion of sulphates either way. When the cornea is in contact with iso-osmotic solutions, diffusion of chlorides is uni-directional and towards the aqueous (confirmatory of F. P. Fischer). The question is whether this valved diffusion is due to living epithelium.

Aug. 27, 1865.—Prof. James H. Breasted, director of the Oriental Institute, University of Chicago.

I am endeavouring to trace the course of human development from the merely physical man disclosed by the palæontologist to the rise and early advance of civilised societies, the product of social evolution culminating in social idealism.

The scene of this evolution has unquestionably been shown to be the ancient Near East—the region folded like a horseshoe around the eastern end of the Mediterranean. The diverse civilisations which arose there are now known to have been the background and basis of European civilised development. These countries to-day constitute an almost inexhaustible storehouse filled with perishing and still unsalvaged evidence disclosing early human development. There has been no comprehensive and systematic effort to save and study this enormous body of perishing evidence *as a whole*. These facts lay a twofold responsibility on modern science: first, the task of salvaging this evidence by scientifically organised and equipped field expeditions; second, the study and constructive interpretation of this evidence.

These responsibilities adequately met will require not only scientific training and method on the part of the *individual*, but also organised effort and funds surpassing those which have been available in humanistic research hitherto. The organisation which I have hoped might contribute to meet this situation, the Oriental Institute of the University of Chicago, is now twelve years old. It maintains a series of twelve field expeditions operating along a front of more than 2000 miles, from the southern shores of the Black Sea on the north, eastward to south Persia (Persepolis), and thence to north-east Africa and the Upper Nile on the south. Its administrative and scientific headquarters, a new building at the University of Chicago, houses a series of research projects and serves as a focus on which converges the new evidence from the excavations and the salvaging operations of the field expeditions.

The subject matter of these researches both at home and abroad—the rise of man—is a process which in itself constitutes the greatest event in the history of the universe so far as it is known to us. The purpose of these researches is eventually to make possible an understanding of human origins and early human advance, based on fuller evidence than has ever been available before, and in so doing perhaps to discern more fully something of the causes and the nature of that mysterious and persistent buoyancy of the human spirit which, in spite of declining intervals, has made the direction of human movement from the beginning —and for probably several hundred thousand years— a rising line.

Aug. 28, 1858.—Prof. ROLAND THAXTER, emeritus professor of cryptogamic botany and honorary curator of the Farlow Herbarium, in Harvard University.

I am publishing this summer my fifth quarto memoir on the taxonomy of the Laboulbeniales (*Memoirs American Academy of Arts and Sciences*, vol. 16, part 1, pp. 1-435, with 60 plates), illustrating many new and curious generic and specific types, and am planning to begin the preparation of a sixth and final part, to include the genus *Laboulbenia* and various addenda, with a general summary, host-index, etc.

Societies and Academies.

PARIS.

Academy of Sciences, June 22.—The president announced the death of Jacob Eriksson, *Correspondant* for the Section of Rural Economy.—**H. Deslandres**: Simple relations between the molecular spectrum and the structure of the molecule. A table of the infrared frequencies of gaseous ammonia and carbon dioxide, and a discussion of the data.—**Charles Achard and Augustin Boutaric**: Some physical properties of the blood serum in lipoid nephrosis. Quantitative measurements of the light absorption and viscosity, before and after heating the blood serum to varying temperatures, are used for determining the changes in the number of particles in the colloidal suspension. The theoretical basis of the method was described in an earlier communication (*C.R.*, **191**, 1332).—**R. Fosse, A. Brunel, and P. E. Thomas**: The quantitative analysis of very small quantities of allantoin at high dilutions. The application to human urine. The method is based on the destruction of urea by the diastases of the soja bean in presence of cyanide, followed by hydrolysis by hydrochloric acid. The glyoxylic acid thus produced from the allantoin is estimated by a colorimetric method with phenylhydrazine; full working details are given.—**C. Sauvageau**: Three new examples of plethysmothallus (*plethysmothalle*) (*Myriotrichia* and *Protasperococcus*).—**Paul Delens**: Orthoptic congruences and isotropic congruences.—**W. Sierpinski**: A property of the limits of ensembles.—**M. Kourensky**: The variation of the arbitrary constants for the integrals of ordinary differential equations of the second order.—**Florent Bureau**: Holomorph functions in a circle of finite radius and integral functions.—**Gabeault**: The air resistance to ballistic velocities.—**M. Aubert and R. Duchêne**: The determination by the photographic method of the resistance of petrols to detonation.—**D. Barbier**: Function of distribution of the eccentricities and mean anomaly of long period visual double stars, the orbits of which have not yet been calculated.—**G. Foex and Mlle. B. Kessler**: The various magnetic states of the nickel ion in solutions of its chloride. Moderate rise of temperature (to 90° C.) does not influence the magnetic state of the nickel ion, but raised to a higher temperature (100° C.) the Weiss magnetons are lowered.—**Horia Hulubei and Mlle. Yvette Cauchois**: The monochromatic stimulation of Raman spectra in the ultra-violet. Applications. The monochromatic radiation was obtained by filtering the light from a mercury lamp through chlorine gas under pressure. Details of experimental results with water and ethyl alcohol are given.—**P. Dupont**: Study of the hydrolysis of sulphate of zinc solutions with the aid of the quinhydrone electrode.—**M. Haïssinsky**: A new reaction of polonium. Polonium forms an insoluble pyrogallate: in this reaction it resembles bismuth and antimony, but differs from tellurium.—**Mlle. Germaine Bernheim**: The preparation of the cyanamides of the earths and alkaline earths. Study of the reaction

$$C_2N_2 + MO = CN.NM + CO$$

as a function of the temperature, where M is barium, strontium, magnesium, zinc, cadmium, or beryllium.—**Pierre Jolibois and Georges Chaudron**: A new method for getting calcium triphosphate in a soluble form. The method is based on the conversion of the mineral phosphate into an insoluble lead chlorophosphate, followed by treatment with nitric acid. The process is worked in a cycle, with recovery of lead, and the products are ammonium nitrate and ammonium phosphate containing a little ammonium nitrate, both of which can be used as manures.—**Al. Yakimach**: Phosphate of trivalent manganese and of aluminium. An account of the preparation and analysis of $(NH_4)H_2Mn(PO_4)_2$, $(NH_4)H_2Al(PO_4)_2$, $KH_2Al(PO_4)_2$, and $Ca[H_2Al(PO_4)_2]_2$.—**Malaprade and Schnoutka**: The separation and estimation of boric acid and alumina. The alumina is separated as a basic sulphite, the excess of carbon dioxide and sulphur dioxide removed by boiling, and the boric acid in the filtrate estimated by the usual double titration.—**André Kling and René Schmutz**: The decomposition of solutions of sodium hypochlorite (Javel's liquid).—**Georges Darzens**: A method of separating the cresols and the properties of pure *m*-cresol. The method is based on the formation of a stable addition compound of *m*-cresol and dry sodium acetate: the *p*-cresol forms an addition compound with oxalic acid.—**Picon**: Silver camphocarbonate. Chemical organosols of silver.—**E. Urion**: 1, 2-cyclohexanedione or dihydropyrocatechol. This α-diketone has been isolated from the products of decomposition of divinylglycol by reduced copper at 280° C.—**Robert Lantz and Georges Mingasson**: Researches on the napthalene bisulphite compounds. The abnormal action of sodium bisulphite on certain derivatives of β-oxynaphthoic acid.—**Ch. Courtot and Chaix**: Study in the diphenylene sulphide series.—**N. Kouriatchy**: The layers of serpentines and chromites of Togo.—**Paul Cristol**: The hæmorachidian equilibrium of the bicarbonates.—

Mlle. Choucroun: The hypothesis of mitogenetic radiation acting on the multiplication of bacteria. An account of experiments tending to negative the hypothesis of a mitogenetic radiation or of any action through the walls of the tube containing the bacteria; if the latter vessel is corked, the action ceases.—**Edouard Ducloux** and **Mlle. Georgette Cordier**: The study of certain humoral modifications arising in the course of experimental bovine marginal anaplasmosis.—**Denis Bach**: The mechanism of the antiseptic action of lactic acid on *Bacterium coli*.—**Georges Blanc** and **J. Caminopetros**: The virus of exanthematic fever is hereditary in the tick *Rhipicephalus sanguineus*.

Cape Town.

Royal Society of South Africa, June 17.—**Gunnar Nygaard**: Freshwater Algæ and phytoplankton from the Transvaal. The phytoplankton was found to be in general a typical pond-plankton, with *Microcystis aeruginosa* and *Botyococcus Braunii* sometimes becoming dominant. That of the larger river-dams was often dominated by the diatom *Melosira*, which West found to be the chief form in Lake Nyassa. Both lakes and pans appear to be rather poor in species of Algae, only 98 species and varieties being found in the samples, of which six species and five varieties are new. Two noteworthy finds were *Draparnaldia Ravenelii*, a species not found since 1887, when it was described from North America, and a new Coscinodiscus, *C. incomptus*, a freshwater species of this otherwise typically marine genus.—**F. Rich**: Phytoplankton from South African pans and vleis. 262 species and varieties were found, among which were nine species and eight new varieties, as well as several new forms. The occurrence of *Pleodorina californica* is interesting, for this genus had not been recorded for South Africa. The marked differences found in the plankton from various bodies of water is noteworthy, suggesting that an interesting correlation of this with the chemical and physical characters of the water could be made by collectors in South Africa.

Sydney.

Royal Society of New South Wales, June 3.—**Daphne L. Coulston**: (1) A new colorimetric method for measuring the hydrogen ion concentration of natural waters. This method consists of comparing the intensity of colour produced when the indicator, para nitro phenol, is added to the solution of unknown hydrogen ion concentration with a standard depth of colour in a Dubosq colorimeter. The results have been checked by comparing buffer solutions of known hydrogen ion concentration with the standard.—(2) The splenectomy of tadpoles. The object of the investigation has been to ascertain whether the absence of the spleen influenced the metamorphosis of the larval frog. Frogs used in the experiments belonged to various species of *Limnodynastes*. The tadpoles were about 7·5 cm. in length, and possessed small hind limbs. Urethene was used as an anæsthetic. Six splenectomised and ten normal tadpoles developed similarly over a period of three to four weeks. No deep regeneration had taken place during one month.—(3) Variations of the hydrogen ion concentration of sea water. Of numerous samples taken off the coast at Cronulla, La Perouse, Bondi, Manly, Collaroy, etc., 60 per cent showed a pH of 8·5 and 40 per cent of 8·4. These results were obtained using phenol red as an indicator. As samples were taken in Port Jackson the alkalinity of the water decreased perceptibly within a mile from the Heads. Increase in the tension of carbon dioxide decreased the alkalinity. Sea water is only slightly buffered, since so small an increase as 8 millimetres tension carbon dioxide sufficed to alter pH from 8·5 to 7·0.—(4) On the metabolism of cold-blooded animals. Experiments have been made to determine the carbon dioxide expired and the oxygen absorbed for resting frogs and to relate the figures obtained to the surface area of the frogs. Surface area was determined from plasticene moulds lined with silk. The silk was then separated from the cast, cut into fragments so as to lie flat, and reproduced on sensitised photographic paper. The affected areas were cut out and weighed and from the weight of paper the surface area calculated. A frog weighing 30 gm. has a surface of approximately 100 sq. cm. The metabolism of the frog was obtained by placing it in a wide-mouthed jar of rather more than 1 litre capacity, the jar being closed with a rubber stopper through which inlet and outlet tubing passed. Metabolism diminished during starvation and increased two to three times by a rise in temperature of 10° C. Resting frogs produced about 20 calories per sq. cm. of body surface per day.—**H. F. W. Whitworth**: The mineralogy and origin of the natural beach sand concentrate of New South Wales. Attention is directed to the fact that whilst, in the past, the heavy mineral concentrates have been worked intermittently for their gold, platinum, and tin values, their future value probably lies in their zirconium and titanium contents. The composition of the sand concentrates is given in detail, both chemical and mineralogical analyses being quoted, with descriptions and sketches of individual minerals. The heavy minerals of which the concentrates are formed have been derived, in all probability, from the Triassic sandstones which overlie the Coal Basin between Newcastle and Bulli.—**J. C. Earl** and **Miss T. M. Reynolds**: The celluloses of two water plants. The cellulose of *Eichornia crassipes* and *Ottelia ovalifolia* were isolated and compared by means of their triacetates with the normal cotton type of cellulose. Although the separation from associated substances was difficult to carry out, the cellulose from each of these plants appeared to be of the normal type.

Diary of Societies.

Saturday, August 22.

North of England Institute of Mining and Mechanical Engineers (Annual General Meeting) (at Newcastle-upon-Tyne), at 2.30.—Open for further discussion:—Interim Report of the Support of Workings in Mines Committee, A. Walker.

Tuesday, August 25.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—Informal Meeting—Ornithology.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.

CONFERENCES.

August 25 to 29.

Conference of the International Institute of Bibliography (at the Hague).

Aug. 25.—Prof. A. Pollard: Presidential Address.

Aug. 26.—E. Morel: Statistique du livre en France et son aspect bibliographique.
  Dr. J. Vorstius: Index Bibliographicus.
  Sir Frederic Nathan: International Abstracting and Indexing of Scientific and Technical Literature.
  J. M. C. Muller: Rapport sur le Repertorium Technicum.
  J. Gérard: Création d'une Fedération Française des Offices de Documentation.

Aug. 27.—Dr. R. Sand: La documentation dans le domaine de la médicine.
  Dr. E. Huet: L'Organisation de la Documentation Dentaire par la Féd. Dent. Int.
  Dr. J. G. Priestley: Bibliography of Physiology and the Application thereto of the Decimal Classification.
  Dr. M. Pflucke: Aufgaben und Organisation eines Referatenorgans.
  B. du Retail: Le Centre d'Information Economique de Paris et son Service de Dossiers de Presse.
  B. M. Headicar: The Bibliography of Economic and Social Sciences.
  E. de Grolier: Le classement standardisé appliqué dans la librairie

Aug. 28.—Various Papers.

Aug. 29. Excursions

August 31 to September 4.

International Congress of Neurology (at Berne).

SATURDAY, AUGUST 29, 1931.

CONTENTS.

PAGE
Creative Science and Industry 317
Nansen's Last Journey 319
Chemistry through the Ages. By Prof. John Read . . 321
Short Reviews 323
Modern Diving Devices. By Capt. G. C. C. Damant, O.B.E. . 324
Diet and Disease 326
The Faraday and British Association Centenaries . . 328
News and Views 329
Letters to the Editor:
  Superconductivity a Polarisation Phenomenon.—Prof. J. C. McLennan, F.R.S. 373
  Chemical Effect of a Mendelian Factor for Flower Colour.—The Hon. Mrs. Huia Onslow 373
  A Hard Component of the β-Radiation of Potassium.—Daria Bocciarelli 374
  The Atomic Weight of Fluorine.—H. S. Patterson, Prof. R. Whytlaw-Gray, F.R.S., and W. Cawood 375
  Acromegaly in the Far North.—Prof. Lancelot Hogben . 375
  Biological Effects of Cosmic and γ-Radiation.—Prof. J. H. Orton and S. T. Burfield 376
  Mineral Content of Eyes.—Hugh Ramage and J. H. Sheldon . 376
  The Double Lateral Line of *Lepidosiren*.—J. T. Cunningham . 377
  Age of Certain Gravels in the New Forest Area.—Henry Bury; Harold J. E. Peake 377
  Unusual Lightning.—Capt. C. J. P. Cave . . . 378
  Conservation of Rainfall as Carbohydrates.—Prof. W. A. Osborne 378
  Occurrence of Dulcitol in a Red Seaweed.—Dr. P. Haas and Prof. T. G. Hill 378
Research Items 379
Astronomical Topics 381
Stainless Metals. By F. C. T. 382
Death and Development. By Prof. E. W. MacBride, F.R.S. . 382
Pharmacology of Thallium 383
Swedish Ironfields 384
Weather Foreshadowing 384
University and Educational Intelligence 384
Birthdays and Research Centres 385
Societies and Academies 386
Official Publications Received 387
Diary of Societies 388
SUPPLEMENT:
  Faraday and his Contemporaries. By Engr.-Capt. Edgar C. Smith, O.B.E., R.N. 333
  Faraday and Ørsted. By Mrs. Kirstine Meyer . . . 337
  Gauss's Investigations on Electrodynamics. By Prof. Clemens Schaefer 339
  Italian Physicists and Faraday's Researches. By Prof. Vito Volterra, For.Mem.R.S. 342
  Faraday and French Physicists. By Prof. Pierre Brunet . 346
  Faraday's Connexion with Switzerland and Swiss Industrial and Economic Development. By Prof. Ch. Eug. Guye . 349
  Faraday and Austria. By Prof. Karl Przibram . . . 351
  The Faraday Festival. By Prof. Bohuslav Brauner . . 352
  Faraday's Researches and the United States. By Prof. Willis R. Whitney 353
  The Modern Electric Age in Relation to Faraday's Discovery of Electromagnetic Induction. By Prof. A. E. Kennelly . 356
  Faraday and Electrical Science in Russia and the U.S.S.R. By W. Th. Mitkewich 359
  India's Debt to Faraday. By Sir C. V. Raman, F.R.S. . 362
  Faraday's Researches on Magneto-Optics and their Development. By Prof. P. Zeeman, For.Mem R.S. . . . 365
  Dynamical Aspects of Electromagnetism. By Prof. V. K. F. Bjerknes 369
  Faraday's "Chemical Manipulation". By Sir Robert Robertson, K.B.E., F.R.S., and B. A. Ellis . . . 371

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Creative Science and Industry.

WHILE it would be difficult to find a more brilliant example of the value of creative science to industry than the experimental investigations of Michael Faraday, there is a tendency to regard such contributions of science as exceptional. Even on this point it is pertinent to recall the verdict of Huxley in 1877 in urging the value of technical education: "If the nation could purchase a potential Watt, or Davy, or Faraday at the cost of a hundred thousand pounds down, he would be dirt-cheap at the money. . . . What these men did has produced untold millions of wealth in the narrowest economical sense of the word." In scientific research, quality counts supremely, but industry owes an incalculable debt to innumerable investigators engaged in scientific research directed by no other motive than the pursuit of knowledge.

At the moment, our interest is centred chiefly on the discovery of electromagnetic induction by Faraday and its consequences—electrical industry and its ramifications of the present day. The dyestuffs industry is, of course, the classical example of the relation of scientific research to industry, and it is worth recalling that this industry owes much to Faraday's discovery of benzene. Chemical industry abounds in similar examples. The manufacture of synthetic drugs may be traced back to such purely scientific work as Kolbe's synthesis of salicylic acid, and its expansion has invariably been connected with external scientific work like Knorr's discovery of antipyrine, Ehrlich's salvarsan, Fourneau's 309, Kraut's aspirin, Molle and Kleist's veronal, the isolation and synthesis of adrenaline, Banting and Best's isolation of insulin, Kendall's preparation of thryoxin and its brilliant synthesis by Harington. Pasteur's scientific investigations on yeast prompted by a brewing difficulty led him to the discovery of the whole theory of fermentation, the existence and action of bacteria, thence to the pasteurisation process, and finally to the discovery of the antitoxin of hydrophobia. These discoveries have not merely transformed the brewing, yeast, dairy, and cheese industries, but have also led to the rise of important new branches in the production of solvents such as acetone and butyl alcohol by fermentation. It would be difficult to measure the debt of either the fermentation industries or, indeed, of humanity to the scientific work of Pasteur, whose chance discoveries were so momentous because he was prepared.

When we turn, however, to such men as Ludwig Mond and Sir William Siemens, whose names are pre-eminently associated with industry, we find once more that the technical processes associated with them equally had their origins in scientific research. Long and patient investigations led to the discovery of nickel carbonyl, and the Siemens process was similarly the outcome of the scientific study of heat economy. The remarkable progress during the last two decades in the metallurgical industries is also based on purely scientific investigations—metals such as tungsten, molybdenum, vanadium being little more than curiosities for years after they were discovered.

Even in our older industries, scientific research has been responsible for revolutionary changes and developments. The art of soap-making has been transformed into a science. Sabatier's observation of the hydrogenating properties of finely divided nickel is the germ from which has developed the industrial hydrogenation or hardening of oils and fats and innumerable processes in almost every section of organic chemistry, including the Berginisation process for obtaining liquid fuels from coal. Scientific investigations on nitrocellulose and cellulose acetate and their solvents have led to the discovery of lacquers which have not only revolutionised the paint and varnish industry but have also made possible the enormous expansion of the automobile industry. The leather-substitute used extensively in upholstering motor cars has itself been produced by industry as an outcome of the scientific investigation of nitrated cellulose. Equally important is the development of the whole rayon industry from scientific investigations and observations in the same field of cellulose—Chardonnet's discovery of nitrocellulose silk and Cross and Bevan's viscose. The technical possibilities of any one of these discoveries were scarcely dreamed of by industry when the first investigation was commenced. Finally, the great fertiliser industry, including the fixation of atmospheric nitrogen, is essentially based on Liebig's discovery of the superphosphate process and Lawes and Gilbert's patient investigations on the effect of fertilisers on plant growth, and from Sir William Abney's measurements of the absorption of light by silver halide emulsions have came the advances of modern photography leading ultimately to the cinematograph industry.

We might continue the story by referring to other industries, and particularly to the electrical industries, which have been developed from Faraday's discoveries in electricity and magnetism and from Maxwell's and Hertz's investigations on electromagnetic waves, but limitations of space forbid. We have only discussed one aspect, however, of the contribution of science to industry. Equally important is the contribution which science makes in technique—the provision of new technical methods. The importance of this aspect of the service of science to industry was enforced on British industry in the early days of the War, when our dependence on continental firms for all classes of scientific instruments and glassware imposed a considerable handicap on the expansion of the munitions and other industries to meet the war-time demand. Without the instruments of precision for measurement and control of temperature, pressure, refractivity, and other properties, which have been evolved by purely scientific work, industrial development would have been much more laborious. Essentially modern advances in the measurement of high temperatures paved the way for the developments in the metallurgical industries. The development of the newer industries such as the radio industry, the manufacture of synthetic resins and rayon, is indeed a record of advance closely related to the utilisation not merely of scientific discoveries but also of scientific methods and scientific instruments for purposes of control.

The significance of such methods of X-ray analysis, ultra-violet light, hydrogen ion determination, thermionic valves for control purposes, including automatic control, in industry is only now being appreciated. In high-pressure reactions as well as low-pressure reactions and distillation in very high vacuum, science has provided industry with a whole range of new technique. Scientific work on the two forms of hydrogen has recently simplified the evaluation of industrial catalysts, while almost simultaneously the discovery of the selective properties of a copper chromite catalyst has enormously increased the possibilities of development in the industrial hydrogenation processes.

X-ray methods themselves provide a striking example of the reaction on industry of scientific technique. The recent application of X-ray methods to textile research has led to discoveries relating to the structure of cellulose, wool, and hair which throw new light on just those typical properties of wool which are of fundamental importance in manufacturing operations. As a result, a correct interpretation of the conditioning, dyeing, and other absorptive processes has been facilitated and a method elaborated for measuring the surface scale structure of the wool fibre which represents the first step towards placing the important technical operations of milling on a scientific foundation. In addition, the discoveries *suggest* an interpretation of the structure of cellulose which has a direct bearing on the mercerisation process.

While science has thus provided industry with instruments of precision and methods of attack on technical problems, an important contribution has also been made in the field of industrial health and safety. Until science had revealed the cause of yellow fever and the methods of its prevention and control, the resources of the engineer were inadequate to construct the Panama canal. Merely to walk through a modern dry battery or accumulator factory is to realise how medical science, by examining the causes of industrial poisoning, dusts, and their prevention, has revolutionised conditions of work. Hundreds of industrial processes operate smoothly every day because the scientific study of the properties of materials has enabled working conditions to be devised which satisfy stringent requirements of safety and efficiency.

In the past hundred years, industry has come to adopt not only the results of scientific discoveries but also scientific methods both for the development of new processes and for the control and improvement of existing processes or products. Individually or collectively, progressive industrial firms are now invariably associated with research departments or institutions in which the investigation of technical problems is systematically undertaken. Such technical research work will, however, usually be restricted either in the subject or the object of the work, and occasionally in both, leaving the investigator only freedom to select his methods. Without detracting from the merits of such work, which frequently compares in brilliancy with the ablest research conducted at the universities, the importance of fundamental scientific investigation, with its full freedom of aim, method, and materials, must not be overlooked. Great as has been the service of science to industry in improving or elaborating technique, it is from the fundamental discoveries of creative science that industry has derived its greatest benefits. While recent *rapprochements* between the universities and chemical industry indicate that this is fully realised, at any rate by chemical industry, economic reasons limit the possibilities of fundamental research being organised in industry. Authorities like Sir Harry McGowan and Dr. Levinstein have recently stressed the relations between industrial research and profits which influence the research policy of any sound industrial organisation, and Major F. A. Freeth has pointed out that the drift of modern life is against discovery. The vertical organisation of industry and of science restricts the exchange of technique, upon which probably the technique of discovery largely depends.

We are, however, as far to-day from a technique of discovery as when Francis Bacon wrote his " Novum Organum ". A century of industrial progress testifies to the interdependence of science and industry. The great names on science's roll of honour are again and again to be found on the roll of the greatest benefactors of industry and of humanity. There is no truer touchstone of the sincerity of the tributes paid by industry and the State to the memory of Michael Faraday than the volume of support accorded to scientific research in Great Britain and elsewhere, and although we live in times of unprecedented depression, we must maintain the facilities, the institutions, and the technical and monetary equipment which will make it possible for others, though like Faraday of humble birth, to devote their splendid gifts unhindered to the service of mankind. The dynamo, broadcasting, the aeroplane, the cinematograph were not further beyond the imagination of Faraday's listeners in the Royal Institution than future developments from our own, if creative science continues to exert its fertilising influence on industry and the ties between discovery and service are knitted closer through the whole fabric of modern life.

Nansen's Last Journey.

Through the Caucasus to the Volga. By Fridtjof Nansen. Translated by G. C. Wheeler. Pp. 255+23 plates. (London: George Allen and Unwin, Ltd., 1931.) 12*s*. 6*d*. net.

IN 1925 Nansen visited Armenia on behalf of the League of Nations as one of a commission of five appointed to investigate the possibility of settling refugees from Turkish Armenia on the land. An earlier book, " Armenia and the Near East ", was a record of the mission up to the end of its labours in Erivan. Nansen now reopens the story in the train as he leaves Armenia on July 2, 1925; but he does not get into the swing of his narrative until he reaches Tiflis. Here he opened negotiations with the Transcaucasian Federation of the three republics, Armenia, Georgia, and Azerbaidjan, with the view of raising a loan in order to carry out the proposals of the Commission—a project which, he tells us, later failed to mature.

Nansen made a short stay in Tiflis, of which he gives a brief description. He speaks of the manifold different races to be seen in its streets and of the varied and cosmopolitan origin of its merchandise. He notes the fact that coats of mail, swords, iron-bound shields, and helmets, " such as might well be relics from crusading days ", are still offered for sale and, what is more, are worn by the mountain tribes of the remote Caucasian valleys. What he found most striking, however, was the " great seriousness which wraps all these people and the little show there is of any kind of joy in life ". The War brought many changes. What was left undone towards the ruin of the country was completed by the suicidal economic policy of the early days of the independent republic ; and on top of that came the Bolshevik invasion. In two respects, however, Georgia appears to have suffered little change. Nansen records that someone who was to meet him on Wednesday at one o'clock turned up at twelve on the following day, apologising for coming a little late. Nor have the Georgians lost their gift for, and appreciation of, opera, drama, and the ballet. It is here stated that when the Soviet government wished to suppress the ballet on the ground of expense, the whole working-class population petitioned against this action. As a matter of fact, before the War the opera in Tiflis was the centre of social life and the opera house the second largest in the whole Russian Empire.

It is a pity that Nansen's stay in Tiflis was not prolonged. It would have been instructive to have had the reflections of his more extended observation of a people of such an individual and distinctive character in their present changed and economically strenuous conditions.

Nansen left Tiflis by car, motoring through the Caucasus range to Daghestan, where he was to stay with Samursky, the president of the Daghestan Republic, whom he had met in Moscow. The Vladihavkas road, by which he travelled through the only pass over the range, is the great military road laid down by the Russians for their final conquest of the Georgians at the beginning of the nineteenth century, and along which the Bolsheviks advanced when they overthrew the independent republics after the War. Apart from its natural difficulties, this journey offered Nansen possibilities of excitement in another form. In the previous year a passenger in the post-car had been stripped and robbed while the mail-carrier at his side had been shot dead, and only a few months before Nansen's trip another passenger had had a bullet through both his knees. As it fared, however, the assurance that the road was now safe from these little attentions from the mountain tribes was justified and the party arrived at Vladikavkas in safety. The danger was very real, for in these remote valleys isolation has preserved the fierce and indomitable character of tribes who held off the Russian arms for so long. As Nansen loosely but graphically says, there are more people of different race and speaking different languages in this small area than in any other spot in the world.

Of the magnificent scenery which once made the Caucasus one of the holiday grounds of the Russian Empire and of the resources of the country the author has given a vivid word picture which he has supplemented with some striking photographs. He notes the remarkable proclivity of the Georgians for building magnificent churches on inaccessible heights, inclining to the explanation that it is an expression of the Persian doctrine that on the lofty holy mountains we are nearer to heaven and to God. He does not incline to the view of that delightful old seventeenth-century traveller, Chardin (whose account of the Georgians has much that is still true to-day), that they chose this situation for their churches " to get out of decorating them or keeping them up, as it was seldom that anyone went there " —a reason which he, at least, considered in full accord with the rest of their actions. He does not appear on the whole to have cared very much for the Georgians.

Nansen was much impressed by the number of different tribes he saw near the military road, and he describes their character and culture at some length. He was also much attracted by their folklore, from which he quotes freely, and institutes a comparison between Scandinavian and Ossete mythology and the paganism beneath the orthodoxy of the latter with its holy groves in which now stand the altar and church. Prometheus still lies chained to Kasbek, the highest peak of the Caucasus, still expiating his sin of stealing fire from heaven for the use of man. Now, the people of the mountains say, he is old, his hair is white, like his beard, which reaches his feet, and his whole body is covered with hair. He is glad to see anyone who comes to him, but anyone who tries to visit him more than once never returns. The old man asks after the present state of the land, whether the young people are taught in the school, and whether the wild fruit trees bear much fruit, and when he is told " no ", he is sorely afflicted.

Nansen was keenly interested in social, political, and economic conditions in Daghestan and discusses them at some length. Daghestan is now one of the Soviet Socialist Republics ; but in religion it is Moslem. The Soviet Government has shown itself unusually tender to this religion ; but, owing to the preponderance of Moslem schools and the administration of justice among Moslems by their own religious officials, apprehension is beginning to be felt lest Moslem influence should become too great. For this there is probably good ground. It makes the situation as interesting to outsiders as it is difficult for the authorities. For the people of Daghestan before the War were said by some, who professed to be competent to judge, to be the most fanatical of all Islam. This is probably an exaggeration; but a country in which thirty-two different languages are spoken by as many and more separate races, and where blood-feud and blood-revenge are widespread, is likely to afford any government a sufficiency of problems without the addition of religious intolerance. The amazing career of Schamyl, a Rob Roy of the Caucasus on a heroic scale, who held back the Russians in a guerrilla war for more than thirty years and only surrendered in 1856, had a fit setting. His career conveys a warning which the Soviet Government is scarcely likely to ignore.

It says much for Nansen's powers of observation and narrative that, after the incidents of the Caucasus, Astrakhan and the Volga with its sturgeon fisheries, though on a lower key, are no anticlimax. The author would surely never have allowed his book to appear without a map. There are few regions for which a map is more necessary.

All who read this book, which is a striking example of the author's powers of observation and quickness in seizing the essentials of a situation, will feel the inevitable pang of regret that this acute and sympathetic intellect will travel no more.

Chemistry through the Ages.

Makers of Chemistry. By Eric John Holmyard. Pp. xvi + 314. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 7*s.* 6*d.* net.

MANY efforts have been made to assign an origin to alchemy. In less critical and sophisticated ages than ours, individual founders were sought: for example, in Thoth or Hermes; in Muhammad or the Caliph Ali; in Aristotle, Plato, Pythagoras, or Democritus; and in the patriarchs. Thus, Moses, from his convincing manipulation of the golden calf, was elected a member of "this strange chemical society"; Miriam, his sister, was added on account of her supposed invention of the water-bath; Tubal-Cain was welcomed as the metallurgical expert; Cleopatra, a second and rather disturbing woman member, was elected in recognition of her early work on calcium acetate; Jason was admitted as the first gold-maker; Hermes evidently troubled the publication committee with his 36,000 original contributions to chemical literature; "finally", as Dr. Holmyard remarks, "the *Song of Solomon* is an alchemical treatise, and chemistry is so called because it was invented by Noah's son Shem or Chem"! According to this intriguing conceit, Shem may have fitted up the first chemical laboratory in the Ark!

In recent years it has been suggested that alchemy arose in China from the philosophy of Taoism. Dr. Holmyard, however, quotes with approval the belief of von Lippmann, "the greatest living historian of chemistry", that alchemy proper reached China from the west in the eighth century: "in A.D. 714 the first Arab ships dropped anchor at Kanton, and thereafter trade developed with amazing rapidity". Dr. Holmyard casts his vote for "the probable truth of the tradition that chemistry first saw the light in the laboratories of Egyptian priests". Later, at Alexandria, Egyptian practice made effective contact with Greek scientific thought; Greek knowledge and theories were transmitted in turn to Islam; fresh material came in from surrounding countries, including perhaps even India and China; and eventually the accumulated knowledge of the Muslim chemists was disseminated throughout western Europe.

The tenor of these comments will perhaps suggest that Dr. Holmyard's "Makers of Chemistry" is something more than a series of biographical sketches of eminent chemists, such as he presented in his earlier work on "The Great Chemists". The book under notice is, indeed, a history of 'the noble science'; further, it is decidedly the best and brightest of the short histories of chemistry with which the present reviewer is acquainted. A novel point, which strikes the reader at the outset, is that the author has abandoned the customary division into chapters for a more fluid arrangement in a series of 58 sections, of which the following succession (Nos. 12 to 17) is illustrative: neo-Platonism, the fusion of practice with speculation, Zosimos the Panopolitan, a retrospect, the rise of Islam, the origins of alchemy in Islam. This device, blended with a skilful selection of the material, has resulted in a smoothly flowing narrative, seasoned with spirit and colour, which holds the attention from beginning to end. Indeed, it occurs to us that the professional teacher of chemistry (and even the professional student, if the term be admissible) may object that the treatment is too delicate, and that a subject which has so often been handled with a ponderosity proportionate to its importance should not be turned into a light and graceful similitude of a historical novel.

It must not be imagined, however, that Dr. Holmyard has reached so pleasing a result by shirking the primary duties of the historian. On the contrary, the weighing of evidence, the appraising of achievement, the portrayal of personality, the isolation of the salient features of an age, have all been undertaken in a manner worthy of the high reputation of the author. If he relaxes at all from his attitude of rigid and impersonal impartiality, it is when he deals with those former Cinderellas of historical chemistry—the Muslim chemists and the phlogiston theory. Thus, our author says of Razi that he " must be accepted as one of the most remarkable seekers after knowledge that the world has ever seen . . . with the possible exception of his acknowledged master, Jabir, Razi was the most noteworthy intellectual follower of the Greek philosophers that mankind produced for 1900 years after the death of Aristotle ". And here is his eloquent farewell to phlogiston :

" As Priestley's splendid but lonely figure disappears over the horizon, the old theory vanishes for ever. It was a great and brilliant theory, and served chemistry well : the reader will therefore feel a peculiar pleasure in learning that the victors always spoke of it with respect. One of them truly remarked that ' it made chemistry a new science by the precision of its luminous ideas ', and that its simple and easy principles had long been a compass to guide the path of each and every chemist."

Many chemists, however, will continue to hold that although the phlogiston theory—that ' veritable Proteus ' of Lavoisier, which changed its form at every instant—to some extent co-ordinated facts which might otherwise have remained in isolation, yet in the main the notable chemical discoveries of the phlogiston period were made in spite of the theory rather than as a consequence of it.

Roger Bacon is characterised as the epitome of his age rather than as a thinker in advance of it. Paracelsus's chief merit " lies in his emphatic opinion as to the aim of chemistry. . . . The honourable task of the age of iatrochemistry . . . that he inaugurated was to make the way clear for a reasonable medicine ; but it did more—it made the way clear also for a reasonable chemistry." Later, we read of Joseph Black that he " is correctly regarded as one of the greatest chemists of one of the most fruitful periods of chemistry, and his fame rests upon impregnable foundations ".

In discussing the Greek atomists, Dr. Holmyard wisely remarks that " it is fatally easy to read into the views of bygone scientists ideas of a later period ". Thus the superficial resemblance between the classical and modern theories of atomism " very largely vanishes in the light of close inspection ". In other words, each age has its own point of view, which the successful historian must learn to assimilate and understand. " Although Mayow appreciated the necessity of air for combustion, and the similarity between combustion in air and deflagration in nitre, he had no real conception of the true nature of burning or of the composition of the air."

The presentation of the chemical story is enhanced by the author's knack of providing it at intervals with a thumb-nail suggestion of its general historical setting. There is a wealth of illustrations, admirably selected and reproduced. The text, moreover, abounds in quotations from original sources ; these are so illuminating that the chemical reader will possibly regret the omission of the exact references which would allow him to identify them in the originals. Of errors in detail we notice surprisingly few in a work of this amplitude, but it may be remarked that van 't Hoff's space theory (p. 238) dates from 1874, and that it would be preferable to include oxygen in referring to the elementary composition of organic dyes (p. 274).

In concluding, one cannot do better than quote the following reflections upon the position of chemistry a hundred years ago and now :

" The ' makers of chemistry ' — those who fashioned it into the science as we know it—had accomplished their work, and a chemist of 1831 would feel more at home with the chemistry of 1931 than with that of 1781. True, he would be at first bewildered by the multitudes of new compounds, new elements, new reactions, new applications, but he would find the oxygen theory still reigning, the name of Dalton in present reverence, and Avogadro's hypothesis in universal currency. After the first amazement had evaporated he would realise that the basic theories of modern chemistry were the basic theories of his own day ; he would find expansion, extension, modification, but no such revolution as that which was witnessed by the closing years of the eighteenth century. The world has produced chemists of scintillating genius in the nineteenth and twentieth centuries, but their work, marvellous though it be, is but a working out of the principles laid down by Lavoisier, Dalton, and Avogadro." JOHN READ.

Short Reviews.

Textbook of Quantitative Analysis. By Prof. William Thomas Hall. Pp. vii + 279. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 12*s.* 6*d.* net.

THIS book sets out in detail a course in analytical chemistry for the more advanced grades of intermediate students, who are likely to proceed to a final course in some branch of chemistry. It is based largely on Treadwell and Hall's well-known work, and is complete for the purpose in view so far as inorganic analysis is desired. An introductory course of organic analysis might, we think, have been included with advantage, even at a sacrifice of some of the more specialised portions such as the chapter on steel analysis and tungsten and titanium in ores. Prof. Hall takes the line that it is more advantageous for the student to begin analytical chemistry with volumetric analysis, on the ground that the student is likely to obtain a better view of the subject. This may well be the result in practice, for a volumetric process may be a far more searching test than a gravimetric. A feature of this work is the attention devoted to potentiometric methods. The chapter assigned to this is necessarily a short one in the circumstances, but is nevertheless a desirable addition to a book of more or less elementary character. The volume is free from printing errors, is well got up, and may be commended for its general utility as an intermediate textbook of analytical chemistry.

J. J. F.

La mesure des rayons de courbure des surfaces sphériques employées en optique. Par Albert Arnulf. Pp. 179. (Paris: Éditions de la *Revue d'Optique théorique et instrumentale*, 1930.)

THIS monograph by the director of practical work in the Institute of Optics at Paris gives an excellent account of the theory and practice of the measurement of the radii of spherical surfaces used in optics. The first part deals briefly with the ordinary and dihedral spherometers, their use and errors. The second part, about two-thirds of the book, gives a full account of the method of the dihedron of G. Burch as developed by Fabry, both for workshop and laboratory use, of the method of tangent spheres invented by Fabry, and of interference methods as practised in the laboratory of the Institute of Optics. The remainder of the book deals fully with the autocollimation methods, due originally to Guild, improved by Prytz, and perfected in the Institute, and also gives an account of the various pieces of apparatus built for carrying out these methods.

The book is well illustrated by diagrams and drawings of the apparatus described, and freely supplied with tables giving the results of laboratory experiments and the errors incurred in the various methods. It is extraordinarily complete for its size, and will no doubt prove of the greatest use to those engaged in the measurements indicated and in the construction of the optical apparatus needed.

Faraday. By E. W. Ashcroft. Pp. 134. (London: The British Electrical and Allied Manufacturers Association, 1931.) 7*s.* 6*d.* net.

WITH the forthcoming celebrations of the centenary of the discovery, on Aug. 29, 1831, by Michael Faraday of electromagnetic induction, the interest of scientific workers and of the general public will turn towards the life-story of this remarkable man. His friend and contemporary, Dr. Bence Jones, published a biography, but the time has now come when we can appreciate better the permanent value of Faraday's life and work. Early this year, Mr. Rollo Appleyard issued a brief 'life', and Mr. E. W. Ashcroft has now produced an equally brief survey but of a different type; whereas Mr. Appleyard gave us an intimate view of Faraday, Mr. Ashcroft deals rather with broad aspects of his work and philosophy. He takes successive periods in Faraday's career and endeavours to trace from his writings and from those of his contemporaries, both British and foreign, the growth of his character and work.

As a book, we may criticise the lack of headings to the twenty short chapters and the absence of an index, but we prefer to regard it as an inspiring little souvenir of a great but very human man, whose work marks the inception of an important stage in the progress of civilisation.

Epidemiological Essays. By Dr. F. G. Crookshank. Pp. ix + 136. (London: Kegan Paul and Co., Ltd., 1930.) 7*s.* 6*d.* net.

THIS little book, by a well-known consultant physician interested in epidemiology, consists of ten papers which, with the exception of the essay entitled "Why Times Flies", contributed to *Psyche*, have all been previously published in various medical journals. It may be doubted if some of the papers included were worth saving from the well-merited oblivion which enshrouds most contributions to the medical press; but those interested in the history of medicine and epidemiology are advised to read the essay on the "Trousse-Galants" of 1528–29 and 1545–46, a mysterious disease which seems to have been a severe form of influenza, and that entitled "Some Problems of Influenza", in which the author discusses the periodicity of the disease and the correlation between influenzal prevalences and cosmic and telluric influences.

Introduction to Human Parasitology. By Prof. Asa C. Chandler. Fourth edition, rewritten and enlarged, superseding "Animal Parasites and Human Diseases". Pp. xiv + 655. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 25*s.* net.

THIS volume is an extended form of an earlier book which was intended for students and the lay public. This larger edition should be more useful to students of biological and medical sciences where an intensive study is not indicated. Its presentation is clear and readable. A short, incomplete account of filterable viruses is included with protozoa, helminths, and arthropods. Only animal parasites are dealt with.

Modern Diving Devices.

By Capt. G. C. C. DAMANT, C.B.E.

THE rubber diving dress evolved by Siebe a hundred years ago extended the useful range of human activities to rather more than a hundred feet below the surface of the sea, and for several years engineers and physiologists have been striving in their respective spheres to double or treble this working depth. Much progress has been made, and as an example of the most advanced methods now in use we reproduce, by courtesy of Messrs. Siebe, Gorman and Co., Ltd., two illustrations (Fig. 1) of the Davis submersible decompression chamber already described in these columns (NATURE, March 15, p. 415; 1930) and to the British Association at its Bristol meeting last year. The diver on finishing his work ascends not to the salvage ship but to this chamber, and, clambering in, finds an attendant waiting to divest him of the helmet and lead weights; the two men close the bottom door, and the chamber, retaining air at any desired pressure, is hoisted on board the salvage ship, which is then free to manœuvre or explode blasting charges while the diver is being slowly decompressed. Within his range the rubber-suited diver will always be supreme, but for objectives still beyond his reach another system is being developed.

Beebe and Barton (*Bulletin New York Zoological Society*, Nov.-Dec. 1930; see also NATURE, **126**, p. 220, Aug. 9, 1930), wishing to investigate life in the ocean at far greater depths than man had ever attained, adopted a method of admirable simplicity which H. G. Wells had foreseen in one of his early short stories. They constructed a spherical observation chamber (Fig. 2) capable of withstanding the external hydrostatic pressure of 2000 feet of water, furnished it with quartz windows, a telephone, simple apparatus (including two palm leaf fans) for renewing the air vitiated by respiration, and in it they were eventually lowered to a depth of 1400 feet in the sea off Bermuda, where many interesting observations were made. Their 'bathysphere' was a single steel casting 4 ft. 9 in. in diameter and 1½ in. thick; it weighed 2¼ tons in air and ⅞ of a ton when submerged. Beebe, who with his companion spent 1½ hours in it on his principal descent, seems to have been quite comfortable, and writes, "I never realised how much room there was in a sphere four and a half feet in diameter". He found that blackening the interior made it easier to distinguish objects in the dimly lit waters outside, and that something warm and dry to sit on should by no means be forgotten. Since the adventurers were breathing air at atmospheric pressure, no question of compressed air illness arose.

To combine the flexibility of Siebe's dress with the protecting rigidity of Beebe's sphere has been a dream of enthusiasts for at least fifty years, and in 1923 Neufeldt and Kuhnke in Germany produced what at last seemed to be its practical realisation. Their steel dress, nicknamed 'The Iron Man', weighs about 800 lb. in air and has exquisitely constructed joints, watertight yet capable of movement at a depth of 500 feet under an external hydrostatic pressure of 220 lb. per square inch. The diver breathes air at atmospheric pressure, the necessities of respiration being provided for as in the bathysphere. The mechanical tongs in which the arms terminate are well seen in Fig. 3, as well as the telephone cable and steel wire by which the apparatus is raised and lowered.

The inventors soon gave ample demonstration at sea that their apparatus enabled men to descend 400 feet deep in safety, but technical opinion in Great Britain remained unsatisfied that the limbs could be moved with sufficient freedom and the tongs manipulated with sufficient accuracy to do much useful work. However, the Italian salvage company, 'Sorima', of Genoa, took up the invention and exploited it with extraordinary skill and energy in salving the cargoes of ships sunk at great depths during the War. Their remarkable successes, culminating in the location of the famous wreck of the *Egypt* off Ushant, are worthily described in a recent book,[1] the writer of which combines the shrewdest observation with vivid and witty descriptive powers, so that it will be read with lively pleasure by salvage engineers as well as the general public. The former will find it significant that in the hands of the Italian experts the original iron man has undergone a process of involution. At first there were twelve joints, three to each limb; next, the total number of joints was reduced to six; and finally the jointed appendages were cast off altogether, leaving the diver enclosed in a limbless rigid steel shell, where he becomes, as Scott says, "merely the directing brain of the salvage ship, which does its work by machinery under his control".

A limbed suit is still held in reserve, but one infers that, after years of experience, those best qualified to judge have found that the amount of work that can be done by this sort of apparatus does not justify its cost and complication. The observation chamber on which the Sorima now relies differs externally from the bathysphere in being of tapered cylindrical form, and, as a protection in the hurly-burly of salvage work, possessing a buoyancy chamber by which the occupant can cause it to float to the surface in case of breakage of the supporting cable.

It is odd that such a simple method and one requiring so little strength or skill in the diver, has not been used before; often it is desirable for engineers to inspect submerged structures, and many of them, from a sense of duty, have acquired enough of the technique of the rubber suit to be able to go under water, but it is very difficult for anyone not thoroughly practised in diving to make a critical inspection: tides sway the tyro about,

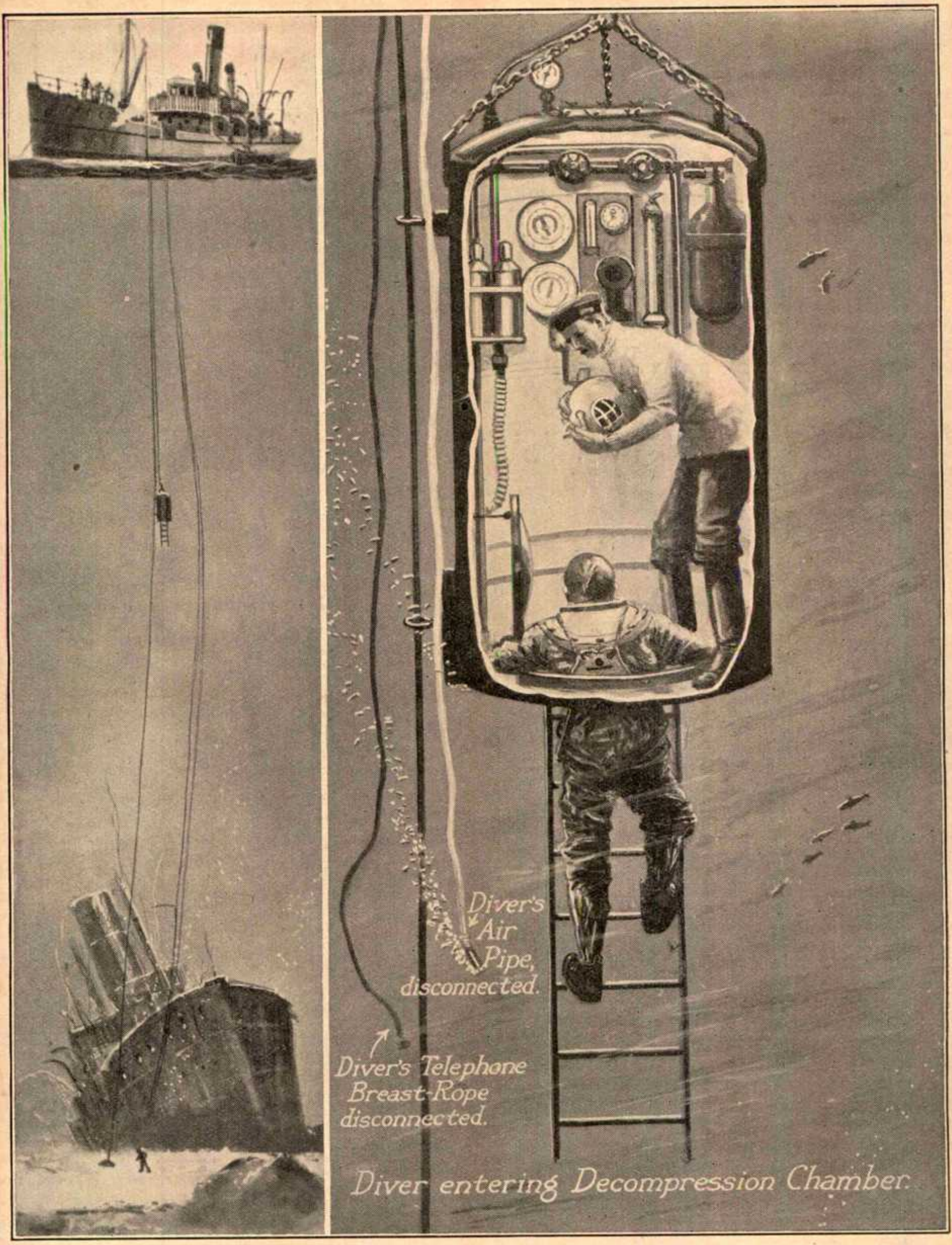
Diver's Air Pipe, disconnected.
Diver's Telephone Breast-Rope disconnected.
Diver entering Decompression Chamber

FIG. 1.—The Davis submersible decompression chamber. On the left, the chamber is slung in mid-water ready for the diver's ascent. On the right, the diver is entering the decompression chamber, which, until the lower door is closed, acts like a diving bell. The attendant has removed the diver's helmet and disconnected his air-pipe and breast rope.

he flounders and, stirring up the mud, obscures his own vision, his breathing is laboured and the discomfort so great that judgment is apt to be hasty; moreover, for elderly men the thing is impossible. The same man in a suitable observation chamber could be travelled by overhead tackle from one end of the work to the other without the least exertion. Beebe was surprised to find what misleading information his nets had been giving about the distribution of the bathypelagic creatures, and it seems certain that under-water observation will sooner or later be used in solving practical fishery problems; it is to be hoped that Great Britain, which used to lead the world in diving, will not be the last to divert some of her marine biologists from determining salinities and measuring herrings to going under water and watching the reactions of fish to the baits on a long line, or even to being towed along in the mouth of a trawl to see what proportion of fish dodge it and how they may be circumvented.

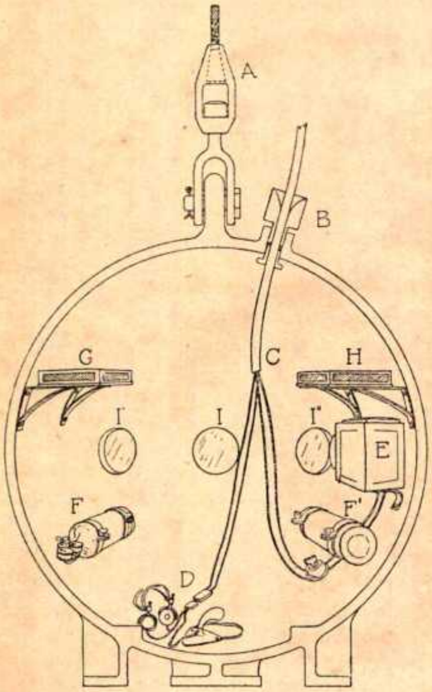

FIG. 2.—Section of the bathysphere. A, swivel for attaching cable to sphere. B, stuffing box through which electric cable enters sphere. C, electric cable, containing two wires for the telephone circuit and two for the electric lights. D, telephone. E, searchlight with beam focused through window I″. F, oxygen tank ready for use with valve attached—one dial showed the amount of oxygen remaining in the tank, the other the rate of discharge. F′, reserve oxygen tank. G, tray containing soda lime for absorbing carbon dioxide. H, tray containing calcium chloride for absorbing moisture. I, main observation window, 6 in. in diameter. I′ and I″, windows for searchlights. The windows were discs of fused quartz 3 in. thick and 8 in. in diameter.—From *Bull. New York Zoo. Soc.*, vol. 33, No. 6. By courtesy of Mr. William Beebe.

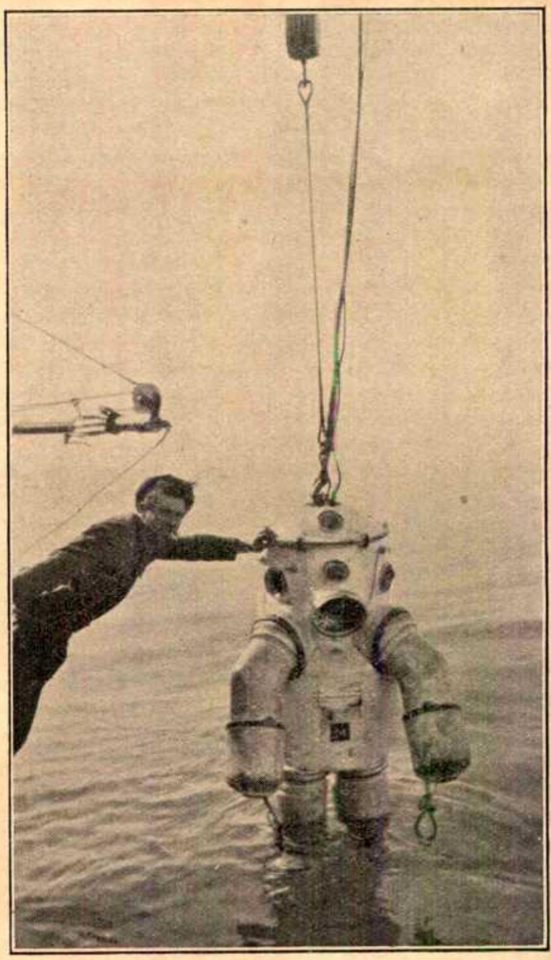

FIG. 3.—Neufeldt and Kuhnke's 'iron man' articulated shell.

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[1] Seventy Fathoms Deep: with the Divers of the Salvage Ship *Artiglio*. By David Scott. Pp. 288+32 plates. (London: Faber and Faber, Ltd., 1931.) 12*s*. 6*d*. net.

Diet and Disease.

REFERENCE has already been made in these columns to certain recent dietary surveys[1, 2]. From such researches it is possible to enlarge our knowledge of the types of diet which different peoples or individuals may find adequate, to point out in what respects diets in common use may fail to satisfy accepted standards, in certain cases to correlate prevalent diseases with a particular type of diet and, by means of additions to the food supply, to confirm the results of the survey and indicate how the diet may most simply be improved. A recent report by Orr and Gilks is of great interest, since the investigators find a marked correlation between diet and physique and general health.[3]

The survey was carried out on two tribes living in Kenya, the A-Kikuyu, who are agriculturists, and the Masai, who are pastoralists. The Kikuyu diet consists chiefly of cereals (maize or millet), tubers, plantains, legumes, and green leaves. Only the women eat green leaves in any quantity; moreover, the consumption of edible earths (salt) is almost confined to them and children up to five years of age. Analysis of the dishes in common use showed that the diet was probably adequate in calories, protein and phosphorus, but low in fat for both sexes. The intake of calcium by the men was definitely subnormal, and probably that of sodium also; the women obtained more of these elements from the green leaves and salt consumed, and their intake of them was probably adequate: some of the edible earths eaten also supplied additional iron.

In contrast to the Akikuyu, the Masai live chiefly on meat, milk, and blood, with small amounts of cereals or fruit. The milk is richer in protein, fat and sugar, than English milk, but poorer in all inorganic constituents except calcium. The diet supplies a large excess of protein and fat, and a liberal supply of mineral elements, but is low in carbohydrate, cellulose, and other indigestible residues. The diet of the women was less extreme than that of the men and approached in composition that of the Kikuyu women.

Physical measurements showed that the Masai men were 5 in. taller and 23 lb. heavier on the average than the Kikuyu men, and the women 3 in. taller and 27 lb. heavier than the Kikuyu women. The Masai are typically larger in the chest and smaller in the abdomen than the Kikuyu. Dynamometer readings showed that the Masai men can exert a hand pressure 30 lb. greater than the Kikuyu; the latter, in fact, are only as strong as the Masai women, but their maximum pressure is about 10 lb. greater than that of their own women.

The incidence of disease was found to be very different in the two tribes. Among the Kikuyu children bone deformities, especially those of late rickets, dental defects, and anæmia were common, but relatively uncommon among the Masai. The incidence of enlarged tonsils and cervical adenitis was the same in both tribes, occurring in about half of the children examined. In the case of the adults, respiratory infections and ulcers were common among the Kikuyu, intestinal stasis and arthritis among the Masai. The Kikuyu women appeared to be less susceptible to disease than the men and were generally in better physical condition.

Some experiments were carried out on native prisoners, on hospital and prison diets, with the object of confirming the inadequacy of the native dietaries, by making additions to the diets and noting any improvements in the retention of different elements or in the composition of the blood. The diets were considered to be inadequate in calcium, and possibly some other inorganic constituents, and in vitamins A and D. The salt supplement was given as a mixture made up to supply in the daily dose approximately the amount of minerals present in 1 pint of milk; the vitamins were supplied in cod liver oil. In adult Kikuyu, it was found that the minerals, especially when given with cod liver oil, increased the calcium retention and also raised the level of the blood calcium, which is lower than that of Europeans at home or in Kenya. With growing Masai boys, it was found that a milk supplement was the most effective in increasing the weight and the calcium retention. The mineral mixture, calcium carbonate and bone flour, also increased the retention of calcium, but cod liver oil had little effect: it appears, therefore, that the chief deficiency in the diets is that of calcium. Bone flour also increased the retention of phosphorus. It was also found that a reformatory diet of maize, potatoes, and beans with ghee and salt did not permit of maximum growth; milk, maize and bone flour and maize supplements increased the growth rate of the boys, milk being the most effective. The diet appeared to be low in energy value as well as in calcium.

Tropical ulcer is common among the Kikuyu but comparatively rare among the Masai. Its incidence could not be correlated with the presence of malaria, syphilis, or intestinal parasites. Although slight injuries appear to precipitate its development, it is difficult to believe that they are the sole cause. The number of cases increases at the end of the dry season. Examination of the blood disclosed the fact that the inorganic phosphorus was very definitely raised in cases of ulcer as compared with other natives or Europeans in Kenya; the serum calcium was about the same in all natives and below the European level. A similar change in the direction of high phosphorus and low calcium occurs in animals on diets containing an excess of the former but deficient in the latter, suggesting that the abnormal ratio between these elements in the native diet is responsible for the change in the composition of the blood; the very high level of the blood phosphorus in ulcer cases, however, is not explained. The evidence certainly suggests that diet plays a large part in the ætiology of ulcer, presumably by decreasing the patient's resistance to trauma. No dramatic healing of ulcers was however produced when additions were made to the diet, although it appeared that they healed more quickly as the patient's general condition improved.

The observers conclude their survey with suggestions for the improvement of the diet of the tribes; both should consume more green vegetables, and the Kikuyu should also drink milk. The preliminary step would be a general improvement in agriculture and animal husbandry, especially among the Kikuyu.

The study is a striking illustration of the fact that man does not invariably select for himself a suitable dietary: it discloses that the incidence of disease among natives may be higher than among more civilised nations, which nevertheless consume 'artificial' rather than 'natural' foodstuffs. Finally, from the varying incidence of different diseases among the two tribes, it suggests that similar diseases among civilised peoples may also have a fundamental dietetic basis.

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[1] NATURE, Vol. 126, p. 963; 1930.

[2] NATURE, Vol 127, p. 897; 1931.

[3] "Studies of Nutrition: The Physique and Health of Two African Tribes". By J. B. Orr and J. L. Gilks (for the Dietetics Committee of the Economic Advisory Council). Medical Research Council Special Report Series, No. 155. (London: H.M. Stationery Office, 1931.) 2s net.

The Faraday and British Association Centenaries.

THE Royal Institution, the Institution of Electrical Engineers, and the British Association have recently issued programmes of the various events arranged in connexion with the Faraday centenary celebrations and the British Association centenary meetings, being held in London in September. From these, it will be seen that the Faraday centenary celebrations will begin with a reception of the delegates in the Royal Institution on Sept. 21 and conclude with the closing of the Faraday Exhibition on Oct. 3, while the meetings of the British Association will extend over the period Sept. 23–30.

The principal events of the Faraday celebrations will take place, with certain exceptions, on Sept. 21–23. At 11.30 A.M., Sept. 21, an informal meeting will be held in the lecture theatre of the Royal Institution, when an explanation of the programme will be given in English, French, and German, and at 3 P.M. the delegates to the celebrations will be received in the lecture theatre by the president and managers of the Institution. The Faraday commemorative meeting will be held that evening at 8 P.M., in Queen's Hall, Langham Place. W.1. Short speeches will be made by distinguished representatives of institutions in various parts of the world. Music will be given by the Symphony Orchestra of the British Broadcasting Corporation, under the direction of Sir Henry Wood, and the proceedings will be broadcast.

The proceedings of Sept. 22 will begin at 10.30 with a conference of the Institution of Electrical Engineers, to be held at Kingsway Hall, Kingsway, W.C.2. Speakers will include Mr. C. C. Paterson, (president), Mr. Ll. B. Atkinson, Miss C. Haslett, Mr. J. S. Highfield, Sir Oliver Lodge, and Sir Josiah Stamp, the subject for the conference being " The Place of Electricity in the Production and Utilization of Power, and in Transport, Communications, and the Household ". On that evening, at 8.30, conversaziones will be held by both the Royal Institution and the Institution of Electrical Engineers, the conversazione of the latter taking place at the Albert Hall, thus enabling the guests to have a private view of the Faraday Exhibition.

The Faraday Exhibition has been organised by the Institution of Electrical Engineers, assisted by the Royal Institution, in regard to Faraday's original experiments, and by the Federal Council for Chemistry, in relation to chemical discoveries. It will be formally opened to the public at 4.30 on Sept. 23, and will remain open until the evening of Saturday, Oct. 3, the charge for admission being 1*s.* for adults and 6*d.* for children under fourteen. The exhibition is being planned to illustrate the developments of electrical and chemical science and industry in all branches which have followed Faraday's work. Around a statue of Faraday, in the centre of the hall, will be an exhibition of historic apparatus, and from this the exhibits will spread out radially, so that at the outer circumference of the hall will be found the latest examples of electrical apparatus and machinery. There will be nine sections in all, relating to such things as the generation, transmission, and distribution of electric power, electric transport, domestic uses of electricity, and the many branches of electric communication.

In the Albert Hall also, on Sept. 23, at 3 P.M., Lieut.-Gen. the Right Hon. J. C. Smuts will assume the presidency of the British Association, and will receive the invited delegates to the centenary meetings of the Association. At 4.30 P.M., at the invitation of the Institution of Electrical Engineers, he will open the Faraday Exhibition. These will be the inaugural proceedings of the British Association, and in the evening at 9 P.M., in the Central Hall, Westminster, General Smuts will deliver his presidential address.

In addition to these events, the Royal Institution has arranged for a garden party on Sept. 24, at the National Physical Laboratory, by the invitation of the director, Sir Joseph Petavel; and on the evening of Sept. 25, His Majesty's Government will entertain representative delegates and guests to dinner at the Dorchester Hotel, Park Lane. The Prime Minister, Mr. Ramsay Macdonald, hopes to preside. Various visits and excursions are being arranged, and the rooms of the Royal Institution will be at the disposal of delegates and guests from Sept. 12 until Sept. 26.

In connexion with the British Association meetings, a volume is being issued to members, entitled " London and the Advancement of Science ", containing a historical survey of the advancement of science in London through the principal scientific, educational, and State institutions, etc., by various authors ; together with another on " The British Association : a Retrospect, 1831–1931 ", by Mr. O. J. R. Howarth. This is a revised edition of the volume issued in 1922 through the generosity of the late Sir Charles Parsons. It was in 1831, at York, that the Association held its first meeting, and York has been chosen for the meeting in 1932. But an invited party from the Association will pay a visit to its birthplace on Saturday and Sunday, Sept. 26-27, in the middle of the present meeting.

The publications from which these particulars have been taken contain much further information regarding the general arrangements, railway fares, hotel accommodation, passport visas, etc.

Attention may also be directed to a small pamphlet issued by the Metropolitan Borough of Southwark about the Faraday Memorial Library, which was opened in Southwark in 1927. Faraday was born at a house in Newington Butts in the borough, in 1791, and the library, which was established to commemorate his work, now contains some 1800 books devoted to the life and work of Faraday, with text-books and periodical publications of scientific societies. It is maintained by a small endowment fund in the hands of four trustees.

News and Views.

ALTHOUGH it has been exhibited there before, the walrus is sufficiently rare in captivity to make the recent acquisition of two young specimens by the Zoological Gardens at Regent's Park, London, a noteworthy event. Walruses are delicate animals in captivity, perhaps because those that come to land are young, tuskless individuals. It is said that the walrus-cub is suckled by its dam until the tusks appear, so that it may be that the change from the maternal milk diet is at the root of the trouble. At the same time, there is no doubt that some species exhibit innately poor viability in captivity, and that these are sometimes the most robust-looking, and not highly specialised in diet: thus, the gorilla is delicate as well as the walrus, and the capercailzie is the most difficult subject of all the game-birds. The walrus is not only interesting scientifically, but also is a good popular exhibit, for its face exhibits a curiously close caricature of humanity. It would seem, therefore, that Tacitus was playing the arm-chair critic when he cynically suggested ("Annals", ii. 24) that the "marine monsters, forms half-human, half-bestial", told of by returned legionaries of Germanicus after a storm in the North Sea which drove some of them as far as the coasts of Britain, might have been "conjured up by their fears"; for the walrus, which even at the present day occasionally visits our northern coasts, would no doubt have been well in evidence farther south at that date—the early years of the first century of our era. These men also reported "unknown birds", which were also probably not imaginary, as the Great Auk would be equally likely with the walrus to be present and attract attention there and then.

"LIVE and let Live", a plea for the preservation of wild life, is a pamphlet supporting the activities of the newly founded "Association for the Preservation of Game in the United Provinces" of India. Already the Forest Service of the Government has taken a firm stand for the preservation of the wild life within its jurisdiction, but more is required. This new Association is setting out to educate public opinion in the need for the protection of wild life, to encourage the study of natural history in schools and the protection of 'game' in private territories, to check unnecessary slaughter by the public, to co-operate with the Government along similar lines, and, lastly, to create and keep up a national wild game reservation in the United Provinces, where representative Indian animals shall be preserved for all time, and shall be available for the enjoyment and inspection of the people of India. The objects of the Association are worthy of the support of all interested in the preservation of wild life, and the pamphlet, which is signed by Hasan Abid Jafry of Agra and Major J. Corbett of Naini Tal and is countersigned by several Indian and English men of standing, appeals for members and for subscriptions towards the accomplishment of its aims. Contributions should be sent to the Honorary Secretary, Hasan Manzil, Shahgani, Agra, U.P., India.

IN an article in the *Auk* (vol. 48, 1931, p. 22), Dr. Joseph Grinnell, who has done much for the interpretative study of birds in western America, sets out to discuss some problems of the migrations of birds from what he calls a rational point of view. He would shun all notions of mystery and unfathomableness and would attack each problem as if it were a simple thing capable of being "understood eventually in all its details upon the basis of facts discriminately gathered and rationally interpreted". The first batch of results from this inquiry are such as these: that "birds are primordially equipped easily and quickly to cover territory by flight through air" and that "they react in all sorts of ways with exceeding speed and accuracy", fairly obvious conclusions, though the latter in this very general form still requires proof. Dr. Grinnell further deduces that the migration habit in birds is due to a development of ordinary feeding journeys, that it is as easily acquired or discarded as any other habit, and that the factors that induce, maintain, and modify habits of migration are in all likelihood precisely the same as those which control general geographic distribution in all the higher vertebrates.

THIS is travelling pretty far along the line of assumption, reasonable though the assumptions seem to be. Nor does it seem very helpful simply to state that the senses used by birds in finding their way during long seasonal migratory flights are the same as those used in the course of their daily movements. The fact is that Dr. Grinnell, having accepted (curiously enough without proof) the assumption that wonder is inconsistent with rationality, puts the gloss of simplicity over the problems of bird migration. In all probability it is no more accurate to think that when a man wonders he stands with his mouth open and brain paralysed, than it is to assume that simplicity in Nature is necessarily more truthful than complexity and mystery. The fact remains that there is much in the migration of birds that is problematical or mysterious—the best two general books on the subject, English and German, use the word 'problem' in their titles, as Dr. Grinnell does in his—and the scientific approach by way of the analysis of the wonder-arousing phenomenon seems to us to be perfectly legitimate.

IN view of the stories current in the tropics of both hemispheres of dangerous snakes resorting to a spot where a member of their species has been killed, a note in the *Field* of Aug. 8 (p. 218) deserves attention, although appearing over initials (E. P.) only. A milkman of Godalming, it relates, killed a grass snake, measuring 38 inches, and full of eggs, in the road; and, on revisiting the spot next day, found no less than 16 other snakes by the dead one, of which he killed all but two, and was apparently photographed along with them, since a photograph of a young man festooned with snakes of various sizes illustrates the note. He did not, it seems, know what the unfortunate reptiles were or that they were harmless. It is certainly a great pity that, with so limited a wild-life list as ours, such ignorant slaughter should still take place; but the congregation of all these snakes about a dead female, and that a pregnant one, certainly calls for inquiry into its cause.

The presidential address of Sir Henry Miers to the Museums Association at Plymouth, like his former addresses to that body, marks a stage in the progress of museums in Great Britain. It is no exaggeration to say that to Sir Henry himself that progress is almost entirely due. There were strivings in many museums, and many curators were working towards new ideals, but the president of the Museums Association has been instrumental in crystallising rather amorphous efforts and in fixing the stages by which the ideal may be gradually attained. He enumerated some of the gains of the year that has passed. A summer school for the training of curators and assistants was held in London, and this year Edinburgh is to take a share in the instruction. An exhibition was organised in the County Hall, London, to illustrate the manner in which museum specimens and works of art are being distributed by the museums to schools; and a beginning has been made with the allocation of grants-in-aid to various deserving museums from the funds of the Carnegie Trustees. We are at one with him in his praise of the increasing efficiency of the *Museums Journal* under the editorship of Dr. F. A. Bather, and welcome the announcement that the Carnegie Corporation of New York has undertaken to place a sufficient sum at the disposal of the Association for the purposes of an Empire survey of museums. Co-operative sympathy between the museums of the Empire would be for the overwhelming good of all concerned.

The completion of the Saluda Hydro-Electric Station near Columbia in South Carolina shows how the demand for electric power can alter the appearance of a country. When work was first begun on the project in the early part of 1927, the site of the development was an area of gracefully rolling hills, dotted with small farms and homesteads. The population was about four thousand, and there were three churches, six schools, and 193 graveyards in the area which is now inundated to make the largest reservoir in the world. The Saluda dam spans the river and valley for a length of nearly a mile and a half, and is almost a quarter of a mile wide at its base. Along the top of this huge wall of earth a concrete highway forming part of the State roads has been built. Motorists driving along this road have an excellent view of the reservoir, or rather, lake, as it is 41 miles long, 14 miles wide, and has a shore-line of 520 miles. It required more than a year's flow of the river to fill it. In comparison with the dam, the power station, which will have a capacity of 200,000 kilowatts, looks quite small. The Saluda development is a part of the power system of the Associated Gas and Electric Company. The power generated by water turbines is converted into electric power, transmitted at 114 kilovolts, and sold to power companies in South Carolina and neighbouring States. This should ensure the south-eastern part of the United States with an abundant supply of electric power. Photographs of the power station, the transmission lines, and the completed dam are shown in the *Westinghouse International* for August.

In the *G.E.C. Journal* for August there is an interesting paper on discharge tubes and their technical applications, by N. L. Harris and H. G. Jenkins, which shows how rapidly this application of science to industry is developing. Tubes of many types, negative glow, positive column, hot cathode, etc., are now being manufactured. Reservoirs of various gases, including neon, argon, helium, and nitrogen, are connected to the pump system, so that the tube can be filled with any gas required at the required pressure, and direct current and alternating current voltages up to 1000 are available for 'glowing' the tubes. These tubes are used for sound-film recording, picture telegraphy, television, pyrometry, etc. Discharge tubes are also used for protective devices. For example, the Osram earthing lamp can pass 50 amperes for 1/40 sec. without damage. They can also be employed economically for dimming lamps by reducing the applied pressures in lighting circuits. Tubes for rectifying alternating currents are supplied which will give 50 milliamperes at 150 volts. The largest commercial application is the use of neon signs for advertising and decorative lighting. For night flying they are of great use as beacons, landing lines, boundary lights, and obstruction and wind direction indicators. In 1904, Moore introduced long high-voltage tubes filled with carbon dioxide gas at a pressure of about a millimetre of mercury for lighting. These tubes will probably again become popular, as the light they emit is pleasing, and improved technique in manufacture has remedied defects. In 1910, Claude introduced neon tubes for decorative lighting which give a rich red light and the luminous efficiency of which is about double that of the Moore lamps. They are particularly useful for danger signals.

Statistics prove that the use of telephony in large cities is continually increasing. In the statistics, taking into account data up to Jan. 1, 1930, published in *Electrical Communication* for July, we notice that the number of telephones in use per 100 of the population is 4·7 in Liverpool but 8·7 in London, the population in the latter city being seven times greater. In Paris the corresponding number is 12·5, in Berlin 11·9, and in Rome 4·3. In Copenhagen it is 17·3, in Oslo 18·1, and in Stockholm 30·5 or nearly one telephone for every three inhabitants. In New York it is 26·3, in Chicago and Los Angeles about 30, in Seattle and Denver 31·3, in Washington 32·7, and in San Francisco no less than 40·8 telephones for every 100 inhabitants. In the British Dominions, Toronto heads the list with 28·4 telephones for every 100 of the population.

The standard frequency of alternating current supply in Great Britain is fifty cycles per second and electrical engineers are agreed that this frequency should be accurately controlled. Capt. Donaldson, the president-elect of the Institution of Electrical Engineers, has strongly insisted on the importance of having a time-regulated frequency, and this has been done in the case of the extensive system of the North Metropolitan Company, of which he is the chief engineer, for the last three or four years. It has been found possible to operate clocks from the ordinary electric mains of consumers connected to this company's networks. Such clocks can be purchased at prices ranging from three pounds upwards. It is quite possible that these synchronous clocks will gradually supersede hand-wound or hand-regulated clocks.

IN the *Journal of the National Institute of Industrial Psychology* (vol. 5, No. 7) there is a report of a lecture by Mr. Seebohm Rowntree on "Some Industrial Problems of To-day". He pointed out that, when the era of big-scale industry began, Great Britain started with immense advantages, owing to the fact that it had the cheapest coal and iron in the world, the best workmen, machines, mercantile marine, and banking system, with the result that it built up a huge export trade and maintained a higher standard of living than any other country in Europe. Gradually it has been losing ground. Mr. Rowntree attributes this partly to the debasing of currency by our creditors, to our very high real wages, to the money spent on the social services, to the conservativeness and inflexibility of employers and workmen. In the circumstances, he thinks we must either lower our standards or raise our efficiency, or maintain an ever-growing army of unemployed. Of these alternatives he discusses ways in which efficiency might be increased. He thinks that we have made more progress in dealing scientifically with the *material* side of industry than with the *human* side. We have lost in strikes and lock-outs during the last twelve years on the average more than 31 million working days. The nation that first solves the problem of how to induce a man to work as hard in the factory as if he were working for himself is secure in the industrial leadership of the world. As a step in this direction, Mr. Rowntree urges that a right selection of personnel by scientific tests should be made, so that people are assigned to the work for which they are best fitted. A good selection reduces labour turn-over, as well as the cost of training, alleviates monotony, and discloses ability that might otherwise be hidden. Next, the conditions under which the employees work must be good, and this necessitates a study of incentive systems, environmental conditions, etc. The article is suggestive and very interesting, and based on direct experience.

IN the "Summary of Progress of the Geological Survey of Uganda for 1919–1929" (Entebbe, 1931; price 4*s*.), Mr. E. J. Wayland, the director, presents an extremely useful and interesting statement of the knowledge gained during the ten years that have elapsed since his flourishing department was founded. Only a vague idea of Uganda geology was possible in 1919; now there is much to be said about the ten divisions of the geological column that are represented, about the long list of igneous rocks that have been investigated, from the Pre-Cambrian granites to the Tertiary and recent alkali-lavas of Mt. Elgon and the volcanic field of Bufumbiro, and about the tectonics and geological history. Useful minerals and water supply have naturally been given considerable prominence, since the Survey is primarily an economic one, but to geologists the chief interest of Uganda lies in such topics as its past climates, its earth-movements, rift valleys and reversed rivers, and not least in its volcanic activity. Mr. Wayland and his staff have undoubtedly one of the most fascinating countries in the world to investigate, and this admirable report, with the clearly printed provisional geological map which accompanies it, shows how enthusiastically and competently they have attacked the great problems that Uganda offers. Several excellent photographs by Mr. A. D. Combe have been effectively used as illustrations. The officers of the Survey are to be congratulated on a record of achievement of which they may be justly proud.

THE May number of the *Hong Kong Naturalist*, which is issued quarterly and edited by Dr. G. A. C. Herklots and Major H. P. W. Hutson, contains some valuable natural history articles. This is the second part of Volume 2, and in it Major Hutson continues his description of the birds of Hong Kong (Part 6), which is, as before, illustrated by beautiful coloured plates drawn by A. M. Hughes. The present part includes the kingfishers, and there are many species recorded. Not all the kingfishers are fish eaters, and those which live on insects, crabs, frogs, and small reptiles do not show any marked preference for the vicinity of water. Notes on colour, habits, nesting, and field identification make this series a peculiarly happy one. A new series entitled "The Crabs of Hong Kong" (Part 1), by Mr. Chia-Jui Shen, begins in this issue. The introduction gives instructions for collecting, preserving, and shipping, for great care must be taken when handling these often fragile creatures. The Dromiidæ, Raninidæ, Calappidæ, Leucosiidæ, and Parthenopidæ are described, and the work is well illustrated by photographic plates and line drawings. Mr. W. Fowler continues his synopsis of the fishes of China (Part 2), the herrings and related fishes, and an article on fresh-water sponges by Mr. Gist Gee with other smaller papers make up a good number of this interesting magazine.

THE *Proceedings of the California Academy of Sciences*, Fourth Series, vol. 19, No. 13, May 1931, contains the report of the president and that of the director of the Museum and of the Aquarium for the year 1930. One of the latest and most important acquisitions by the Department of Palæontology of the Museum is the large Baldwin collection of molluscs. David Dwight Baldwin was a famous shell collector, the shells being chiefly from the Hawaiian Islands, where he lived and collected for many years. Hawaiian land shells are noted for their beauty, wonderful colouring, and variability, especially the tree and ground snails, and this collection, representing years of individual labour, is unique. Besides collecting, Mr. Baldwin contributed several conchological papers to various scientific journals, including the well-known "Catalogue of the Land and Fresh Water Shells of the Hawaiian Islands". It is well that the Museum should have made this historic and valuable addition to its store, which has now been installed in the Academy's research series.

A REFERENCE to an article of interest to many English naturalists appears in *Svenska Linné-Sällskapets Årsskrift* (Årg. 14, 1931, p. 169). It is a short review of a paper by Dr. Knut Hagberg discussing the influence of Linnæus upon the great author of the "Natural History of Selborne", Gilbert White. The paper itself appeared in *Samf. Nios årsbok Vår tid*, vol. 11, 1930, and it traces the effects of White's correspondence with such disciples of Linnæus as Solander and Sir Joseph Banks. Indeed, in Dr. Hagberg's opinion, the Linnean nature study, through many enthusiastic followers, took a firmer grip in England than in Sweden, and through White's "Selborne" it influenced the poetry of such as Keats, Coleridge, and Wordsworth.

British Birds for August contains two very interesting records from northern Scotland. The first is that of the breeding of the whimbrel (*Numenius phæophus*) in Inverness-shire, and the most gratifying part of A. H. Daukes's description is that the young were allowed to hatch. In all the previous records of the nesting of this rare wader upon the mainland, the clutches of eggs were taken by the self-interested discoverers. The second record is that of the first occurrence in Britain of the red-headed bunting (*Emberiza icterica*) of Asia. The bird was seen in North Ronaldshay, in the Orkney Islands, by Col. G. Eardley Todd, and was shot so that the observation might have "real scientific value"!

IN view of the increased and continued prevalence of cerebro-spinal fever in England and Wales, the Ministry of Health has issued "A Review of Certain Aspects of the Control of Cerebro-Spinal Fever" (*Reps. on Pub. Health and Med. Subjects*, No. 65. London: H.M. Stationery Office. 6d. net.). A survey is given of the present incidence of the disease, the salient clinical, pathological, and bacteriological features, and its infectivity and mode of spread by healthy carriers. Control and treatment are discussed, and in regard to the last-named it is suggested that trial should be given of anti-meningococcus serum, supplies of which are available; and records of such treatment, if employed, are desired by the Ministry.

A LARGE earthquake was recorded at Kew Observatory on Aug. 18. The first impulses at Kew occurred at 14 h. 30 m. 40 s. G.M.T. The records indicate that the disturbance originated about 3800 miles north-east by east of Kew. The epicentre was, therefore, in Northern Mongolia near the great Altai Mountains, and it appears to have been some 400 miles north of that of the very large earthquake which occurred on August 10.

THE Council of the Zoological Society of London has agreed to confer the Society's Silver Medal on Mr. A. St. Alban Smith, in consideration of the very numerous donations he has made to the collection of the Society in 1927, 1928, 1929, and 1930, and of other valuable assistance he has given in Singapore. The actual number of specimens which arrived in London alive from him was 8 in 1927, 33 in 1928, over 200 in 1929, and more than 400 in 1930. They have included binturongs, leopards, a magnificent tiger, a gibbon, tree kangaroos, a number of valuable birds, and a very large number of reptiles, including the largest hamadryad ever seen in captivity, some rare gharials new to the collection, and a number of smaller snakes and lizards.

FOLLOWING the recent exhibition of chemical apparatus in London on July 13–18 in connexion with jubilee celebrations of the Society of Chemical Industry and the Achema exhibitions organised by the Dechema, the German Society for Chemical Apparatus, a similar exhibition in Paris in 1932 is under consideration. The Achema has now received from France, from the Société de Chimie Industrielle, a proposal that these exhibitions should be held alternatively in each of the three countries concerned, an arrangement which would have the advantage not only of avoiding the simultaneous occurrence in different countries of such exhibitions but also of affording opportunities for the mutual study and comparison of the methods of production in the different countries. It is expected that an international exhibition of chemical apparatus and plant will be held in Paris in 1932, followed by a German exhibition (Achema VII.) in Cologne in 1933, and a similar British exhibition in London in 1934.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the building trades department of the Burnley Municipal College—The Director of Education, Education Office, Burnley (Aug. 31). A lecturer in physics and a lecturer in chemistry at the Denbighshire Technical Institute, Wrexham—The Director of Education, Education Offices, Ruthin (Aug. 31). A junior assistant in the pathological department of the Royal East Sussex Hospital, Hastings—The Secretary, Royal East Sussex Hospital, Hastings (Aug. 31). A full-time lecturer in engineering at the Sunderland Technical College—The Chief Education Officer, 15 John Street, Sunderland (Sept. 7). A demonstrator of biology at St. Bartholomew's Hospital Medical College—The Dean, St. Bartholomew's Hospital Medical College, E.C.1 (Sept. 10). A Clement Stephenson entrance scholar at the Royal Veterinary College—The Secretary, Royal Veterinary College, Camden Town, N.W.1. A teacher of mechanical science at the Croydon Central Polytechnic—The Principal, Central Polytechnic, Scarbrook Road, Croydon. An instrument maker and laboratory attendant in the electrical department of the Dundee Technical College and School of Art—The Secretary, Technical College and School of Art, Bell Street, Dundee.

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Faraday and his Contemporaries.

By Engr.-Capt. EDGAR C. SMITH, O.B.E., R.N.

IN the introduction to his " Dissertation on the Progress of the Mathematical and Physical Sciences from 1775 to 1850 ", written during 1852–1854, and published in the eighth edition of the " Encyclopædia Britannica ", J. D. Forbes mentioned as amongst the most eminent workers in physical science during the first quarter of the nineteenth century Young, Malus, Brewster, Fresnel, Arago, Volta, Dalton, Davy, Ørsted, Prevost, Leslie, and Fourier, while among those whose labours belonged to the second quarter of the century he included Faraday, Melloni, Gauss, Sir John Herschel, Poisson, Mitscherlich, Liebig, and Dumas. These were to Forbes some of the outstanding physicists and chemists of his own time, and in the course of his dissertation he reviewed the work of each and gave an estimate of the worth of their achievements.

The position of Forbes as an original investigator, his wide knowledge of contemporary scientific work, his relationship with many of the leaders of science, his judgment and impartiality, give to his summaries a permanent interest, and at the present time, when the centenary of the discovery of electromagnetic induction is being celebrated, it is worth while recalling what Forbes said of Faraday. Having in turn reviewed the work of Galvani, Volta, Davy, Wollaston, Ørsted, Ampère, and Seebeck, Forbes began another section of his history of electricity with the remark, " Immeasurably the larger part of what we know with regard to the nature and laws of electricity and its connexion with magnetism, so far as it has been developed since the discovery of Ørsted, is due to the genius and perseverance of one man—Michael Faraday " ; while later on, when referring to the researches of Faraday as published in the *Philosophical Transactions,* he says, " It would be difficult to name in the history of any progressive experimental subject so large an amount of research prosecuted for so long a time in so methodical a manner and with such remarkable uniformity in plan, and with such unvarying success ". It was with the experiments which led to the discovery of electromagnetic induction that those famous researches began.

Though, when Forbes wrote, Faraday had long been regarded as one of the foremost experimentalists of his age, his reputation had extended far beyond the world of science, and his name had become a household word. In the positions he occupied at the Royal Institution as director of the laboratory and Fullerian professor of chemistry, he became the nation's semi-official exponent of scientific advance, and his lectures rivalled in popularity those previously given by Davy. His great reputation, it is true, was not due to his lectures, but that it was much enhanced thereby there can be no question. For this work he had deliberately and assiduously prepared himself, and his success was unequalled. Men who had no particular interest in science heard him with pleasure, and long afterwards would speak of the impression made on them by his lucid explanations, his unfailing experiments, and his eloquence. When at the height of his powers, he was not only a man of science of international repute, but also a prominent figure in the life of the nation, and as such occupies a place in history beside his contemporaries, Dickens, Thackeray, Ruskin, Carlyle, Mill, and Huxley, as one of the intellectual leaders of his age. Of his private life and character much has been written, but as Sir William Bragg has said, "It is Faraday's public life that belongs to us; it is one of the possessions of the nation, one of the great treasures".

Faraday was born in London on Sept. 22, 1791, in the middle of the reign of George II., and died at Hampton Court on Aug. 25, 1867, in the thirtieth year of the reign of Victoria. His life therefore covered a period of vast social and economic development. He was a bookseller's apprentice when Trafalgar was fought; a young man of twenty-four when Waterloo was won. His first journeys were by coach; his first voyages made under sail; the first books he read were printed by hand. Within his lifetime England was covered by a network of railways; steamships found their way into every sea; while books and newspapers were brought within the reach of all. Industries, manufactures, and commerce multiplied apace, and transport and communication were revolutionised. His was indeed an age of great men and great enterprises.

Faraday's own original work, however, done within the quiet of the laboratory, was of a different order from that of the Stephensons and the Brunels. Neither was it of a kind to attract widespread interest. Nothing he ever did took the world by storm as did the discovery of Neptune by Leverrier and Adams; nothing he ever wrote raised such controversies as the works of Darwin and Huxley. It was of the same character as that of Lavoisier and of Joule, and it has proved to be of the same fundamental importance.

Faraday first gained distinction as a chemist. His first contribution to scientific literature was a chemical paper; he is known to every chemist as the discoverer of benzene; he was offered the chair of chemistry in the newly founded University of London; he counted many of the greatest chemists as his friends; a chemist delivered his *éloge* before the Paris Academy of Sciences, and his name is perpetuated by the Faraday Lecture of the Chemical Society. His earliest knowledge of the subject he gained when a boy from the "Conversations on Chemistry" of Mrs. Marcet, the wife of a Swiss doctor. In after life he came to know Mrs. Marcet and, after her death in 1858, in writing to Auguste de la Rive at Geneva, he referred to his debt to her.

The story of how Faraday's studies led to his being given a ticket to Davy's lectures at the Royal Institution, of how he appealed to Davy for employment, and of how he became Davy's assistant and accompanied him and Lady Davy to the Continent in 1813 is well known. The long visit to France, Switzerland, and Italy made a great impression on Faraday and, as Ostwald said, it proved for him a high school of incomparable value. Brewster also visited the Continent in 1814, as did Mrs. Somerville in 1816, and in their biographies, as in those of Davy and Faraday, are to be found much of interest regarding the scientific circles into which Faraday gained an insight. One outcome of the journey was the friendship of Faraday with the elder De la Rive, of whom Faraday once wrote, "I may say he was the first who, personally at Geneva and afterwards by correspondence, encouraged, and by that sustained me".

Returning home with Davy in 1815, Faraday was re-engaged by the Managers of the Royal Institution and was thus brought into contact with Davy's successor, Brande. Described as "a model lecturer, gentlemanly, perfect of expression, exact of execution", Brande occupied a high position in both scientific and official circles, but his vocation when lecturing with the assistance of Faraday was pronounced to be "lecturing on velvet".

Among the most eminent chemists whom Faraday counted his friends were Graham, Liebig, Schönbein, Sainte-Claire-Deville, and Dumas. The correspondence of Faraday and Schönbein has been published in a separate volume, while among the letters from Liebig is that written from Giessen in 1844, in which Liebig openly expressed his admiration, affection, and esteem for Faraday. None esteemed Faraday's friendship more highly than Dumas, who when delivering his *éloge* on Faraday to the Paris Academy of Sciences, began with the sentence, "Je ne sais s'il existe au monde un savant qui ne fût heureux de laisser en mourant des travaux pareils à ceux dont Faraday a fait jouir ses contemporains et qu'il a légués à la postérité; mais je suis sûr que tous ceux qui l'ont connu voudraient approcher de cette perfection morale qu'il atteignait sans effort".

It was but natural that Faraday's first work should be in the realm of chemistry, but as Tyndall said, he was "swerving incessantly from chemistry into physics", and it was as a physicist he gained his great fame. Just as he had obtained his first information on chemistry from the pages of Mrs. Marcet, so while still an apprentice he gleaned his first knowledge of electricity from the pages of the "Encyclopædia Britannica". There, no doubt, he read of the experiments of Gilbert, Boyle, and Newton; of the electric machine of Otto von Guericke; of the lectures of Hauksbee; of the experiments of Stephen Gray in the Charterhouse;

of the invention of the Leyden jar, and of that " auspicious period when Dr. Franklin raised electricity to the dignity of a science, and connected it with that tremendous agency which had so often terrified the moral and convulsed the physical world ".

No branch of experimental science was more actively pursued during the eighteenth century than that of electricity. In Italy, in Germany, in France, and in England, thousands of experiments were made, and to the latter half of the century belong the labours of Coulomb, Aepinus, Priestley, Canton, Watson, Beccaria, Galvani, and Volta. Faraday was born in the year that Galvani wrote his memoir, " De viribus electricitatis in moto musculari commentarius " ; he was a boy of nine when Volta described his pile to Sir Joseph Banks. Yet in spite of all these advances, when Faraday was poring over the pages of the " Encyclopædia ", the sciences of electricity and magnetism were still unconnected, and it was not until 1820 that Ørsted at Copenhagen made known his epoch-making discovery of electromagnetism. Eagerly seized on by a score of investigators in all parts of Europe, Ørsted's experiments were quickly repeated and extended, and on Christmas Day 1821 Faraday called his young wife into the laboratory at the Royal Institution to show her a magnetic needle rotating around a wire carrying an electric current. That experiment was the direct outcome of Ørsted's discovery that by an electric current magnetism could be produced. Ten years later, Faraday himself set up another landmark in the history of electricity by showing how magnetism could be used to generate currents.

During the eleven years which elapsed between the discovery of electromagnetism and that of electromagnetic induction, Faraday was largely occupied with his researches on the condensation of gases, the alloys of steel, the compounds of hydrogen and carbon, and the manufacture of glass. But the new science of electromagnetism was developed in many laboratories. De la Rive in Switzerland was the first to give a public demonstration of Ørsted's experiment. In Paris in 1820, Arago, Savart, and Biot all began to work on electromagnetism, and in the same year, at Halle, Schweigger made the first galvanometer. Of especial importance was the work of Ampère, ' the Newton of electricity ', whose " Exposé des nouvelles découvertes sur l'Électricité et le Magnétisme de MM. Ørsted, Arago, Ampère, H. Davy, Biot, Erman, Schweigger, De la Rive, etc.", published in 1822, contained an account of his own researches as well as of those of his contemporaries. In 1824, Arago observed the damping effect of a plate of copper on an oscillating magnetic needle; in 1825, Sir John Herschel and Babbage caused a pivoted copper disc to move by spinning a magnet near it; and the same year, Sturgeon, the ex-artilleryman, presented the first electromagnet ever made to the Royal Society of Arts, and, as Silvanus Thompson said, thus furnished mankind " with a magnet the attractive power of which could be increased absolutely indefinitely by the mere expenditure of sufficient capital upon the iron core and its surrounding copper coils and the provision of a sufficiently powerful source of electric current to excite the magnetisation ". Two years later, Ohm, then on leave in Berlin, published " Die galvanische Kette, mathematisch bearbeitet " ; and in 1829, on the other side of the Atlantic, Henry, of Albany, " the first to undertake important original electrical experimentation in the United States since the time of Franklin", made his famous electromagnet capable of sustaining fifty times its own weight, which had 400 turns of silk-covered copper wire.

It was therefore no unsurveyed territory, no untrodden country that Faraday re-entered in the summer of 1831. He was but one of many pioneers who were advancing along different paths into this fruitful domain of electromagnetism. " In the history of discovery ", said Emerson, " the ripe and latent truth seems to have fashioned a brain for itself." The latent truth we associate with the name of Faraday is that of electromagnetic induction, the discovery of which was made with the historic iron ring wound with two separate coils of copper wire, and which is recorded in his diary on Aug. 29, 1831. But just as the theory of gravitation had simultaneously occupied the minds of Hooke, Halley, and Wren, as well as that of Newton, so electromagnetism was being studied by others than Faraday, and the observations on the production of an electric current by a magnet by Zantedeschi and Henry actually preceded that of Faraday. Francesco Zantedeschi, the Italian priest and physicist of Venice, it is claimed, published papers on the production of electric currents in closed circuits by the approach and withdrawal of magnets in 1829 and 1830, and Henry in August 1830, by sending a momentary current through the coils of one of his electromagnets, detected a current in a wire wound around the armature of the magnet. But Henry failed to make known his observation or to follow it up immediately.

In commemorating the centenary of Faraday's discovery, however, the world is commemorating not a single and isolated experiment but one which marked the commencement of that long and remarkable series of investigations which occupied Faraday for a quarter of a century, and an account of which is given in his "Experimental Researches in Electricity". The experiment of Aug. 29 was but the key to a Temple of Science as vast as that Temple of Art of which Lafcadio Hearn wrote in one of his letters: "The more you advance the more seemingly infinite becomes the vastness of the place, the more interminable its vistas of arches and the more mysterious its endless succession of aisles".

Having thus found the key, Faraday immediately began to explore further, and with remarkable success. "In ten days of actual work during the autumn months of 1831", as Sir Ambrose Fleming has said, "Faraday not only discovered the facts of current induction and magneto-electric induction as well, but embraced them all in the statement of one great generalisation of the utmost simplicity".

These researches alone led finally to the invention of the magneto-electric machine, the induction coil, the dynamo, and the transformer, but they were succeeded in the course of years by his electrostatic investigations and researches on specific inductive capacity, by his electrochemical researches and researches on voltaic action, and by his researches on magnetism and light; investigations which have engaged the attention of the most eminent physicists of nearly a century, and on some of which has been based that extended application of electricity to man's use we see around us to-day.

In the prosecution of these investigations, Faraday utilised every resource provided by his forerunners and his contemporaries, and his results he placed unreservedly at the service of his fellows. There are many aspects of his work in relation to that of his contemporaries which invite consideration, but to one only can reference be made here. The discovery of electromagnetic induction may be compared with that of the discovery of the pressure of the atmosphere. From the latter came the steam engine; from the former the dynamo. But just as half a century elapsed between the observation of Torricelli and the work of Huygens, Papin, Savery, and Newcomen, so more than thirty years passed before the discovery of Faraday was applied to the self-exciting electric generators of Varley, Ladd, Wheatstone, and Werner Siemens, to which the last gave the name dynamo-electric machines.

Many inventors like Pixii, Dal Negro, Saxton, Clarke, and Jacobi had made small magneto-electric machines in the early 'thirties; the induction coil was developed by Page and Ruhmkorff, and experiments were made with lighting by electricity generated by magneto-electric machines. But interesting as was the work done with these machines, when Forbes wrote, they were still regarded mainly as instruments for the laboratory, and the most important source of electricity was still the voltaic cell, the invention of which Forbes compared to that of the steam engine. From the invention of Volta and the discovery of Ørsted had come the use of electricity for signalling, and the grand achievement of the electricians of Faraday's lifetime was the electric telegraph. Gauss, Weber, Steinheil, Wheatstone, Cooke, and Morse were all contemporaries of Faraday, and it was they who laid the foundations of the great telegraph systems of the world. Five years before Faraday died, it was estimated that Great Britain had 15,000 miles of electric telegraph, Europe 80,000 miles, and America 45,000 miles. But no one had yet dreamed of the generation, transmission, and utilisation of electricity on a large scale. Even Faraday himself failed to see what his own child would grow into, and just as Watt would have nothing to do with the steam locomotive and the steam boat, so Faraday set down the magneto-electric engine along with mesmerism, odylism, the sympathetic compass, and perpetual motion as an ill weed which should not be cultivated.

Nevertheless, gradually, step by step, the difficulties were being solved, and with the work of Pacinotti, Wilde, Varley, Wheatstone, and Siemens a new chapter was opened in the history of the application of electricity. In the retirement of his home on Hampton Court Green, Faraday heard with interest of Wilde's machine, but when the dynamos of Wheatstone and Werner Siemens were described to the Royal Society, both his physical and mental powers were rapidly waning, and a few months later he passed away.

Nearly a century before Faraday died, Boswell had visited the famous steam engine factory of Boulton and Watt at Soho, and Boulton had proudly exclaimed to him, "I sell here, sir, what all the world desires to have—POWER". The demand of the world for power has been an ever-increasing one, and a multitude of discoverers, inventors, and engineers have contributed towards the satisfaction of that demand. Some live in history, some are forgotten, but among those whose names are imperishable is Michael Faraday.

Faraday and Ørsted.

By Mrs. Kirstine Meyer, Copenhagen.

ØRSTED'S discovery of electromagnetism came as a surprise to the scientific world and apparently without any preparatory work. It was communicated in a paper (July 1820), which in the briefest form possible gave an account of the conditions under which the experiments were made and of their results. His results have proved to be correct, but there are no drawings, no indications of the series of experiments he made,[1] or rather of the several series of experiments, to indicate the way these results were reached. It has been said that the whole discovery was due to chance; that was far from being the case. Ørsted had for years been seeking a connexion between electricity and magnetism, and the discovery was the result of his search.

The chief contents of the communication are as follows:

The electric current—in Ørsted's language, "the electrical conflict" in the conductor—acts on a magnetic needle; the direction of the force is sideways and outwards from the conductor, and it has been found in, one might almost say, every possible position of the conductor in relation to the magnet. A simple rule is given for finding the direction of the force. It is shown that the action of the force does not depend on the intermediate substance between the magnet and the conductor. The magnitude of the force is found to depend on the distance from the magnet, the power of the battery, and the quality of the connecting conductor. He also noticed that a circuit in the form of a polygon carrying an electric current attracts or repels the pole of a magnet. Finally, quite briefly, attention is directed to the fact that "the electrical conflict", judging from these experiments, is not restricted to the conductor, but is communicated to the surrounding space, and must be assumed to traverse circles the planes of which are at right angles to the conductor.

The experiments were extended and the results were published soon after, under the title "Neuere elektromagnetische Versuche", in the July number (1821) of *Schweiggers Journal für Chemie und Physik*. This work was evidently finished shortly after the first and should be regarded as coherent with it, as it forms an important supplement to it. It contains the following results:

(1) The effect of a conducting wire on the pole of a magnet depends on the quantity of electricity and not on its tension—in modern words, on the current and not on the electromotive force of the supply.

(2) The reaction effect is found by showing that a suspended closed circuit is turned by a magnet.

(3) It is established in a new way that a closed circuit has a north end and a south end just like a magnet.

From the moment that Ørsted's discovery became known, it created an enormous sensation. The results communicated were so astounding that they were received with a certain distrust, but they were stated with such accuracy that it was scarcely possible to entertain doubts. The treatise itself was thus a strong inducement to put the results to a test; as Ørsted had given no real description of his procedure, scientific workers made the experiments in a variety of ways. Many of those who repeated Ørsted's experiments were thus led to consider themselves and others to be Ørsted's equals in this field of research, and published their work as new discoveries, even if their results were in reality to be found in Ørsted's communication. The language of the latter also caused difficulty, and was responsible for the imperfect comprehension of its contents.

All were soon imbued with the excessive importance of the discovery, and the scientific journals were filled with electromagnetical essays. In England, too, the discovery received full credit. In 1821, Faraday wrote a historical survey of the evolution of electromagnetism up to April 1821.[2] Though only eight months had passed since Ørsted's communication, so much had already been written that Faraday found it very difficult to make head or tail of the many works, of what had been done and by whom, "in consequence of their great variety, the number of theories advanced in them, their confused dates, and other circumstances".[3] He then undertook to go through systematically, "with great labour and fatigue", everything that had appeared in journals and other places. He gives full credit to Ørsted's work; about the first communication he writes: "It is full of important matter, and contains, in few words, the results of a great number of observations; and, with his second paper, comprises a very large part of the facts, that are as yet known relating to the subject". He acknowledges Ørsted's discovery to be not only a lucky chance but also the fruit of a deliberate search: "Mr. Ørsted . . . has for many years been engaged in inquiries respecting the identity of chemical, electrical, and magnetic forces . . . his constancy in the pursuit of his subject, both by reasoning and experiment, was well rewarded in the winter of 1819–20 by the discovery of a fact of which not a single person beside himself had the slightest suspicion ; but which, when once known, instantly drew the attention of all those who were at all able to appreciate its importance and value ".

Faraday repeated almost all the experiments Ørsted described, and this led him in the beginning of September 1821 to discover a method of producing a continuous rotation of a wire with an electrical current round a magnet and of a magnet round the wire. Although the fact of the tangenial force between an electric current and a magnetic pole was clearly stated by Ørsted and clearly apprehended by Ampère and others, the realisation of the continuous rotation of the wire and the magnet required ingenuity for its original solution.

This article of Faraday's, containing his first work on electromagnetic problems, forced on his mind the facts that an electrical current and a magnet act on one another with forces which could create continuous rotations, that a closed electrical circuit could act as a magnet with a north pole and a south pole, that an electrical current could magnetise iron, and that all these results had been observed because Ørsted "had for many years been engaged on inquiries respecting the identity of chemical, electrical, and magnetic forces ".

From this time on, Faraday applied the full force of his mind to certain problems arising out of these results, and he kept them persistently in view even when, year after year, his attempts to solve them were unsuccessful. One of these problems was : "Convert magnetism in electricity ", as he writes in his note-book in 1822 ; he solved the problem in 1831. Another problem was to find a relationship between electricity and magnetism and light. In 1845 he found that magnetism exerts an influence on light.

The philosophical problem, the correlation of physical forces, interested Faraday as well as Ørsted. In the year 1834, Faraday gave a course of six lectures on "The Mutual Action of Electrical and Chemical Phenomena; . . . Relations of Chemical Affinity, Electricity, Heat, Magnetism and other powers of Matter ". In the last lecture he gives his first utterance on the correlation of physical forces : "Now consider a little more generally the relation of all these powers. We cannot say that any one is the cause of the others, but only that all are connected and due to one common cause." . . .

While the philosophical views of Faraday and Ørsted thus present similarities, a marked difference is also exhibited. In his youth, Ørsted had been strongly influenced by the German *Naturphilosophie* and was thereby led to accept too uncritically theories which rested only on speculation and had no sufficient experimental verification. Although through his experimental work Ørsted's connexion with this philosophy was gradually weakened, he was never so sceptical towards theoretical speculation as Faraday, whose critical mind is typically expressed in his attitude to the electromagnetic theory of Ampère ; nor, of course, was Ørsted so ingenious in seeking for experimental verification of theories as Faraday. The truth of the points here emphasised appears also clearly from the contributions of these two men in quite a different field of research.

The first important experimental work from the hand of Ørsted was among the publications of the Royal Danish Society of Sciences for the year 1807, and bore the title "Forsøg over Klangfigurer " (Experiments on Acoustical Figures). Influenced by his ideas about the universal importance of electricity in physical phenomena, he expected to discover electrical effects due to the oscillations causing the acoustical figures. The paper was based on several hundred experiments on acoustical figures produced on square plates of glass or metal, a few of them on circular plates. While Chladni used sand to make the acoustical figures visible, Ørsted employed lycopodium in most of his experiments, and with this fine powder the figures showed somewhat differently. He did not find electrical effects, but he became aware of certain phenomena which he supposed might afford an important insight into the mechanism of the production of a tone, and hence the treatise gives an account of the many experiments carried out in order to clear up this matter. A series of minor motions in the plate are revealed by the lycopodium ; in particular it is remarkable that small heaps of lycopodium accumulate where the vibration is greatest. He sets forth the idea that these minor motions show that every sonorous oscillation is composed of a number of minor oscillations. "Hence the nature of each tone seems to be more dependent on the relation between the subordinate oscillations and the main oscillation than on the mere number of main oscillations. Each tone thus seems an organisation of oscillations."

Savart took up the same investigation about

M Faraday

twenty years later; he came to the same conclusions as Ørsted and explained them in a similar way, it being his opinion that the minor oscillations offer information about the overtones that determine the timbre of the plate.

Faraday took up the question for definite determination in 1831. He only mentions Ørsted's paper, his attention having been directed to the subject by Savart's paper. By a wonderful series of experiments he shows that the accumulation of light dust in certain places does not mean any secondary division of the plate according to overtones, but is only due to currents of air passing over the plate in motion.

In 1846 Ørsted visited Faraday's laboratory, and his interest was especially aroused by the great electromagnet which Faraday had used in his famous investigations on diamagnetism in 1845. Faraday demonstrated the results of these researches before Ørsted, who became so interested in them that on his return to Copenhagen he had a powerful electromagnet constructed and started an investigation on diamagnetic phenomena, the result of which was published in 1848. In consequence of these observations, Ørsted divided all bodies magnetically into three groups: those repelled and diamagnetic, those attracted and diamagnetic, and those that behave like iron. This division answers to that introduced in modern times: the diamagnetic, the paramagnetic, and the ferromagnetic.

Faraday's discovery of diamagnetism was thus the direct cause of the last published experimental work of Ørsted, but Faraday's activity had another influence on Ørsted which became of vital importance for the rest of his life. When Ørsted in 1823 visited England at the end of a longer journey, his work as a man of science received general recognition; in Paris he had received the mathematical prize of the Academy of Sciences, and in London he was elected a foreign member of the Royal Society. It might then have been expected that on his return he would devote himself entirely to the scientific investigations which he had started already. His visit to the Royal Institution, where Faraday was working, changed these plans. The object of the Royal Institution was to diffuse a knowledge of useful mechanical improvements and to promote the application of science to daily life. The manner in which this object was realised through the activities of Faraday made so strong an impression on Ørsted that he on his return founded a society in Copenhagen with similar aims. This society has had an important although indirect influence on the progress of the Danish community, and also on Ørsted himself, for it directed him away from purely scientific work to a large and unselfish activity in the education of his nation.

It is interesting to see that the character of the two men was evidently of the same type. It has been said of Faraday that he was entirely free from pride and undue self-assertion, and that in his old age he remained content and happy in the exercise of those kindly feelings and warm affections which he had cultivated no less carefully than his scientific power. The same could be said of Ørsted. A Danish poet, a friend of Ørsted, has said that he possessed what one might call a high degree of " mental innocence " and always thought that " everybody was guided by the same interest for science, by the same sense of justice and reason as he himself "; he thought that one who knows how to deal wisely and correctly will do so. One has the same impression of Faraday from his life and from his letters. Each man worked conscientiously and unselfishly for the community in which he lived.

[1] Kirstine Meyer: "The Scientific Life and Work of H. C. Ørsted", 1920, pp. lxxiv-lxxxviii; H. C. Ørsted, "Scientific Papers", vol. 1.

[2] *Thomson's Annals of Philosophy* New series, London, 1821, vol. 2, pp. 195 and 274, vol. 3, p. 107.

[3] l.c., p. 195.

Gauss's Investigations on Electrodynamics.

By Dr. CLEMENS SCHAEFER,
Professor of Experimental Physics, and Director of the Physical Institute, University of Breslau.*

THE greatness of the life-work of an investigator is revealed most clearly, perhaps, when we contemplate his influence on the scientific work of his contemporaries. I propose to endeavour to show the influence exerted by Faraday's discovery of electromagnetic induction on the physical investigations of C. F. Gauss, *princeps mathematicorum.*[1]

Even in his youth Gauss was interested in physical problems, and we possess documentary evidence that, in the year 1806, he had already completed his theory of terrestrial magnetism, although it did not appear until 1839. As is well known, the theoretical nucleus of this theory consists of the development of the magnetic potential of the earth's field in spherical functions, the coefficients

* Translated by Dr. R. W. Lawson.

of which have to be determined empirically. Lack of observational data delayed the completion of this work by more than thirty years, and other physical investigations of Gauss suffered the same fate. Not until about the year 1830 did Gauss again turn his attention to physical investigations.

Meanwhile, however, the situation in science had been completely transformed, as the following statements will serve to show. Electromagnetism was discovered by Ørsted in 1820; in 1820–21, Biot and Savart formulated their fundamental law on the force exerted between a magnetic pole and a current element; and this was followed in 1822–24 by the fundamental researches of Ampère on the replaceability by a magnetic shell of a conductor bearing a current, and the establishment of Ampère's law. Then, in the year 1827, G. S. Ohm established his law of the galvanic circuit; in 1828, Green (Nottingham) published his paper on the theory of potential, which, incidentally, remained unknown to Gauss; and finally, in the year 1831, Faraday discovered induction, the counterpart of electromagnetism. The scientific situation was thus fundamentally changed when, in 1830, Wilhelm Weber was called to Gottingen as professor of experimental physics; and at this juncture, on these well-constructed foundations, Gauss's physical researches commenced.

Gauss's investigations were concerned first with terrestrial magnetism, and he showed us how to measure the earth's field exactly; at the same time, he originated the absolute system of units. But the general foundations had scarcely been developed by him, in conjunction with Weber, before he began to give attention also to the study of electrodynamics. On Oct. 22, 1832, Gauss carried out electromagnetic measurements for the first time, and these occupied him during succeeding years until about 1836. Although investigations on Ohm's law, due in particular to Fechner, were available even in the year 1832, they did not satisfy the high standard of attainment demanded by Gauss. Thus his first measurements were directed to testing Ohm's law under the most varied conditions. In this connexion (1833) Gauss discovered the laws of branched circuits, which to-day are known as Kirchhoff's laws, although Kirchhoff did not discover them until the year 1845. Gauss also found out the principle of minimum heat—which was likewise rediscovered later (1848) by Kirchhoff—according to which the heat produced by the current is a minimum for the actual current distribution. Furthermore, he supplied the exact proof of the identity of frictional electricity and that produced by galvanic elements and thermoelectric forces, of which identity by no means all physicists were at that time convinced. However, these were only the preliminary studies.

His chief interest was concentrated on the investigation of the laws of induction. The year 1834 resulted in the construction of an induction coil, and enabled him to recognise the damping of a magnet vibrating in a coil, as a consequence of the induced currents; this led him to the construction of a copper damper for his magnetic apparatus, and to the discovery of the phenomenon of 'sympathetic vibrations'. His work reached its zenith in the year 1835, for on Jan. 23 of that year [2] he formulated the law of induction, which is to-day designated the 'Franz Neumann law of potential', although Neumann formulated it ten years later, in 1845.

We will now pass on to the narration of this crowning accomplishment. The train of thought which guided Gauss was as follows: When a current-free conductor is moved relatively to a current-bearing conductor, a current is set up also in the first conductor, the induced current; at the same time, however, there are established between the two current conductors electrodynamic forces, which obey Ampère's basal law. The latter law is thus most intimately related to the phenomenon of induction. For this reason Gauss first took up the detailed study of Ampère's law, and immediately recognised that there can be added to the mathematical expression for the forces, differential expressions of such a nature that they vanish when integrated over closed current circuits. We can thus replace this elementary law by an infinite number of equivalent laws. By effecting various transformations of this kind on Ampère's law, Gauss also arrived at a law which was formulated ten years later (1845) by Grassmann, and differs in its outward form quite substantially from the fundamental law of Ampère. In fact, Grassmann did not recognise that his law was wholly equivalent to that of Ampère, and he proposed experiments to decide between the two laws, whereas Gauss perceived from the first that there cannot exist any *experimentum crucis* between the two, if only closed currents are available.[3] Gauss laid no great value on the formulation of Grassmann's law, evidently because he recognised that it contradicts the law of action and reaction for current elements, whereas Ampère's law obeys the last-named law also for the elements.

Gauss's next advance was concerned with the magnitude of the electrodynamic forces. He succeeded in showing that a so-called electrodynamic potential can be specified, the partial derivatives of which, with respect to the parameters that determine the position of the moving current conductor, yield the electrodynamic forces which tend to cause these parameters to increase. This is the first part of 'Neumann's law of potential'. Gauss then made use of the fact observed by Lenz, that the induced current has a direction such that the electrodynamic forces resist the motion, so that in consequence positive work is performed during this motion. On this basis he derived from the law of the electrodynamic forces the law of the phenomena of induction, which latter are therefore likewise closely linked with the expression for the 'Neumann-potential.' This is precisely the same train of thought which was followed later also by Franz Neumann and finally by Helmholtz in his famous paper, "Über die Erhaltung der Kraft" (on the conservation of force), a train of thought that can be formulated in modern terms by the statement that the phenomena of induction can be deduced from the law of electromagnetism and the energy principle, or that the laws of electromagnetism and of induction together are compatible with the energy principle. Finally, we again meet with the same train of thought, for example, in the derivation of Poynting's theorem from Maxwell's equations. The discovery of these relations may well be designated the pinnacle of Gauss's achievements in physics.

Nevertheless, Gauss was not content with what he had already achieved. In those days the problem was not regarded as having been solved until it was possible to trace it back to the position and motion of electrical charges, that is, the general fundamental law was sought for in a generalisation of Coulomb's law. This process of thought had its ultimate foundation in the unique authority of Newton's law of gravitation, with which Coulomb's laws agreed in their form. The true key to Nature was descried in generalisations of these laws. These endeavours culminated in the well-known law of Weber (1845–47). Gauss had also attempted to formulate such fundamental laws (1835), and one of them, designated Gauss's fundamental law, is examined in detail, for example, in Maxwell's "Treatise". Gauss himself had already proved that the basal law represents correctly the electromagnetic phenomena; on the other hand, Maxwell showed that it fails with the phenomena of induction. We are probably right in assuming that Gauss also recognised this deficiency, for he did not publish this law. In fact, practically all of the physical discoveries mentioned here first became known when his unpublished papers became available.

Whereas these developments of Gauss's ideas stand in diametrical contrast to Faraday's ideas of a field action, in later years Gauss nevertheless drew nearer to Faraday's view. This is clear from a celebrated letter written to Wilhelm Weber in the year 1845. In this Gauss states that the generalisations of Coulomb's law had not satisfied him, because they assumed an instantaneous ("instantanen") propagation, whereas *his* real aim had been the derivation of the forces from an action which is not instantaneous, but propagated in time in a similar manner to light. (In his letter to Weber, Gauss refers to a "nicht instantanen, sondern auf ähnliche Weise wie beim Licht in der Zeit sich fortpflanzenden Wirkung.") He frankly asserts that, in view of the fact that he did not succeed in arriving at the solution of this problem, he could see no justification for publishing anything about these electrodynamic investigations. We see here how closely Gauss's conceptions approach those of Faraday, and it is perhaps not entirely chance that Gauss's pupil, Bernhard Riemann, was the first to attempt, in 1858, to replace Poisson's equation for the potential $\Delta\phi = -4\pi\rho$, by the equation, $\frac{1}{c^2}\cdot\frac{\partial^2\phi}{\partial t^2} - \Delta\phi = 4\pi\rho$, which would result in propagation of the potential with the velocity of light, c.

It is clear from the above considerations that the discoveries of the years 1820–31, and especially the discoveries of Ørsted and Faraday, supplied Gauss with the material for his investigations. He was not really a physicist in the sense of searching for new phenomena, but rather always a mathematician who attempted to formulate in exact mathematical terms the experimental results obtained by others. Thus the brilliant achievements of Gauss would have been impossible had it not been for Faraday's discovery of induction, the centenary of which we are celebrating this year.

May then this brief outline also redound to the glory of Faraday, to whom in very truth those words apply which are to be found on Newton's grave:

> "Congratulentur sibi Mortales,
> tale tantumque exstitisse decus generis humani."

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[1] Only since 1929 has it been possible to review with certainty Gauss's accomplishments in the field of electrodynamics in their entirety. Readers who are interested in this matter may refer to my essay "Gauss' physikalische Arbeiten" (Julius Springer, 1929), which has also appeared in "Gauss' Werken", vol xi, 2

[2] "Morgens 7 Uhr vor dem Aufstehen" (At 7 o'clock in the morning, before rising), these are the words of Gauss's entry.

[3] It was not known until recently that Gauss was also the discoverer of the law of Grassmann. We must ascribe blame for this to a slip on the part of Gauss, which has been overlooked hitherto, and which rendered his formula unintelligible.

Italian Physicists and Faraday's Researches.

By Prof. Vito Volterra, For.Mem.R.S., Royal University, Rome.*

THE discoveries made by Faraday were so numerous and important that they brought about a new and immense development of physics, and inspired the most varied and remarkable practical applications. The concepts that guided him in his famous experiments modified our ideas of natural phenomena so profoundly that a new epoch in the history of natural philosophy begins with him.

There has been no worker in the field of physics in recent years whose labours have not been more or less directly linked up with Faraday's. For that reason, if one wanted to mention all those who can claim to have continued his work or who have taken advantage of its results, one would have to name every physicist of modern times. This is as true of Italy as of other countries. This is not the place to embark upon the history of physics in Italy during the last hundred years, and I propose to deal rather with those researches which were most directly inspired by Faraday's, particularly at the time when the latter were first made known and had their greatest success and most important applications.

I will therefore go back to the autumn of 1831, when Faraday's attempts to obtain electric currents by means of the action of magnets were finally crowned with success. The results were not communicated to the Royal Society in London until November of that year, but the publication of the memoir was delayed, and the French translation only appeared in May 1832, in the *Annales de Chimie et de Physique*. In order to make up for this delay, Faraday wrote a very concise letter on the subject to Hachette of Paris, who brought it before the Academy of Sciences in December 1831.

Nobili, of the Museum at Florence, a physicist of unusual ability, who was already well known for his astatic galvanometer and his thermoelectrical studies, among other things, heard of the discovery from Amici, who had read of it in the *Temps*. Realising at once its vast importance, he set about repeating Faraday's experiments with the assistance of another Florentine physicist, Antinori. Their first memoir appeared in January 1832, and is explicitly so dated, but it was published in the *Antologia* for November 1831, which was very late in appearing.[1] Further papers came out in subsequent numbers of the same journal.

The two Florentine physicists obtained induced currents by approaching a closed circuit to the pole of a magnet, by breaking a circuit formed by a horseshoe magnet and its keeper, by reversing the current in a helical circuit arranged parallel to a dip needle, and by introducing a core of soft iron into a helix forming part of a closed circuit.

These experiments would not have provoked a controversy (one of the few in which Faraday engaged) but for the observations that accompanied them, particularly with reference to Arago's magnetism of rotation and the induction spark. The delay in receiving the authentic text of Faraday's memoir, and the misinterpretation of his letter to Hachette, contributed to the creation of the misunderstandings which gave rise, as Naccari points out, to the controversy mentioned above.[2]

The study of induction was carried on in Italy, in particular by Matteucci, who gave his attention to the distribution of the currents in Arago's rotating disc and to the magnetism of rotation, and published in 1854 his "Cours spécial sur l'induction, le magnétisme de rotation . . .", which gave an extensive account of as much as was then known with regard to the phenomena of electromagnetic induction.[3]

There is, however, a work of much greater philosophical and experimental importance, the memory of which I should like to revive. In 1852, Felici, who was at that time Matteucci's assistant and afterwards succeeded him in the chair of physics in the University of Pisa, began the publication of three memoirs entitled "Sulla teoria matematica dell' induzione elettro-dinamica".[4]

F. Neumann had already given his famous formula in his two works of 1845–47, and Weber's had appeared in 1846. Felici left the paths which these two scientific workers had trodden, and set himself to obtain the formulæ expressing the laws of electromagnetic induction by going step by step along the road of pure experiment by which, a quarter of a century earlier, Ampère had arrived at the mathematical expression of the mechanical force which two elements of current exert on one another. Like Ampère, Felici rested his case in his first memoir solely on experiments involving balance methods. By an ingenious arrangement, he intensified the effect of the induction, repeating the making and breaking of the current, and integrated with his galvanometer the intensities of the repeated induced currents of the same direction. He thereby obtained a formula which gives the electromotive force corresponding to the action of elements of current—a formula containing a term which vanishes when the electromotive force round closed circuits is integrated. Thus Felici's formula, besides telling us something more, supplies experimental proof of that obtained by Neumann by means of special hypotheses in extension of Lenz's law.

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* Translated by T. Mark.

In his subsequent memoirs, Felici studied induced currents, not only in filiform circuits, but also in conductors of more than one dimension, thus linking up with Matteucci's experimental researches set forth in the " Cours spécial " referred to above.

Ottaviano Fabrizio Mossotti, one of the most eminent Italians of last century, was teaching in Pisa at the time when Matteucci and Felici were working there. Born at Novara (Piedmont) in 1791, he obtained his doctorate at Pavia, studied there with Brunacci, and also heard Volta. Political persecution forced him to leave Italy, and he went to France and to England, where he was received with great esteem and had many friends. He was first invited to Argentina, then went as a teacher to Corfu while it was under English protection, and finally to Pisa in Tuscany, where he founded an astronomical and physico-mathematical school which has been of great importance in the recent history of science in Italy.

Among Mossotti's numerous and beautiful researches, the one that now stands out as the most important, and to which he chiefly owes his fame, is the theory of dielectrics. Faraday devoted the eleventh and twelfth series of his " Experimental Researches on Electricity " to the study of the action of dielectrics in the phenomena of electrostatic induction. This effect had already engaged the attention of Avagadro [5] for many years, but Faraday's famous and decisive experiments established its nature and led to the theory of the polarisation of dielectrics.

Mossotti's great merit is that he showed the relation of the theory of electrical induction in dielectrics to the theory of magnetic induction. Now, Poisson had supplied the mathematical theory of magnetic induction ; so one had only to read in the language of *electricity* what Poisson had arrived at in terms of *magnetism* in order to obtain a mathematical theory of dielectrics based on the concepts of Faraday. Indeed, part of Mossotti's memoir of 1846 [6] is, as the author himself points out, nothing but a reproduction of Poisson's. The remarkable and elegant conclusions that Mossotti drew from it, and the interesting applications that have been made of it by others, such as Clausius, for example, who applied it to oscillating discharges, make Mossotti's work particularly valuable.

This brings us to Mossotti's own concepts with regard to the constitution of matter, a subject to which he frequently returned, as in a memoir dedicated to Plana [7] in the foreword to his Corfu lectures,[8] and on other occasions. Faraday, in the nineteenth series of his "Experimental Researches", shows his approval of these ideas of Mossotti's, which corresponded in a measure to his own. They deserve to be re-read to-day, to be pondered over and compared with the most modern theories, for, although the fact that they were thought out before the development of thermodynamics renders them remote from the present conception of many phenomena, they nevertheless may contain the germ of many fertile ideas.

The study of dielectrics, which had been fully investigated by means of Mossotti's mathematical analysis, did not come to a halt in Italy, but was continued in various works, among which I may mention those of Belli, Matteucci, and Felici on dielectric constants, and Felici's own investigations on the viscosity of dielectrics. Theoretical and practical researches of this kind have been continued down to our own days in the writings of Italian physicists and electro-technicians.

Mossotti's analysis is an example of the adaptability of Faraday's ideas to treatment in mathematical form. It is not the only example, nor is it the most famous, and indeed it is well known that Maxwell succeeded in translating Faraday's concepts into the equations of the electromagnetic field, and discovered in them the germ of the electromagnetic theory of light.

Faraday did not possess the technique of the analytical mathematician, but he could express accurately in words all that is told us by formulæ. The same thing may be said of Volta. If I wished to draw a parallel, after the manner of Plutarch, between these two heroes of science, I should have to bring out this similarity between the minds of the English physicist and the Italian, which were also so much alike in other ways. Both had mathematical minds in the truest sense, for analytical symbols and devices are not the substance of mathematics but only its outward aspect.

The problem of the electric motor, and its converse, that of generating the electric currents first obtained with Volta's pile, and then, thanks to Faraday's principle of induction, by a method capable of practical application on a large scale, were certainly ' in the air ' when a very ingenious solution was supplied in 1860 by Antonio Pacinotti, who constructed his celebrated ring armature in the Technological Physics Laboratory of the University of Pisa. It was not until 1864 that the inventor set down in writing a description of his apparatus, which he modestly styled "una machinetta elettromagnetica" (a small electromagnetic machine), and he published it in 1865 in the *Nuovo Cimento*.[9]

I do not think it worth while to give this description here, for it appears in most elementary treatises on physics and electro-technics. The brilliant solution of the problem proved to be adapted to the most extensive and important industrial applications, which the inventor himself had at once foreseen, and the machine became one of the most useful and most widely employed in the world. There is no need to repeat the well-known story of its rapid dissemination and the controversies, now concluded, to which it gave rise.

As we have already said, the researches connected with Maxwell's theories cannot be dissociated from the memory of Faraday, to such an extent are the theories themselves derived from his experiments and concepts. The pressure of light, which Maxwell arrived at as a consequence of the electromagnetic theory, was demonstrated by Bartoli, by a new and original method, described in a memoir published in 1876, which was practically devoted to the study of the radiometer.[10] Bartoli imagines four concentric spherical enclosures: the outermost and the innermost are perfectly black; the two in between are perfect reflectors. By means of a cycle, which may be repeated as often as desired, he makes heat pass from the outermost enclosure, which may be assumed to be the coldest, to the innermost, which may be assumed to be the warmest. In accordance with the second law of thermodynamics, before the cycle can be completed a certain amount of work must be changed into heat, and then, by virtue of the radiation of the black body on the inside, a pressure is exerted on the adjacent enclosure. From this follows, as a consequence, the pressure of light.

This is the most celebrated of Bartoli's numerous investigations, and it is undoubtedly with this that his name is always associated. The curious thing is, however, that Bartoli, who died in June 1896, before the pressure of light had been experimentally verified, was doubtful of its reality and strove to interpret his reasonings in various other ways; but he always kept his doubts to himself while he lived, and they were only revealed later on.

We must also mention Bartoli's researches in electrolysis, and in particular his investigations into the possibility of decomposing water even with the weakest electromotive forces.[11] They are allied to Faraday's studies in his fifth and following series of "Experimental Researches".

The prime characteristic of Faraday's thought lies in his transference of the seat of electromagnetic phenomena into the dielectric, where he perceived and followed the movement and the changes of the lines of force which were the embodiment of the conception he had used to explain electrodynamic action.

One of the most luminous and inspiring expositions of Faraday's conceptions, and of the manner in which they were developed by Maxwell and Hertz, was the address on the electrical transmission of energy delivered by Galileo Ferraris to the Academy of the Lincei in June 1894.[12] But an address of this kind would only be remembered as a happy popularisation of the concepts of the localisation and flux of energy, at that time novel to the public at large, if it did not serve to show us a good deal more, namely, the quality of Ferraris's intimate insight into the nature of electrical phenomena, which had been the point of departure for his discovery, nine years earlier, of the rotary magnetic field. Indeed, it was seeing 'in his mind's eye' the electrical vibrations completing themselves, not within the confines of the conductors, but in the common medium external to them, and thus persuading himself of the possibility of superimposing two alternating electrical currents at right angles to one another—a vision that came to him like a flash as he was taking a lonely walk one night through the streets of Turin—that led Ferraris to the discovery to which he chiefly owes his fame.[13] This brilliant achievement had been preceded by lengthy and searching studies of transformers, of which Ferraris provided a complete theory which led him to establish the well-known law of phase-displacement and to work out the power of a transformer. This served to dissipate the mistaken views then prevalent regarding the output of a transformer, and to show the full importance, in its industrial applications, of this fundamental piece of apparatus, the direct offspring of the principle of induction, occupying in electro-technics the place of the lever in mechanics.[14] The transmission of energy over a distance by the use of alternating currents, from which all our industries have received so great an impetus, was the practical outcome of these studies.

The history of the evolution of Faraday's ideas, which led to Maxwell's mathematical theory, then to the experiments of Hertz, would not be complete without some reference to wireless telegraphy, in which the memorable cycle reaches its astounding close. In Italy, Righi, among others, repeated and successfully extended Hertz's experiments, following out in every particular the analogies between the phenomena of optics and those of the electromagnetic waves.[15] Then Marconi, with amazing perseverance, availing himself of the most ingenious and varied methods, succeeded in carrying out actual transmission over a distance by means of electromagnetic waves. The rapid progress of radiotelegraphy and radio-telephony is going on every day before our eyes, and is being followed with interest and wonder throughout the world.

I cannot enlarge on numerous other questions, interesting though they are—electrolysis and electrophysiology, for example—or recall Matteucci's studies [16] and his correspondence with Faraday,[17] nor must I go back to the chemical theory of the Voltaic pile, which Faraday preferred to the contact theory, thus associating himself with the ideas first put forward by Fabbroni.[18] It is impossible for me to say anything on the question debated by Faraday, whether electricity, however generated, is always the same, follows the same laws, and produces the same effects; Volta himself considered this problem, and has been the subject of recent studies by living writers. I will only mention the observations communicated by Father Bancalari in 1847,[19] and the subsequent memoir by Zantedeschi on the magnetism of flames,[20] which attracted Faraday's attention to the magnetism and diamagnetism of gases.

Let me close with a reference to magneto-optics, which takes its rise from one of Faraday's most famous discoveries, that of rotatory magnetic polarisation. Righi gave the dynamic explanation of the phenomenon, which later researches have associated with Zeeman's great discovery. Righi himself took advantage of the property of a sodium flame traversed in the direction of the field by a beam from two crossed Nicols, which permits of the observation, by simple means, of Zeeman's converse phenomenon.[21] It is very curious that this experiment should have been carried out with apparatus analogous to that devised by Faraday, who, however, failed to obtain the result, an occurrence extremely infrequent in the course of this great observer's researches.

We are to-day recalling and commemorating the work of Faraday, as we did that of Volta and of Ampère a few years ago. These three great men of science, belonging to different countries, lived their lives remote and apart from each other, but their minds worked together in harmony for the progress of natural philosophy and the discovery of new and marvellous devices of use to human society. The influence which each of them exercised beyond the confines of his native land availed to direct towards similar ends minds very diverse in their racial origin, which acquired fresh virtues by taking part in the common effort.

The aim of my brief essay has been to throw light on the influence which Faraday's work had in Italy. From the philosophical point of view, this influence was enormous, and, as we have seen above, when the discoveries of the English physicist penetrated into Italy, they gave rise to new and original discoveries there, of singular importance even from the point of view of their practical applications, which awakened the enthusiasm not only of men of science but also of the whole of the civilised world for which they have provided such benefits and advantages. The feelings of admiration and gratitude cherished in Italy towards the great British thinker and experimenter are widespread and profound.

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[1] "Sopra la forza elettromotrice del magnetismo" *Antologia* No. cxxxi; "Nuove esperienze elettromagnetiche e teoria fisica del magnetismo di rotazione", *Antologia* No. cxxxiv.; "Descrizione delle nuove calamite elettriche ed osservazioni sulle medesime . ", *Antologia* No. cxxxvi; "Sopra vari punti di magneto-elettricismo", *Antologia* No. cxxxviii By Signori L. Nobili and V Antinori. "Teoria fisica delle induzioni elettrodinamiche", by L. Nobili, *Antologia* No. cxlii.

[2] "La vita di Michele Faraday": Padua, 1908

[3] "Cours spécial sur l'induction, le magnétisme de rotation, le diamagnétisme et sur les relations entre la force magnétique et les actions moléculaires": Paris, 1854.

[4] *Annali delle Università Toscane*, vol. 3. Felici's three memoirs were translated into German and issued in "Ostwalds Klassiker der exakten Wissenschaften".

[5] "Considérations sur l'état dans lequel doit se trouver une couche d'un corps non-conducteur de l'électricité lorsqu'elle est interposée entre deux surfaces douées d'électricité de différente espèce", *Journal de Physique, de Chimie et d'Histoire Naturelle et des Arts*, by J. C. Delaméthene: Paris, vol. 63, July, 1806; Suite des considérations, etc.; Avogadro, "Saggio di teoria matematica della distribuzione dell' elettricità sulla superficie dei corpi conduttori nell' ipotesi dell' azione induttiva esercitata dalla medesima sui corpi circostanti per mezzo delle particelle dell' aria frapposta", *Memorie della Società Italiana delle Scienze*, vol. 23, 1844.

[6] "Discussione analitica dell' influenza che l' azione di un mezzo dielettrico ha sulla distribuzione dell' elettricità alla superficie di più corpi elettrici disseminati in esso," *Memorie della Società Italiana delle Scienze*: Modena, part 2, vol. 24, 1846.

[7] "Sur les forces qui régissent la constitution intérieure des corps." Taylor's "Scientific Memoirs", vol. 1: Turin, 1836.

[8] "Lezioni elementari di fisica matematica": Florence, 1843.

[9] "Descrizione di una macchinetta elettromagnetica del Dott. Antonio Pacinotti", *Nuovo Cimento*, June 1864, published May 3, 1865.

[10] "Sopra i movimenti prodotti dalla luce e dal calore e sopra il radiometro di Crookes": Florence, 1876

[11] We may mention among various memoirs by Bartoli on this subject "Su le polarità galvaniche e su la decomposizione dell' acqua con una pila di forza elettromotrice inferiore a quella di un elemento Daniell", *Nuovo Cimento*, 1879.

[12] Address before the Royal Academy of the Lincei, at the special meeting of June 3, 1894.

[13] "Rotazioni elettrodinamiche prodotte per mezzo di correnti alternate," *Atti della R. Accademia delle Scienze di Torino*, vol. 23, Mar 18, 1888.

[14] "Ricerche teoriche e sperimentali sul generatore secondario Gaulard e Gibbs," *Memorie della R. Accademia delle Scienze di Torino*, vol. 37, series 2, Jan. 11, 1885. "Sulle differenze di fase delle correnti, sul ritardo dell' induzione e sulla dissipazione di energia nei trasformatori", *Memorie della R. Accademia delle Scienze di Torino*, Dec. 4, 1887.

[15] "L' ottica delle oscillazioni elettriche": Bologna, 1897.

[16] "Electro-physiological Researches," *Phil. Trans.*, 1845–1850; "Lezioni sui fenomeni fisico-chemici dei corpi viventi": Pisa, 1846.

[17] Dr. Bence Jones, "The Life and Letters of Faraday", vol. 2.

[18] "Sur l'action chimique des différents métaux à la température de l'atmosphère et sur l'explication de quelques phénomènes galvaniques": Paris, 1796. "Dell' azione chimica dei metalli nuovamente avvertita": Florence, 1793.

[19] "Über seine Entdeckung des Magnetismus der Flamme", *Pogg. Ann.*, vol. 73.

[20] *Raccolta fisico-chimica Italiana*, vol. 3.

[21] "Di un nuovo metodo sperimentale per lo studio dell' assorbimento della luce nel campo magnetico." Two notes, *Rendiconti della R. Accademia dei Lincei*, series 5, vol. 7, part 2, 1898.

Faraday and French Physicists.*

By Prof. Pierre Brunet, Centre international de Synthèse, Paris.

Even if it is one of the essential tasks of the historian of science to find exactly what work was done by certain savants, he should still aim at showing the continuity of effort and research—if not of discoveries—by determining the place of the piece of work in question, its antecedents and consequences, what discussion was centred on it, and the depth and rapidity of its penetration into scientific thought. The necessity for consideration of environment would appear to be less if the savant belongs to a fairly recent period, since the speed with which discoveries become generally known has increased steadily through the centuries with the development of what may be called the internationalisation of science.

In the case of Faraday we are naturally led to inquire into the relation between his work, that of his own countrymen, and that of foreign savants. Even when we limit our study to that of the French physicists, under the last head, we are still left with a large field, and are compelled to restrict it further for the purposes of the present article. Without attempting, then, to give an exhaustive treatment, and passing over bibliographic matter—this would involve a very large number of references, and we should have to refer in particular repeatedly to thirty or forty numbers of the *Comptes rendus de l'Académie des Sciences* and as many volumes of the *Annales de chimie et de physique*, without counting a certain number of issues of the *Bibliothèque universelle* of Geneva and of *Poggendorffs Annalen*, where the French savants also published articles—we should like to point out specially, in a general way, what were the main lines of thought.

In the report on the founding of a prize for electricity presented by Biot to the Institut on July 1, 1802, which is signed by Laplace, Halle, Coulomb, and Hauy, an epitome of the history of electricity makes it appear that a second phase had started with Volta. The work of the Italian physicist had indeed not been long in making its effects felt in France, and had been taken up with some enthusiasm and had soon raised exaggerated hopes. Dumas alluded to this in his *Éloge de Faraday* when he referred his hearers "aux souvenirs d'une époque où les professeurs de physique exposaient à leur auditoire étonné la théorie mystérieuse de la pile voltaïque ; le simple contact de deux métaux, qui ne perdaient ni ne gagnaient rien, disaient-ils, faisait néanmoins sortir de cet appareil magique des effluves capables de rivaliser avec l'éclat du soleil . . . ."[1]

The first to question seriously this 'mystical theory' of contact was Becquerel, in France, who communicated a paper to the Academy of Sciences on May 19, 1823, dealing with his researches on thermoelectric phenomena and the electric effects of chemical reactions. His memoir of July 7, 1823, on the electric effects which develop during various chemical reactions, is of capital importance ; it was followed on Sept. 22, 1823, by another paper in which he described a method for measuring the intensity of a chemical reaction by the resulting electrical effects. He described other experiments in November 1823. Finally, he completed his work on April 12, May 31, July 5, and Oct. 3, 1824, by giving an account of a theory of the distribution of electricity in the voltaic cell, and by a discussion of various points arising out of his previous work. This established the general laws of the production of electricity by chemical action. Becquerel was able to construct a cell giving a steady current in 1829, after a first attempt in 1826.

Electricity produced chemically was studied after Becquerel by Pouillet, who presented two very important papers to the Academy of Sciences in 1825 (he also gave the results of his researches on the electricity of elastic fluids and on the origin of atmospheric electricity), and continued this work until 1828.

Whilst the work started by Volta was being developed in France on these lines, the experiment of the Danish physicist, Ørsted (July 21, 1820) was opening up the way for Ampère's and Arago's discoveries in electromagnetism. It would be interesting to give some details of Ampère's experiments. However, to keep strictly within the plan of this study, we shall merely recall the main features of the work, during the course of which the author established the basis of electromagnetism in a few months. The paper presented to the Academy of Sciences on September 18, 1820, is particularly worthy of attention, not only as the first, but also because the views expressed there contain the germ, so to speak, of all the subsequent work. We find established here the existence of an effective electrodynamic force in all parts of the conducting wire as well as in the cell, the notion of the direction of a current, the means of recognising this direction, and finally the general law determining the sense in which the current deviates the needle. Further, Ampère gave there a description of some instruments which he had designed, and elaborated some remarks tending towards an explanation of the properties of magnets. The papers of Sept. 25 and Oct. 9 were devoted to the study of the action of one current on another. During this time, Arago, following up some experiments with Gay-Lussac, had demonstrated the magnetisation of a needle placed in a spiral of wire carrying a current and the attraction of a conductor for iron filings;[2] and announced on Nov. 10, 1820, in the *Moniteur universel* that he had magnetised iron needles by electric sparks.

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* Translated by Dr. K. G. Emeléus.

Whilst Biot was communicating results of experiments he had undertaken with Savart to the Academy at the meeting on Oct. 30, and formulated the law which goes by their names, Ampère was continuing to publish his work, his concluding communications being made on Oct. 30, Nov. 6, and Dec. 4 (1820), and on Jan. 8 and 9 (1821).

At the end of this year (1821) Faraday's work and Ampère's work became closely connected for the first time. It was indeed Ampère's experiments which had given Faraday the idea of making a current element rotate by means of a magnet (we may note that Wollaston had already had this idea) and had made him try the converse experiment. The result of this double experiment in turn led Ampère to extend it, at the same time making his theory of magnetism more exact, and also to remedy its partial failure by improving certain faulty arrangements.

Ampère established the production of electric currents by induction so early as 1822. "Il s'établit", we read in "Recueil d'observations électro-dynamiques" (p. 321), "dans un conducteur mobile formant une circonférence complètement fermée un courant électrique par l'influence de celui qu'on produit dans un conducteur fixe, circulaire et redoublé, placé très près du conducteur mobile, mais sans communication avec lui." About this time Ampère also arrived at the fundamental law of electrodynamics by studying the phenomena of rotation of current elements by means of two circuits.

Whilst other physicists entered the field of electromagnetism, Ampère and Arago persisted in their research, and in 1824 the latter, following up an experiment of Gambey (1824), made the new discovery of magnetisation by rotation. He first ascertained that a magnetised needle returns much more rapidly to its position of rest when oscillating if it is put over a non-magnetic metallic disc, and then showed that the needle was deviated when a non-magnetic metallic disc was rotated above or below it. Arago went still farther and found the direction of the resultant action of the disc on the needle (1826). Before he had taken his analysis of the phenomenon even thus far, however, Prévost and Colladon, working in conjunction with Ampère, recorded (1825) the damping action of a fixed intercalated disc, and in 1826 Ampère showed in collaboration with Colladon that a spiral of wire passing a current was acted upon by the disc like a magnet. Physicists were very puzzled, nevertheless, when it came to explaining these phenomena. It was at first thought that it was a question of induced magnetism, all bodies being supposed to be capable of showing magnetic properties (an idea put forward by Coulomb in 1812), but this suggestion was soon discredited by Arago himself (1826). We can see from this how very far he had progressed towards the idea of induced currents, and how in quite a different way from Ampère, but just as directly, he had reached, so to speak, the frontier of the discovery reserved for Faraday.

There is no doubt that the ground had been prepared for Faraday's work in this way in all directions by the French physicists; and when their contemporaries mentally compared Arago and Ampère with Faraday they let themselves be guided by a proper understanding of the connexion between Faraday and his French rivals. Dumas wrote in his *Éloge de Faraday* that "Quand l'électricité aura trouvé son Newton, on pourra dire que, si Ampère en fut le Kepler, Faraday en fut le Galilée". He then drew a parallel between "ces deux hommes, si divers par les dons de la nature, si rapprochés par le génie et par les travaux", "inséparables dans le tableau du mouvement scientifique dont l'électricité a été l'objet, comme dans le souvenir de ceux qui les ont vus à l'œuvre". We do not think it is correct to add that "ce que l'un a fait, l'autre aurait pu le faire", or to write, as Becquerel did, that "si Ampère eût cherché à vérifier par expérience quels étaient les effets produits par les courants électriques sur les corps à l'état neutre, ainsi qu'il l'avait annoncé, il aurait enlevé à Faraday l'honneur de la découverte de l'induction". Nothing is less certain and more fallacious than a retrospective prediction after an event has taken place. Scientific discoveries have their origin in spontaneous inspiration, which is not part of a logical development and outside the range of extrapolation. The historian of science has done enough when he has established connexions and priorities and his function ends there.

The effect of Faraday's discovery in France, when it was announced to the Academy of Sciences by Hachette on Dec. 17, 1831, can be readily imagined. Not only did his results support Ampère's ideas on the structure of magnets, and by making it possible to pass from magnetism to electricity bring out clearly the identity of the two sets of phenomena, but also the idea of induction seemed especially fruitful from the fact that the existence of induced currents explained satisfactorily what Arago had found about magnetisation and rotation. In fine, Faraday gave a new cohesion to discoveries which had remained, if not isolated, at least somewhat separate; he imparted some sort of unity to convergent ideas which were not obviously comparable, his work being at once synthetic and explanatory.

In another connexion, Faraday's researches on cells led him to reject completely contact action, by his insistence on the chemical origin of the electrical energy of the cell. His influence in France in this matter was a powerful contributory factor in the overthrow of the contact theory, which still persisted in spite of Becquerel's work. Seen from this angle, Faraday's rôle was to supply the necessary support to a piece of work which had not been completely accepted, and which received in this way the authority needed for it to become properly established.

After this, French physicists undoubtedly paid more and more attention to Faraday's researches, and looked to them both for suggestions and direction. For example, shortly after Faraday discovered self-induction, Masson was engaged in 1837 in finding the conditions under which currents could be produced by this means. He succeeded later in finding the relation between the tension of the currents and the sense of the induced currents. Moreover, following up a remark of Faraday's, he and Bréguet studied the conditions which determine the static effects which occur when currents are induced. Abria (1843) and Verdet tried especially to develop the results obtained outside of France by Henry (1839), but the induced currents of various orders studied by him constituted, nevertheless, a sort of extension of Faraday's discovery, and the two French physicists worked under the inspiration of the great English physicist. Still later, to quote only a few examples, it is perfectly certain that the experiments which Lallemand did between 1848 and 1851 on the mutual attraction and repulsion of induced currents, and Foucault's discovery of the heat developed by induction of currents (1855), are closely connected with ideas which originated with Faraday himself.

In sketching above the electrical research done in France prior to Faraday's work, we have ignored two small pieces of work which were too isolated to have any immediate effect. These were Le Baillif's observation of the repulsion of bismuth by a magnet, and Becquerel's observation (1827) of the repulsion of antimony under the same conditions. It was again left to Faraday to find the explanation by discovering diamagnetism, which groups these with other phenomena; even this mention of them, however, gives them rather undue prominence, since it can scarcely be maintained that Faraday's work was anticipated in France. On the other hand, he very soon had pupils, notably Ed. Becquerel, who first showed how to measure the attraction and repulsion of a magnet for different bodies in 1849, and perfected his method the following year and made it possible for Faraday to take up the problem again in the same way and push the solution much farther.

Finally, Faraday's letter to Dumas on Jan. 17, 1845, in which he announced the discovery of rotary magnetic polarisation, had an immediate effect in France. It was the origin of the work of Pouillet (1846), Ed. Becquerel (1846), and again of that of Verdet (1854). We cannot even make a brief study of these researches, and merely mention them to indicate the trend of later work, and the many directions in which the work of French physicists was orientated by Faraday. They were, moreover, not merely distant pupils; they found a living example in their teacher, who was to all intents and purposes a valuable collaborator, always ready to advise them, or to encourage them by some expert suggestion. Dumas tells us that "Foucault, dont les procédés avaient tant d'analogie avec ceux de Faraday dans l'art de consulter la nature, ne fut jamais plus heureux, peut-être, que dans les occasions où il l'avait pour témoin intime de ses admirables expériences". One can appreciate the prestige of the great English savant amongst his contemporaries, and his enthusiasm for scientific research, when one considers the admiration implicit in the following passage from Dumas, describing how Faraday allowed him to be present at one of his experiments: "Ses yeux pleins de feu, sa physionomie animée, témoignaient du sentiment passionné qu'il portait à la découverte de la vérité".

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[1] It is interesting to notice that Biot himself spoke in his report with some wonder of electricity being put into motion 'by simple contact'.

[2] Arago having shown this experiment to Ampère, the two then collaborated in new work.

Faraday's Connexion with Switzerland and Swiss Industrial and Economic Development.

By Ch. Eug. Guye, Honorary Professor of Physics in the University of Geneva.*

IT was through being assistant to Sir Humphry Davy that Faraday came into contact with the Swiss savants, and most particularly, at Geneva, with Gaspard de la Rive, then professor of chemistry in the Academy of that town, and with his son Auguste de la Rive, the great physicist, well known for his treatise on theoretical and applied electricity, his theory of the Volta cell, and his discovery of electro gold-plating, etc.

Apart from his invention of the miners' safety lamp, which made his name so popular, Sir Humphry Davy discovered the electric arc, that extremely valuable aid to science and industry, which has made possible the attainment of very high temperatures in the electric furnace and has revolutionised both illumination and the metallurgical industry.

Switzerland is, however, indebted to Sir Humphry Davy not only for his discovery of the electric arc, which benefits its industry, but also for taking Faraday to Switzerland and introducing him to the savants of the country. Geneva is greatly honoured in having and caring religiously for the tomb of the illustrious English chemist in the ancient cemetery of the Plainpalais commune.[1]

We may perhaps recall the circumstances which took Faraday to Switzerland.[2]

Faraday had been filled with enthusiasm by the lectures which Sir Humphry Davy gave at the Royal Institution in 1812, and he sent his notes on the lectures to Davy. In the following year a vacancy occurred for the post of laboratory assistant, and Faraday was appointed to it by Davy, giving up the work in a bookseller's shop in which he had been engaged for several years. A little later, Davy discontinued his work as professor at the Royal Institution to travel through Europe with Lady Davy to study. Faraday accompanied him as his laboratory attendant. They took with them a small portable cabinet which allowed them to do some chemistry on the way. They went first to Paris, which they reached on Oct. 27, 1813, and where Davy presented various notes to the Academy. On Dec. 13, this body appointed him as one of its associate foreign members in the first class. Leaving Paris, Davy, still accompanied by Faraday, stopped at Montpellier, where he met the celebrated Geneva botanist, A. P. de Candolle. We see him in Italy in 1814, and finally, towards the middle of September in the same year, we find him at Geneva, where he remained until the beginning of winter. He finally proceeded to London in the spring of 1815 by way of Austria and Germany.

Thus it happened that by accompanying Sir Humphry Davy on his travels, Faraday had the opportunity of coming into contact with Swiss savants, and particularly with Gaspard and Auguste de la Rive, with whom he kept up a sustained correspondence afterwards, which is now deposited in the public University library of Geneva.[3]

These letters make it clear that Faraday and the Geneva savants were in communication for many years on scientific matters, exchanging opinions from time to time on each other's work. There is neither time nor space at present to go into this in detail, but we can perhaps return to it at some future date. There does, however, emerge from this intimate correspondence an impression of mutual confidence and of profound friendship. We may be permitted to quote in this connexion a letter which Faraday wrote, dated Oct. 16, 1852, when, having reached an age of some sixty years, he felt the first touches of age, although his exceptional activity might still make many a savant envious. A vein of modesty and sincerity brings out all the sympathetic greatness of this choice nature.

à Monsieur Auguste de la Rive,
PRESINGE
Geneva, Switzerland.

Royal Institution,
16 October 1852.

" My dear De la Rive,

From day to day and week to week I put off writing to you, just because I do not feel spirit enough; not that I am dull or low in mind, but I am as it were becoming torpid: a very natural consequence of that land of mental fogginess, which is the inevitable consequence of a gradually failing memory. I often wonder to think of the different causes (naturally) of different individuals, and how they are brought on their way to the end of this life. Some with minds that grow brighter and brighter but then physical powers fail; as in our friend Arago; of whom I have heard very lately by a nephew who saw him on the same day *in bed* and at *the Academy*: such is his indomitable spirit.—Others fail in mind first, whilst the body remains strong, others again fail in both together: and others fail partially in some faculty or portion of the mental powers, of the importance of which they were hardly conscious until it failed them. We may, in our course through life, distinguish numerous cases of these and other natures; and it is very interesting to observe the influence of the respective circumstances upon the characters of the parties and in what way these circumstances bear upon their happiness. It may seem very trite to say that *content* appears to me to be the great compensation for these various cases of natural change; and yet it is forced upon me, as a piece of knowledge that I have ever to call afresh to mind, both by my own spontaneous and unconsidered desires and by what I see in others. No remaining gifts though of the highest kind; no grateful remembrance of those which we have had, suffice to make us well and be content under the sense of the removal of the heart of these which we have been conscious of.

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* Translated by Dr. K. G. Emeléus.

I wonder why I write all this to you: Believe me it is only because some expressions of yours at different times, make me esteem you as a thoughtful man and a true friend.—I often have to call such things to remembrance in the cause of my own self examination and I think they make me happier. Do not for a moment suppose that I am unhappy. I am occasionally dull in spirit but not unhappy; there is a hope which is an abundantly sufficient remedy for that, and as that hope does not depend on ourselves, I am bold enough to rejoice in that I may have it. . . ."

Now that we have recalled the circumstances which took Faraday to Switzerland, let us see what consequences his discoveries, in particular his discovery of electromagnetic induction, have had in the industrial development of our country.

It is no exaggeration to say that Faraday's discovery is, with that of Ampère, one of those which has contributed the most to our civilised life. Its influence on pure physical science has been admittedly fundamental. Without dwelling on the scientific consequences of this work, we may recall that the discovery of induction, taken up and developed by the illustrious English physicist Maxwell, has become the explanatory basis of the theory of light, and, more generally, of all electromagnetic wave phenomena, which embrace more and more the whole of physics.

It is, however, above all, in its numerous applications that the discovery of induction has been so marvellously fruitful; as we know, these applications have altered the very face of our civilised world.

This transformation has been particularly significant in Switzerland; applications of electricity have rapidly assumed a place of first-class importance in this country. The immense water power which Switzerland employs has in fact only become available through the possibility of transforming it into electric energy, which permits of carrying and distributing it through the whole country, including the most secluded valleys.

To attain these marvellous results, it has been necessary in the first instance to build generators, motors, and electric transformers, the operation of which is controlled fundamentally to a considerable extent by the laws of induction, the discovery of which is due to Faraday's great genius.

At the present moment, the power in use for the production of electric energy in Switzerland is more than a million kilo volt-amperes and the electric energy produced annually by the whole of these installations now reaches about four milliard kilowatt-hours (kw.h.).[4]

The establishment of immense hydraulic works was, however, necessary to capture this enormous energy; moreover, to obtain sufficient regularity in the utilisation of this water power (it is well known how a watercourse varies from one season to another), it has been necessary to accumulate immense reserves; to create by dams large artificial lakes, or to harness by more or less important pieces of work large lakes already in existence. The hydraulic energy accumulated in this way in these immense reservoirs exceeds four hundred million kw.h.

Amongst the artificial lakes made to provide the necessary reserve of energy, we may mention specially Lake Barberine (Valais), with a capacity of nearly thirty-five million cubic metres, and Lake Dixence (Valais), now in active course of construction and with a capacity of fifty million cubic metres.

At the same time, for topographical reasons, Swiss industries have been called upon to make use of considerable heads of water. The installation at Fully (Valais) employs a head of 1650 metres, necessitating conduits and turbines working at pressures of about 165 atmospheres. Even this record will shortly be beaten by the Dixense installation, which will utilise a head of 1750 metres.

All this hydraulic energy is transformed into electric energy in large installations by means of generators and sets of transformers; not only is it used to light towns and even the most remote villages in the high mountains, but also industry in all its forms absorbs a considerable proportion. Mechanical and electrochemical and electrometallurgical industries have grown up rapidly through the marvellous adaptability of the 'electric fairy' for distribution. In the first rank of the Swiss electrochemical industries one finds the Aluminium Company, with large factories at Neuhausen, Chippis, etc., the manufacture of ferrosilicon, and that of calcium carbide, finally used to a large extent for the manufacture of nitrogenous manures (cyanamide). Finally, the whole network of the Swiss railways has been completely electrified quite recently, and this change represents an annual consumption of about a half-milliard kw.h. Quite apart from the many advantages of electric traction, notably from the point of view of multiplicity of trains, the rapidity with which they can start from rest, the absence of smoke, etc., this electrification is a very considerable economy for Switzerland. It obviates the necessity for importing a quantity of coal worth some tens of millions of Swiss francs annually.

Such is a very brief account of the use of our natural resources in Switzerland, which has been made possible in the first instance through Faraday's fortunate discovery. It will be readily understood why the country which has had the privilege of giving birth to a genius whose work has been so astoundingly productive should have decided to honour his memory, and to celebrate the anniversary of one of the discoveries the consequences and repercussion of which have played so important a part in the whole of our civilisation.

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[1] Sir Humphry Davy died at Geneva on May 29, 1829. He was buried on June 1 in the Protestant Cemetery at Plainpalais; the Conseil d'État granted a concession for 99 years, which was renewed a few years ago at the instance of the Faculty of Science of the University. In gratitude, Sir Humphry Davy's widow left to the Academy a sum to found a prize for the encouragement of scientific research.

[2] We take these details from an account of Sir Humphry Davy by the late Prof. Ph. A. Guye, of the University of Geneva.

[3] This correspondence contains about ten letters to Gaspard de la Rive (between 1818 and 1832) and about twenty-five letters to Auguste de la Rive (between 1840 and 1861).

[4] A kilowatt-hour corresponds to the energy developed by a machine of 1·36 horse power in an hour.

Faraday and Austria.*

By Prof. Karl Przibram, Institut für Radiumforschung, Vienna.

IN the autumn of the year 1814, towards the end of the Napoleonic drama, a travelling coach wended its way southwards over the picturesque mountain roads of the Austrian Tyrol. Its three occupants were the celebrated Sir Humphry Davy, his haughty wife, and a modest young man who played the part of a scientific assistant, and also, but with suppressed reluctance, that of valet. Waterfalls thundered down into the valleys, and the eyes of the young man followed them in wonderment. What were his thoughts? Deeply religious by nature and upbringing, was he simply admiring the works of the Almighty, or had he a glimmering presentiment of the possibility of harnessing these vast sources of energy for the benefit of mankind, to the realisation of which his later discoveries were to supply the key?

Young Faraday passed through the Austrian Tyrol twice during that memorable tour; but the influence which he exerted by his later discoveries, not only on Austria but also on the whole world, is in no way to be assessed by these fleeting visits. Is not water power an important asset of our sorely stricken country, and its present and future utilisation directly due to that flutter of a magnetic needle by which the first induction current revealed itself in Faraday's laboratory a century ago? We may recall to memory here two Austrians who though very different in station and in temperament, have both contributed to these extensive developments: first, the brilliant engineer and author, J. Popper-Lynkeus, who, far in advance of his time, upheld the possibility and necessity of electrical power transmission, in a thesis presented to the Vienna Academy of Sciences in the year 1862; and secondly, the university mechanician, Kravogel, of Innsbruck, who anticipated Gramme's ring in an electro-motor of his own construction.

Just as Faraday's discoveries opened up new avenues in engineering, so also, as a result of his novel ideas, translated into the language of mathematics by his great fellow-countryman, J. Clerk Maxwell, was physics confronted by new problems, in the solution of which Austria played no mean part. From amongst the four first magnitude stars in the constellation of Austrian physics—Doppler, Loschmidt, Stefan, and Boltzmann—the last two at least can be brought into direct relation with Faraday; Stefan by virtue of his researches on electrodynamic and diamagnetic induction, and Boltzmann as one of the first and most ardent protagonists, on the Continent, of the ideas of Faraday and Maxwell. Boltzmann's famous experimental investigations on the dielectric constant of gases and of sulphur can be regarded as a direct continuation of Faraday's pioneer work. We are moved as by a breath of Faraday's characteristic homeliness and devotion to his work when we hear of young Boltzmann waiting for hours for admittance to a classical performance in the Vienna Burgtheater, wedged in a crowd of art enthusiasts, and meanwhile, much to the displeasure of those around him, unremittingly polishing the sulphur spheres which he requires for his experiments.

Faraday's experiments on the liquefaction of

* Translated by Dr. R. W. Lawson.

gases were continued in Austria by Natterer, who constructed the first reliable machine for liquefying carbon dioxide; and Boltzmann's successor, Fritz Hasenöhrl, to some extent united the two last-named fields of Faraday's researches, dielectrics and the liquefaction of gases, by determining the dielectric constant of liquid air. Hasenöhrl fell in the War, in the defence of those selfsame Tyrolese mountains upon which Faraday's gaze may have rested little more than a hundred years earlier.

In view of the far-reaching influence of Faraday on contemporary physics, the selection of Austrian physicists referred to in this note is necessarily somewhat arbitrary. We might well also have drawn upon names such as E. Mach, V. v. Lang, L. Pfaundler, E. Lecher, and Franz Exner.

May the spirit of Faraday continue to dwell amongst us. It would be a sad prospect for science were those two complementary characteristics of Faraday's genius to depart from us—creative imagination and unconditional devotion to experiment.

The Faraday Festival.

By Prof. Bohuslav Brauner, Prague.

THE whole scientific world will join in celebrating Faraday's discovery of electromagnetic induction, and it will certainly not be passed over in Bohemia. I may be excused if I begin with myself. In our middle school (gymnasium) we had a most excellent teacher of physics, Prof. Pokorný. In his clear and beautiful lectures, which would have served as a model to those given at a university, he taught us in 1870 the principal discoveries in the domain of electricity. He spoke of Galvani, Volta, Carlyle and Nicholson, Ørsted, Ampère, and others, but before all he praised the discoveries of Faraday.

Pokorný accompanied his lectures by the most delicate experiments. We became so enthusiastic about the matter that we constructed many of his pieces of apparatus at home. I myself constructed first a Daniell cell, but for want of the necessary means the porous diaphragm was made of paper cardboard coated on both sides with plaster of Paris. A series of such elements gave a distinct spark between carbon poles. Further, I constructed a Neff's hammer, an electric alarm bell, an induction coil with condensers and a regulator, an electric telegraph for reaching a distance of a mile, an electric contact-thermometer showing the temperature at a distance and ringing the alarm bell to avoid an explosion—such as that which occurred in the dynamite works near Prague—and last of all an electric 'waker-up', ringing an alarm-watch. They were novelties in 1870, sixty-one years ago. It must be remembered that the art of 'electrotechnics' was founded only eleven years later, namely, in 1881, at which time the new electric units were established, the one mostly used up to that time having been the B.A. unit. Fifty years of NATURE, with which I became acquainted in 1880, has kept me well informed of further developments of electrical science.

Not only apparatus made by enthusiastic students, but also more serious investigations were made by some of our countrymen. Prof. František Petřina, a Bohemian, born in Semily in 1799, from the year 1844 ordinary professor of physics in the University of Prague, has done research work in galvanism, especially in telegraphy, as is seen from his many publications in *Poggendorfs Annalen* and those of the Vienna Academy of Sciences and so on. While teaching in Linz (1837–44) he constructed a simple instrument for 'faradisation': one magnet wound with insulated wire standing and another magnet on the top which could be turned round, so that the poles were changing. I saw the original model and also 'Petřina's spiral' largely used.

In the Bohemian University the theory of Faraday's discoveries was analysed by Prof. Koláček, professor of theoretical physics, but his work was rather to follow up that of Maxwell.

Prof. František Záček, physicist of the Bohemian University, has given me information upon the experimental significance of Faraday's discovery of electromagnetic induction: without Faraday's work, many aspects of electricity and the whole of electrotechnics could not be thought of. But also from the purely scientific point of view the value of this discovery is enormous, for it is a step showing a further connexion between electrical and magnetic phenomena, following on from Ørsted's discovery of the magnetic action of the electric current.

A further important discovery of Faraday is that of the chemical actions of the electric current and of the laws which it obeys. Besides the experimental importance of this work, due weight should be given to the theoretical side in connexion with our present views on the composition of matter and the atomic structure of electricity.

For the further development of electrical theory, Faraday's views on the relation of electric and magnetic phenomena, on the spreading out of the electric and magnetic forces through the dielectric, on the rôle of the same, on the tubes of force and so on, are highly important. In this respect Faraday may be regarded as the father of modern electrical theory, and he is the creator of the *Nahewirkungstheorie*. Faraday's views were further developed by Maxwell, and we find the fertile consequences not only in the purely scientific field (the electromagnetic theory of light), but also in the practical field (electromagnetic waves and radiotechnics). In this connexion, Prof. Žáček would like to direct attention to the fact that Faraday had a presentiment of the close connexion between electrical and optical phenomena, in pursuit of which he discovered the rotation of the plane of polarisation in the magnetic field.

Faraday's Researches and the United States.

By Prof. Willis R. Whitney,
Director of Research, General Electric Company, Schenectady, New York.

THE spirit and method of Faraday are as worthy of study as the results that flowed from them. Almost anyone could rehearse his cardinal contributions to present-day understanding of magnetic and electric fields, and could cite his electrochemical researches and his studies of magneto-optic and diamagnetic phenomena. No one ever before covered so wide a field of pure research, or discovered and disclosed such a grand territory of expanding and continuing usefulness. No one ever tapped so many sources from which living water flowed. But for anyone, however closely connected with that particular field of pioneering, to attempt to enlarge upon Faraday's work, seems to be lifting one's self by mere words into a position where the light of Faraday's character warms the writer without of necessity illuminating the rest of the world.

In his writings, Faraday touched the spiritual side of life lightly but revealingly when he said, "Yet even in earthly matters I believe that the visible things of Him from the creation of the world are clearly seen, being understood by the things that are made, even His eternal power of Godhead: and I have never seen anything incompatible between those things of man which can be known by the spirit of man which is within him and those higher things concerning his future, which he cannot know by that spirit."

The establishment of publicly supported institutions for the advancement of physical knowledge which was marked by the Royal societies and academies about 1700, looks, at this distance, like an attempted answer to Bacon. Nearly two hundred years before Faraday, Bacon advocated experimental science and orderly collections of physical facts. He saw a continually changing world, and wanted to direct the changes toward utility for all men, not 'before' but 'after' the events of research. "The subtility of nature", he declared, "is far beyond that of sense or understanding", and, again, "The real legitimate goal of the sciences is the endowment of human life with new inventions and riches."

The history of the Royal Institution, when Count Rumford interested the English public in establishing it as a laboratory for research and exposition about 1800, reads also like a continuation of the plan to acquire new knowledge by the direct, efferent method, and to encourage organised methods of dispensing and utilising it. It is scarcely too much to say that, if Francis Bacon could have had the Royal Institution and Michael Faraday in mind when he tried to point the way for useful development of science, he need have foreseen no other means.

It is well for us to realise not only Faraday's natural endowment, but also his artificial environment. Under Davy, he had become equipped with the best physical knowledge of his time. Thus, when he joined the Royal Institution as assistant in the laboratory, he was like some highly sensitive, but very young, plant in a new environment perfectly suited for growth. No other position in the world afforded such an opportunity for a young man who was interested in new science. His driving motive was never an immediate commercial or technical one, but purely the inquisitive searching of the infinite possibilities of Nature. He placed the highest value on new knowledge as such. He was ever ready to fit the theory to the fact. "In knowledge," he said, "that man only is to be contemned and despised who is not in a state of transition." Keenest and most unprejudiced of observers, he was a master of method, and recorded his observations in a manner to make them of maximum usefulness to others. I would estimate as not the least of his contributions to science the way in which he wrote those notes, their fullness, even the distinctly separate and numbered paragraphs. Those seemingly simple methods must have started many a young scientific worker along the way of careful observation and orderly record.

Francis Bacon, Benjamin Thomson (who, with the support of such Englishmen as Joseph Banks, established the Royal Institution), Humphry Davy, Michael Faraday, and their followers at the Institution, form what must be called a world pioneering group. These men had human welfare in mind, and each one showed plainly that while he did not know the particular utilisations to be made of new knowledge, he was certain that service always resulted from new material facts. They worked for civilisation and for more and better types of it. They were insistent on experiment because they were anxious to be led by Nature. While accepting the value of the deductive sciences, they indicated by the successes of their undertakings that taboos, general principles, theories, and laws were largely useful through the values produced on questioning and testing them.

It is difficult to imagine now that Faraday could not foresee the great expansion which would occur in electricity. On the foundations which he laid, all the civilised countries of the world ultimately began building electrically. Electric lighting systems, power transmission systems, transportation systems, telegraph, telephone, and radio are all based on his demonstrations of the relationship between magnetic field and conductors. Here was no sudden flash of intellectual legerdemain. Rather the inspired and tireless work of a master builder. On those impregnable foundations he erected a structure of beauty and utility to which his followers may for ever add.

Developments in the United States of the researches of Faraday are not particularly different in kind from those of other civilised countries, but I can write more intelligently of them. As a nation the United States now uses as much electric energy as the rest of the world combined. It is difficult to realise that one short century ago Faraday was showing the race which had so long known lightning, animal electricity, 'static', and voltaic currents, that these, together with the new magnetically produced currents, were tokens of the same thing. Since that time, all the aluminium and much of the copper in the world has been produced by application of his magnetic induction method for current generation and in accord with his quantitative electrochemical laws. While his first dynamo was described in 1831, it took more than thirty years for appreciation of what such generated current might do technically. We credit him with both the principle of the electric motor and the dynamo or generator, because his first new electrical machine of 1831 produced electric current by the rotation of a copper disc bearing suitable brushes between the poles of the magnet, and as a motor he had forced a wire carrying current to rotate around a magnetic pole. No one supposes that Faraday foresaw the unlimited application of generator and motor which is following in orderly manner the systematic researches he performed. It is this fact which seems to me to connect him inseparably with Francis Bacon, who predicted such results of orderly scientific studies.

The present investments in the United States in the electric power and light industry are about twelve thousand million dollars. To this we must add more than five thousand million for electric railways, and another five thousand million for telephone and telegraph companies. A half million new customers are being added to light and power lines each year (in the United States), and about two thousand million dollars (400 million pounds) is received as income annually.

Even these data are an inadequate expression of value, because the yearly increment in the electric light and power field alone is more than five hundred million dollars annually (100 million pounds a year). About two-thirds of all the homes in the United States are now electrically lighted. More than twenty million houses are now 'wired'.

The value of electrical 'goods' made in the United States in 1929 exceeded two and a half thousand million dollars. In 1930 there were about seventy-five million dollars worth of incandescent lamps sold, and by 1930 there were sold about six hundred million dollars worth of electric household refrigerators.

Statistics and estimates are tiresome and prosaic. It is impossible even to mention many important electrical applications without making an unreadable list, but among those which exceeded a million units in use in 1931 are the flat irons (more than 19 millions), vacuum cleaners (9 millions), radio sets (10 millions), washing machines (7 millions), fans (3·9 millions), toasters (8 millions), percolators (6 millions), refrigerators (2·6 millions), space heaters (3·4 millions). Even such minor products as dry cells, storage batteries, and voltaic batteries were made to the value of 145 million dollars in 1929.

Thus far economy of electrical power production has risen with the sizes of individual generators, so that machines of 160 thousand kilowatt capacity have recently been made.

Probably, also, in no other line of commercial undertaking has an equal development of almost public ownership taken place. In the various electrical industries, including operating companies or 'utilities', there is wide distribution of stock, especially among the employees of the various organisations. This growing modification of participation by employees in the profits of their work is a promising evolution. There are more than 100,000 stockholders in the General Electric Company, more than 500,000 in the Telephone Company, about 675,000 in the three utilities, Cities Service, Electric Bond and Share, and Commonwealth and Southern, and about 85,000 in the Radio Corporation.

Generally speaking, lighting, which once was the major use of electric current, is being exceeded by other uses even in the average homes. There are many home devices coming into use which consume much more energy and save more human effort than lighting does. Electric heating and cooking, electric laundry and refrigeration devices are increasing in number and improving in quality, so that Faraday's utility contribution is just well under way.

Our farmers, because of their scattered or remote condition, have not been receiving much of Faraday's contribution, but 90,000 farms were connected to power lines for the first time last year. The total of electrified farms is now nearly 700,000, and this will rapidly increase because cross-country power lines are being interconnected into immense interlocking 'net works'. More than a tenth of the power is already used in States in which that particular power was not generated. The distance to which electric power may be economically sent is continually increasing.

It is not enough to confine one's self to past developments based on Faraday's work, nor is it correct to attribute every modern electrical advance to his personal researches. The world had to pass through those experiments and to others dependent upon them. But this is an occasion when there is no harm in indicating the potential values as well as the past services. Certainly the applications of electricity to the extent now seen in the United States will be exceeded and extended over the rest of the world. Thus Faraday, whatever he did, is bound to do much more as time goes on.

Then, too, the spread of electrical conceptions is not geographical alone. In the fields of science itself electricity in some form is become broadly basic. We now glibly speak of all matter being electrical, of about all phenomena being traceable in some way to electrical phenomena, and this reaches even to the processes of our nerve and muscle reflexes, our senses, and even our thinking.

It is a far cry from the first little machines of Faraday to the application of electricity to railroads, which at present so interests both England and America. From those machines, too, it seems a far cry to X-rays, to photoelectric cell applications, to the telegraph, the telephone, to radio, and to television. But we must remember in this connexion that it was Faraday himself who first demonstrated the identity of the unknown stuff we call electricity as he found it in the amber, the cat's fur, the electric eel, the voltaic cell, the lightning, and his electromagnetic fields.

We say blandly that electrical applications are certainly revolutionary, but do we realise yet that modern human revolutions are usually due to the natural desire for greater freedom from exhausting or forced physical work, and that Faraday's work has freed more slaves than any other revolution? It can apparently continue this service in ever-expanding degrees and ways. The South Sea islander who learned to want his first red loin-cloth may have killed a missionary to get it, but that is not now the general method. As men grow less and less savage they appreciate their missionaries better and better, and Faraday was supported by the intelligent part of a most advanced community. Perhaps that work will some day bring about co-operative international research institutions, in which more equitable distribution of responsibility and financial support will include the diverse benefited nations, and work be undertaken which is not, strictly speaking, the duty of any one nation to perform.

It is quite probable that the work of Faraday, supported by the Royal Institution, whose aim was discovery and disclosure of new physical facts, had much to do with the development of research laboratories all over the world. There are thousands now where there was none a century ago. Most of them, probably actuated by the motives which influenced the Royal Institution, still provide for broadcasting results of research of possible public value or interest. This was not always an obviously good policy in commercial organisations. But one can say, on looking over the past century's scientific and industrial accomplishments, that it has evidently been to the world's advantage that new scientific work in each of the civilised countries has been so generally and completely published. The completeness and accuracy, even the readability of all the publications of Faraday, set investigators a wonderful example, and science will never go back to the period when important or generally useful truth died out with the individual discoverers.

Electricity has had a marked effect on civilisation. True! Steam-engines broadened our physical and mental territories. But Faraday's researches, which were apparently at the time purely of academic importance, constituted peculiar and bold anticipatory effort. It was an attempt at appreciation of natural phenomena where the word appreciation involves extensive orderly investigations and understanding, followed by efforts at serviceable utilisation. Emulating Faraday—the experimenter—large numbers of industrial pioneers have been advancing into new electrical territory, both geographically and economically. They were probably influenced by the same kind of natural impulse which actuates all our explorers. This new activity is recorded in the modern literature of science, and is seen also in manufacturing and power developments.

The pioneer electrical spirit is evinced by the man who gathers capital to develop an extensive water-power in some remote district. There may be at the time no economic need for the power locally, and often none at any place, but such pioneers build in the faith that advance and change is continuous. It seems that new scientific knowledge does not long remain idle, and that if cheap power can be generated in some neck of the woods, then it is highly probable that worth-while uses will be made of it. In other words, the direction Faraday took into the untilled field of electric research is being pursued now by what we call hard-headed business men. They extend telephone, light, and power lines to connect countless different centres and sources, having the faith that as population increases, manufacturing expands, wants increase, and civilisation grows, they will be met by descending average costs of electric supply.

It is already evident that American factories have now been so completely electrified, that further effort at substituting motors for local steam plants or switches for endless belts is poor business. It is now more intriguing to substitute electrical devices for much of the operating and control of the machines themselves. The aim is to free the mechanical worker as much as possible. Countless electrical devices now take the place of his eyes, his ears, his hands, and his muscles. But as nothing takes the place of brains, these will be put to work in new ways. The millions of young people who now insist on getting advanced education far beyond the wildest hopes of ideal education a century ago, are bound to do for the general welfare much the same kind of useful research that Faraday did in his field; and evidently the way it is all going to work out is still as dim but certain as electric power was when Faraday's magnetic field first forced rotation on his current-carrying wire.

The Modern Electric Age in Relation to Faraday's Discovery of Electromagnetic Induction.

Prof. A. E. Kennelly,
Harvard University and Massachusetts Institute of Technology, Cambridge, Mass.

THE Faraday centenary celebrations in London in September will commemorate the discovery of electromagnetic induction by the great experimental scientific worker, Michael Faraday, one hundred years ago, in the laboratory of the Royal Institution. The principle involved in that discovery has proved of the greatest importance to the whole civilised world during the century which has since elapsed. The whole world, therefore, joins in the commemoration of an event which, in salient measure, has led up to practical electrical applications tending to interlink many nations in the conjoint use of electric power.

It may be of interest to outline very briefly the part which this discovery has taken in electrical engineering development.

Frictional or High-Tension Electricity.

Up to the year 1800, electricity was recognised only in the type that we call 'frictional', that is, capable of being produced by the mutual friction of unlike substances, and characterised by the properties of relatively high voltage, small quantity, and brief impulsive currents. Although in the year 1800 a very wide field of experimental knowledge had been developed in frictional electricity, by investigators in many countries, the number of its practical applications had proved to be very limited. Frictional electricity was hard to insulate and to control.

LOW-TENSION ELECTRICITY.

Volta's announcement, in 1800, of the discovery of low-tension electricity, associated with the contact of different metals and attendant electrochemical action, added a new chapter to the history of electrical development. The voltaic pile, as an electric source, was so different from the frictional machine or the influence machine, that it is no wonder doubts were raised, at first, as to whether voltaic electricity was really the same as frictional electricity. With frictional electricity no electric circuit seemed to be necessary, whereas with voltaic electricity a conducting circuit had to be provided. In this circuit the voltage was relatively low ; but the current produced might be relatively strong and steady. It took several decades for scientific workers to establish the voltaic battery on a firm basis of practical reliability.

Volta's name became incorporated in the list of practical electrical units by the Paris International Electrical Congress of 1881, under the unit name *volt*.

RELATIONSHIP BETWEEN ELECTRICITY AND MAGNETISM.

Up to the year 1820, electricity and magnetism were studied as separate and independent branches of science, electricity being both frictional and voltaic, while magnetism was the innate property of certain iron minerals called ' lodestones ', capable, however, of being imparted, by contact, to previously neutral steel bars or needles. In that year, however, Ørsted, of the University of Copenhagen, discovered that any wire, carrying a steady current from a voltaic battery, was capable of deflecting a magnetic needle suspended in its vicinity. Here was an interrelation between magnetism and electricity in motion, with the birth of a new branch of science—electromagnetism. Ørsted's name was incorporated among the list of magnetic units, under the title *oersted*, by the International Electrotechnical Commission (I.E.C.), at Oslo, in 1930.

Closely following upon Ørsted's discovery, came the work of Ampère, who further strengthened the link of electromagnetism between magnetism and electricity by showing that electric currents exert mutual attractions and repulsions, like magnetic poles. He succeeded in placing these electromechanical forces on a firm mathematical basis. The name *ampere* was assigned to the practical electromagnetic unit of current by the International Electrical Congress of Paris in 1881.

The work of Ørsted and Ampère opened the path of development for electromagnetic current-indicating instruments and galvanometers, which were badly needed. It also provided the starting-point for electromagnets and the electric motor, the movement of a compass needle by a current flowing in a wire being the initial step towards continuous rotation ; but much had to be invented and devised by Faraday, Wollaston, and others, before the first small electromagnetic motor was produced, embodying rotation.

THE ROYAL INSTITUTION.

The Royal Institution, made so famous by the work of Davy and Faraday, was planned and financed by Sir Benjamin Thompson, Count Rumford, in 1799, in conjunction with Sir Joseph Banks, then president of the Royal Society. Count Rumford was born at Woburn, Massachusetts, a suburb of Boston, in 1753, and studied at Harvard College. As a young man he taught in a school in a town of New Hampshire, at that time named Rumford ; but renamed Concord (the State capital) in 1763. He went to England, and after publishing scientific researches there, he was elected a fellow of the Royal Society. In 1796 he established the Rumford Medals by an endowment gift to both the Royal Society in London and the American Academy of Arts and Sciences in Boston, for conferring medals upon persons in Europe and in America, respectively, who made notable contributions to the subjects of light and heat.

It appears that Count Rumford invited Sir Humphry Davy to be the first lecturer at the Royal Institution. Sir Humphry Davy accepted the invitation, and proceeded to establish the fame of the Institution by his lectures and researches in chemistry and physics. Sir Humphry Davy, in 1813, invited Michael Faraday, then twenty-two years of age, to come to the Royal Institution as an assistant. Faraday accepted the post, and later, as we know, succeeded Sir Humphry Davy as the lecturer, researcher, and scientific head of the Institution, which his discoveries made yet more renowned.

FARADAY'S ELECTROMAGNETIC RESEARCHES OF 1831.

Faraday kept for many years, at the Royal Institution, a diary of his scientific work, which has since revealed more kinds of utility than its author may then have imagined. This diary is to be published in full as a valuable permanent appendix to the Faraday centenary celebration of the present year. It is clear from the diary that Faraday suspected there must be some interconnecting link between electricity and magnetism other than that already discovered by Ørsted in 1820. The diary records the details of the crucial experiment that caught the suspected missing link, on Aug. 29, 1831. The apparatus is virtually an elementary type of what we should to-day call a transformer, with primary and secondary windings on a solid iron ring core. On making and breaking the primary circuit, excited by a voltaic source, momentary induced currents were observed in the secondary circuit, closed through a galvanometer. This must have been regarded as an extraordinary new phenomenon at that date. The development of this discovery led on to the dynamo-electric generator.

It might naturally be supposed by any student of modern electrical engineering that the electric generator was first produced, then the electric motor, and thirdly the alternating current transformer. It would seem, however, that, historically, the order in discovery of fundamental principles was first the motor, then the transformer, and thirdly the generator.

CONTEMPORANEOUS RESEARCHES OF HENRY IN ELECTROMAGNETICS.

While Faraday was engaged upon his experiments on magnetic and electric interconnexion, in 1831, at the Royal Institution, at least one other scientific investigator was at work in the same field. Joseph Henry was born at Albany, New York, on Dec. 17, 1799, which happens to have been also the birthday of Sir Humphry Davy in 1778. Albany, some 250 km. up the Hudson River from New York City, and now the capital of New York State, was first settled in 1624, under the title of Beaverwyck. The name was changed in 1664 to Albany, in honour of the Duke of York and Albany, afterwards James II. of England. It was a centre of the fur trade and in 1800 was an active town. Henry studied at the Albany Academy, and was appointed its professor of mathematics and natural philosophy in 1826. It was a remarkable coincidence that Faraday and Henry, so remote from each other, and working under such different surroundings, should be investigating simultaneously the same field of electromagnetics. Faraday was in the Royal Institution, probably one of the best-equipped laboratories of that period, while Henry was in the schoolhouse of a remote American country town. Much time must have been required, at that date, to exchange scientific information between researchers in London and Albany, New York.

It would seem that each independently discovered, through different experimental apparatus, the production of electric currents from the excitation and de-excitation of a magnetic circuit linked with a secondary coil; but whereas Faraday recorded his observations in August 1831 and published them in November 1831, Henry did not publish his observations until July 1832.[1] The field of electromagnetics is, however, so large, and the scientific accomplishments of both these eminent pioneers was so outstanding, that there has been abundant recognition of each. The names of both Faraday and Henry have been included in the list of international electrical units, by international congresses, under the respective titles of the *farad* and the *henry*.

It is curious to note that while Faraday worked for more than fifty years in the Royal Institution, established in large measure by an American, Count Rumford, Henry worked for more than thirty years as the first secretary and director of the Smithsonian Institution, at Washington, D.C., a scientific organisation established by a legacy to the United States from James Smithson, an English chemist and a fellow of the Royal Society.

INTERMEDIATE STAGES BETWEEN THE DISCOVERY OF ELECTROMAGNETIC INDUCTION AND ITS LARGE-SCALE INDUSTRIAL UTILISATION.

Since the discovery of the fundamental principle of electromagnetic induction in 1831, it has required the intervening century to bridge the wide gap between that achievement and the existing stage of its utilisation for electric lighting and power distribution. It was necessary for physicists and mathematicians, in different countries, to place the discovery on a quantitative basis. This work, conducted by such leaders as Gauss, Joule, and Maxwell, occupied many years. All these three have had their names incorporated in the list of international electric and magnetic units.

Then there had to come the work of scientific inventors, to utilise the principles established for satisfying practical needs. Several of these great electrical inventors are still at work with us. After these had to follow a large number of financiers and business men, sufficiently persuaded of the practicability of the inventions to venture expenditure of capital upon them. Next had to be trained and equipped a corps of engineers and designers, to prepare, construct, and install the machines and apparatus in the electric transmission and distribution systems. Next in turn had to be trained an increasing army of operators, inspectors, and repair men to keep the systems in successful continuous operation.

Finally, and by no means least important, the public at large had to become acquainted with, and experienced in, the use and maintenance of the electrical apparatus placed at their disposal. This expanding process of education and training is constantly going on, and has been necessary for the industrial success of the original discovery. So, in our modern civilisation, a scientific discovery of the type here considered has to permeate the minds of millions of people in order to become an international industrial success.

IMPORTANCE OF THE HISTORY OF SCIENCE.

It is only necessary to make superficial inquiries into any important scientific discovery, such as that of Faraday in electromagnetic induction, to realise how little attention is devoted in the world's universities, colleges, and schools to the history (1) of basic science such as in mathematics and physics, (2) of applied science or engineering, and (3) of science in industrial practice. The study of the history of science is surely as worthy and important as the history study of either art, literature, or sociology. A beginning has indeed been made towards establishing university chairs in the history of science; but only a beginning. This study is fully as exacting as that of any other type of history, in regard to scholarship, training, and ability. It needs a knowledge of several languages, and each branch of science, as well as each period of the world's scientific history, demands its own group of working languages. It needs special gifts in exposition; because a historian of science who makes his story technical greatly reduces the number and the interest of his readers. As times goes on, it is to be expected that in each progressive country there will be established at least one university chair for the history of either basic or applied science. But, in all histories of electromagnetics, the date of Aug. 29, 1831, may be looked for as a red-letter day.

[1] "A Memoir of Joseph Henry", William H. Taylor: Philadelphia, 1879. "A Memoir of Joseph Henry", Simon Newcomb: Washington, 1880.

Faraday and Electrical Science in Russia and the U.S.S.R.

By W. TH. MITKEWICH, Polytechnic Institute, Leningrad.

FARADAY'S experimental researches in electricity and magnetism, his great discoveries and deep analysis of our physical conceptions, have produced an exceptional influence upon scientific thought throughout the world. His ideas have impressed themselves on the scientific work of all who were and are studying electromagnetic phenomena, as well as all natural phenomena that have any connexion with electricity and magnetism. All that has been done after Faraday in that domain of science is linked directly or indirectly to the fundamental ideas expressed and developed by him.

The principal idea which guided Faraday in all his works, and formed, so to say, the invariable background of his scientific thinking, was that all the interactions in Nature, and consequently also those of an electric and magnetic character, can exist only when some special physical conditions or phenomena are taking place between the interacting bodies and around them. He would not allow of the possibility of the conception of 'action at a distance' when studying and investigating any natural phenomenon. In his reasoning, he referred to Newton's authority; Newton had quite a definite opinion on that subject (see Newton's third letter to Bentley). Thus, where other physicists saw centres of forces acting at a distance, Faraday in his mind's eye saw physical lines of force traversing all space. From mathematical fictions which were used, and still continue to be used by some, Faraday's point of view leads us to a closer contact with what is actually going on. This may be considered as the first general reason for the great fruitfulness of Faraday's ideas.

The second fundamental consideration that guided Faraday's investigations and led him to a series of discoveries, was that between all the phenomena of Nature, and in particular between the phenomena of electricity and those of magnetism, there must exist some close connexion. He possessed an intuitive bent of mind that enabled him to inquire into the relationship of phenomena. He seems never to have deemed any physical relation complete in which discovery had not been made of the converse relation for which instinctively he sought. Not by chance, but by following up his general views of natural phenomena, Faraday made a hundred years ago, in 1831, his greatest discovery: he succeeded in generating the electric current by means of electromagnetic induction; this discovery is the true basis of modern electrical engineering and all the applications of electrical energy. Faraday saw from the beginning that peculiar properties of magnetic flux are manifested in the phenomenon of electromagnetic induction.

It should be stated * that the conception of the magnetic flux, as such, belongs fully to Faraday himself. Faraday was the founder of the doctrine of the physical properties of magnetic flux. Experimental methods discovered by Faraday permit us, in the right sense of the word, to feel the invisible magnetic flux as something real. Faraday was the first who showed the real existence of magnetic flux, which is of primary importance in all the manifestations of electric current; magnetic flux bearing all the energy of electric current. Faraday was the first who realised the insufficiency, the complete one-sidedness, and even the fallibility of our usual conceptions of the electric current, those conceptions being connected, owing to purely historical circumstances, with the process of movement of electrical fluids. He directed scientific research to the space round the conductor carrying the current, to that space where the energy of the electric current is located. Faraday showed his remarkable power of penetrating to the very nature of things when analysing the specific rôle of magnetic flux in electromagnetic phenomena, and particularly in the electromagnetic complex called by us the electric current flowing through a conductor. Faraday's mind was possessed more and more by this idea, which completely dominated him to the end of his scientific activity (see Faraday's "Experimental Researches in Electricity", beginning with Series XIX.).

Clerk Maxwell, the great interpreter of Faraday's ideas, accepted fully his principal points of view and developed them. Maxwell's differential equations of the electromagnetic field and the modern successes of wireless telegraphy and telephony are the direct development of Faraday's ideas. There is not a branch in the domain of electric and magnetic phenomena which was not considered and investigated by Faraday. His work in studying the properties of the electric field has proved of equal value to pure science as to technical applications of electrical energy. Faraday's discovery of the rotation of the plane of polarisation of light by magnetic action is the direct result of his line of thought; that discovery has revealed the electromagnetic nature of light and enabled Clerk Maxwell to describe the vortex motion in the magnetic field. In discovering the laws of electrolysis Faraday threw a bridge across between chemical and electromagnetic phenomena, and at the same time he laid the foundation for the conception of the atom of electricity that has led in turn to the conception of the electron. On the other hand, Faraday's studies also became the foundation of modern applied electrochemistry. In short, Faraday's work created a specific conception of natural phenomena and gave a powerful impulse to all kinds of practical applications of electrical energy, transforming entirely the general conditions in which modern mankind exists.

It is clear, of course, that the growth of new ideas arising from Faraday's scientific work, and the construction of electromagnetic machinery and other apparatus embodying these ideas, was the source in this field of the work of many other physicists and of many inventors. But it is undeniable that the whole army of those who worked theoretically and practically, and carried on Faraday's task, has been always inspired and supported by the genius of that great man. At the same time, it is undoubtedly true that many of Faraday's scientific achievements are not yet sufficiently understood and appreciated. His "Experimental Researches in Electricity" remains 'an Arabian book under seven seals' for those who, owing to the excesses of purely formal methods of investigation, have lost, in some degree, the capacity of understanding thoughts expressed in simple words. Faraday gave us the highest model of what physical thinking should be. He was a true natural philosopher. Every deviation from Faraday's method of study and analysis of physical phenomena leads to uncertain results. The roots of the modern crisis in physics must be sought to a great degree in this direction.

As noted above, Faraday's works have had a deep influence on the progress of physical thought all over the world. In particular, the discovery of electromagnetic induction of current attracted the attention of a number of Russian physicists. E. Lenz, member of the St. Petersburg Academy of Sciences, was much taken by the studies of this phenomenon. In 1834, that is three years after the discovery of electromagnetic induction

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* W. Th. Mitkewich, "The Work of Faraday and Modern Developments in the Application of Electrical Energy" Paper read before the Second International Congress of the History of Science and Technology, London, 1931.

by Faraday, E. Lenz enunciated the relation between this phenomenon and the mechanical action of electric currents. Lenz's law is as follows:—If a constant current flows in the primary circuit A, and if, by the motion of A, or of the secondary circuit B, a current is induced in B, the direction of this induced current will be such that, by its electromagnetic action on A, it tends to oppose the relative motion of the circuits. In Lenz's law we meet with the first clear indication that in the phenomena of electromagnetic induction we have the manifestation of the conservation of energy. In the later works of Helmholtz, Sir William Thomson (Lord Kelvin), and Clerk Maxwell we have the completion of this idea. Further, in 1839, E. Lenz stated, in spite of the opinion of many of his contemporaries, that induced currents do not possess any special properties, as compared with currents of galvanic batteries. E. Lenz proved, too, the independence of the induced electromotive force of the diameter of wire and of its substance. In his numerous researches on electromagnetic apparatus, E. Lenz established a series of most important statements having an important rôle in the modern theory of dynamos. It may be mentioned that in 1844 he described the phenomenon which is called now the armature reaction, and stated clearly the principal conditions for the proper position of brushes on the commutator of a dynamo.

In 1837, M. H. Jacobi, member of the St. Petersburg Academy of Sciences, invented electroplating. In 1839 he sent some specimens of electroplate deposit to A. Humboldt and to the Paris Academy of Sciences, which bestowed on him a gold medal for his scientific inventions. In his reports and writings, dealing with this subject, M. H. Jacobi gives a detailed account of all the conditions affecting the character of deposition and shows the quantitative relations and examples of calculation, based on the laws of electrolysis discovered by Faraday. It was M. H. Jacobi, too, who pointed out the possibility of making use for electroplating of currents generated by electromagnetic induction. M. H. Jacobi studied also the theory of electromagnetic machines, in particular of electro-motors. He built a special electro-motor, by means of which in 1839 he put in motion on the Neva, against the current of the stream, a boat carrying fourteen persons. Studying the work of electromagnetic motors, M. H. Jacobi established in them the presence of the back electromotive force, which arises according to Faraday's law and is overcome by the electromotive force of the battery. Thus M. H. Jacobi originated the calculation of the energy balance in the process of transformation of electrical energy into mechanical work.

Electrical lighting was the first broad practical application of electrical energy, generated by dynamo-electric machines constructed according to principles indicated by Faraday. Many Russian scientific men and inventors, as Jablotchkoff, Lodygin, Tchikoleff, and others, were interested by this field. Much was done, especially by Jablotchkoff, whose 'candle', invented in 1876, contributed in large measure, thanks to its simplicity, to the development of electrical lighting, and was widely used in many countries, mostly in France. In 1877, Jablotchkoff patented the system of electric light distribution by means of transformers.

In the domain of dynamo construction the merits of the Russian inventor and scientist M. Dolivo-Dobrovolsky are especially to be noted. He studied the physical properties of the magnetic flux, worked out the first sufficiently perfect electro-motors with rotary magnetic field (asynchronous motors), and was the initiator of the application of three phase currents for power transmission (1887). In 1891 he took part in accomplishing the transmission of electrical energy by three phase current from Lauffen to Frankfurt, covering 175 km. This transmission line was of historical importance and was the first experiment that had an industrial significance.

Electrical discharges through gases, to which Faraday contributed with a number of his investigations, were studied by many Russian scientists (Stoletoff, Sluginoff, and others). In 1888, Prof. Stoletoff discovered the photoelectric effect.

In 1900, Prof. Lebedeff published investigations, in which he succeeded, for the first time, in observing and measuring the pressure of light, which was predicted by Clerk Maxwell's electromagnetic theory of light; this theory being, in its essence, an interpretation and a further development of Faraday's cardinal ideas.

It may be permitted to state here that electric welding by means of the electric arc originated in Russia, under the stress of general interest in the domain of practical applications of electrical energy. This method is now widely applied in the Unites States and Europe for shipbuilding, construction of dynamos, and, in general, for metallic constructions. The originators of this method were Russian engineers, Benardos (1882) and Slavianoff (1885).

In 1895, Prof. Popoff made his first experiments in the reception of electromagnetic waves, and in May of the same year he read a report to the Russian Physical Society, in which he demonstrated his receiver for wireless communication. This receiver possessed already such essential parts as a receiving antenna and ground connexion, and was similar in every way to the wireless receivers that were later applied for some years everywhere in wireless telegraphy.

Since 1918 the Government of U.S.S.R. has organised special centres for scientific research, so indispensable in connexion with the technical reconstruction of the Soviet Union. In particular, electrical research laboratories and institutions have been created in Leningrad, Moscow, Nijni-Novgorod, and so on. Out of a large number of Russian scientists working in these institutions we may name Prof. A. Joffe (the theory of disruptive discharge in insulating materials), Profs. M. Bonch-Brujevich, W. Lebedinsky, L. Mandelstam, and N. Papalexy (all working on wireless telegraphy and telephony), Profs. A. Tchernyshoff, A. Smuroff, and L. Sirotinsky (all working on high tension power transmission), Profs. A. Tolvinsky, K. Shenfer, and M. Kostenko (all working on dynamo-electric machines). The investigations of these scientists have an importance in practice, besides their purely scientific interest, as all the research institutions are linked to corresponding electrical factories. At the same time, scientists working in the U.S.S.R. on electricity in most cases are in close connexion with the technical reconstruction of the country, based on the growth of practical applications of electrical energy. During the past few years in the U.S.S.R. there have been erected a series of electric power stations and a number of power transmission lines. For example we may mention the following power stations: Volkhov, Shatura, Kashira, Shterovka, Nijni-Novgorod, Zemavtchaly (with a total power of 460,000 kw), all these stations feeding transmission lines 100 km.–150 km. in length and at 110 kv. pressure). The following power stations are in construction: Dnieper, Svir, Bobriki, Tcheliabinsk, Ivanovo-Voznessensk (with a total power of about 1,200,000 kw., including the 550,000 kw. of the Dnieper). These power stations will feed a series of transmission lines, 100 km.–250 km. in length and at a tension of 160 kv.–220 kv.

Faraday's investigations have had a wide and deep influence upon electrical science and its practical applications in Russia and the U.S.S R., in the course of the hundred years which have passed since the discovery of electromagnetic induction.

India's Debt to Faraday.

By Sir C. V. Raman, F.R.S., University of Calcutta.

THE idea of a life dedicated and consecrated to the service of humanity and involving the renunciation of personal advantages makes a powerful appeal to the mind of India. It is doubtful if, amongst men of science, a finer example of such a life could be discovered than that of Michael Faraday. His ideas and discoveries have benefited all mankind, and, in common with the rest of the world, India owes him a debt which can never be repaid. I consider it a great privilege to be allowed, on behalf of India, to offer my humble tribute of homage to the immortal soul of Faraday.

So long as seventy years ago the career and achievements of Faraday had made a profound impression in India. It is sufficient to mention the fact that, when the late Dr. Mahendra Lal Sircar in the sixties of the last century laboured to promote science in India, he adopted the Royal Institution of Great Britain as the model to follow in establishing a centre for scientific research. The Association for the Cultivation of Science, which he founded at Calcutta in 1876, is thus itself an Indian memorial in honour of Faraday. It has been the great privilege of the present writer and of his numerous collaborators from all over India to have enjoyed the unique facilities for research provided by this institution during the last quarter of a century.

Amongst Faraday's discoveries, the most significant in its theoretical implications was the magneto-optic effect known by his name. It established an experimental connexion between light and electromagnetism, and thus paved the way for the demonstration by Maxwell and Hertz that light is itself an electromagnetic influence propagated through space. But a further implication of the discovery was that the particles of matter which are disturbed during the propagation of light are capable of being influenced by a magnetic field and are therefore themselves electromagnetic in their nature. It required the labours of Larmor, Lorentz, and many others to elucidate and develop this implication of the Faraday effect. But let it be emphasised that the discovery of magneto-optic rotation by Faraday was the seed from which grew the mighty tree of the electron theory of the dispersion and scattering of light.

It was the hope that fundamental advances in knowledge would result from a study of the relation between dispersion and scattering of light that induced me to make it the principal subject of my activities during the last ten years. The hopes which inspired the work have not been unfulfilled. Incidentally, the researches it involved have had the result of taking the workers in Calcutta into other fields of work in which Faraday was also the pioneer. Amongst these may be mentioned diamagnetism, magne-crystallic action, and magnetochemistry. The scattering of light by molecules stands in close relation not only with their optical dispersion but also with their magneto-optic behaviour, and especially the magnetic birefringence exhibited by fluids. The result of computations, based on the theory of magnetic birefringence, is to indicate that the molecule of benzene, the aromatic hydrocarbon discovered by Faraday, and even more so, the molecules of naphthalene, anthracene, and so on, possess an astonishing degree of magnetic anisotropy. Experiments undertaken at Calcutta led to the discovery that the aliphatic hydrocarbons also exhibit magnetic birefringence, but this is extraordinarily *feeble*, and *negative* in sign, while the magnetic birefringence of the aromatic hydrocarbons is known to be *strong* and *positive.* The significance of this discovery is, in the first place, that the magnetic anisotropy of the aliphatic molecules is very small. In other words, the chemical difference between the two classes of organic compounds corresponds to a striking magnetic difference. In the second place, the relations between the optic and magnetic axes of the two kinds of molecules are curiously different, and this gives rise to the difference in the sign of the magnetic birefringence. Experimental studies by Mr. S. Bhagavantam of the magne-crystallic behaviour of organic solids, especially of naphthalene, anthracene, and hexamethylbenzene, gave results in striking agreement with those inferred from magneto-optical experiments with solutions of these substances.

The importance of studying magne-crystallic behaviour, both of diamagnetic and of paramagnetic substances, cannot be over emphasised. Mr. K. S. Krishnan has taken up this subject enthusiastically at the University of Dacca, and has developed very precise methods of measurement, and examined a large number of compounds both inorganic and organic. He has further attempted to correlate the magnetic results with the crystal structure of the substance wherever this is known from X-ray investigations. In the case of diamagnetic crystals, and especially of non-polar substances, we are probably justified in assuming the molecular susceptibility to be a constant characteristic of the substance. On the basis of this assumption, which admits of ready experimental test, it is possible to discuss the question whether the crystal structure assigned by X-ray workers is in accordance with the observed magnetic character of the crystal and the magnetic anisotropy of the molecule ascertained from magneto-optic experiments. It is possible, in fact, to determine what orientations of the molecules are possible within the crystal lattice which are consistent with its observed magnetic properties. This new method of crystal analysis developed by Krishnan appears to be full of promise.

The interpretation of the Faraday effect is itself at the present time not completely free from obscurity. Recent work by J. Becquerel, Ladenburg, and others indicates that we have to distinguish between two kinds of magneto-optic rotation, one associated with paramagnetic substances and the other with diamagnetic bodies. For the latter class, the theory originally suggested by Larmor indicates that the frequency of the 'Larmor precession' in the magnetic field, taken in conjunction with the known optical dispersion, determines the coefficient of magneto-optic rotation. Unfortunately for the theory, however, the observed rotation in many cases falls much short of the calculated value. It seems likely that this anomaly is connected with the known optical and magnetic anisotropy of the molecules, which is not taken into account in the Larmor theory of the Faraday effect. The consideration further suggests itself that, just as we have two kinds of Faraday effect, we should also have two kinds of magnetic birefringence in fluids. In addition to the diamagnetic type of birefringence which is already known, there should be a paramagnetic type of birefringence. Experiments made at my suggestion by Mr. S. W. Chinchalkar indicate that solutions of salts of the rare earths, such as cerium chloride, actually exhibit such an effect. How this special type of birefringence actually arises is not clear. But it seems possible that the cerium ion is optically anisotropic, and that in consequence of the magnetic moment it possesses tends to orientate in the field.

The study of the magnetic behaviour of gases and vapours is a special field of great interest in which Faraday was a pioneer. The experimental technique is very difficult, especially in the case of diamagnetic bodies where slight traces of oxygen as impurity would wholly vitiate the result. Recently the subject has attracted much interest owing to the reported discovery by Dr. Glaser of a curious anomaly at low pressures. The subject was taken up by Dr. V. I. Vaidyanathan, who showed that in all probability the Glaser effect was spurious. Further, he found that ozone and ethylene are diamagnetic gases and not paramagnetic ones as had previously been reported by other workers. Measurements were also made and reported by him for a number of other gases and organic vapours.

The question arises whether diamagnetism is purely a molecular property or whether it is also influenced by the state of aggregation of the substance. The accuracy of measurement in the case of vapours is not sufficient to enable this question to be decided for the transition from the gaseous to the liquid condition. *Prima facie* we should not expect any appreciable changes in passing from the liquid to the solid state except in the case of metallic bodies and electrically polar substances where questions of molecular association enter into consideration. In certain well-known cases, for example, that of metallic bismuth and graphite, large changes with temperature have been reported, and the susceptibility of bismuth is reduced to a very small fraction of itself on fusion. In such cases, the interesting question arises whether mechanical subdivision of the substance into a fine colloidal state would influence susceptibility. From experiments reported from Chidambaram, by Dr. V. I. Vaidyanathan, and more recently by Dr. S. Ramachandra Rao, it would seem that this is actually the case.

Closely related to the general question of dependence of diamagnetism on the state of aggregation is the problem whether the susceptibility of a liquid mixture strictly obeys the additive law in respect of the mass proportions of its constituents. In those cases where anomalies in density and other properties are known, we should expect small deviations from additivity of molecular susceptibilities. A high degree of precision in measurement is necessary to decide this question, and this has been attained by a special optical method developed at Calcutta by Mr. S. P. Ranganadham. It would seem that in certain cases, for example, water and alcohol mixtures, distinct deviations from a straight-line graph are actually obtained.

Before leaving the subject of magneto-chemistry, reference should be made to the work of two notable Indian exponents of the subject, Prof. D. M. Bose of Calcutta and Prof. S. S. Bhatnagar of Lahore respectively. The former has done extensive and valuable experimental work in tracing the relation between paramagnetic susceptibility and chemical constitution and correlating it with atomic and molecular structure. The theoretical considerations advanced by him in regard to the paramagnetism of the compounds of the transition group of elements lay emphasis on the magnetic moment derived from electron spin and yield results different from those indicated by the well-known theory of Hund. They appear to agree better with the experimental facts than the results of Hund's theory. Prof. Bhatnagar is the author of a systematic treatise on magneto-chemistry. He has devised a sensitive interference apparatus for measuring the susceptibilities of small quantities of substances, and discussed very fully the relation between chemical constitution and diamagnetic susceptibility in organic compounds.

Limitations of space do not permit detailed mention of the work of Dr. J. C. Ghosh and others in the field of electrochemistry, in which Faraday was a great pioneer. Reference may, however, be made to the subject of dielectric behaviour, which has received much attention from Indian workers. The study of light-scattering leads one very naturally to consider the question of dielectric behaviour. The birefringence shown by a gas or liquid in an electric field may be connected quantitatively with the electric polarity and anisotropy of its molecules. As was shown by the present writer with Mr. Krishnan, it is actually possible to compute the electric moment of the molecule, and even to indicate its geometric position in the molecule from such considerations. Further, the connexion between dielectric behaviour and electric birefringence indicates that in the case of viscous liquids we should expect at low temperatures or in rapidly oscillating fields a disappearance, or even reversal, in the sign of their electric double refraction. Experiments by Mr. S. C. Sircar and the present writer appear to indicate that the suggested phenomenon is actually observed. The interest of this observation lies in its furnishing a demonstration that the electric polarisation of a polar molecule is of two kinds, one arising from its deformation and the other from its orientation under the action of the field.

Faraday's Researches on Magneto-Optics and their Development.

By Prof. P. Zeeman, For.Mem.R.S., University of Amsterdam.

In connexion with the forthcoming celebration of the centenary of Faraday's greatest discovery, which predominantly has influenced our concepts of Nature and our present electrical industry, there is room in Nature for an article on magneto-optics which may also direct attention to Dutch scientific work in relation to Faraday's researches and discoveries.

On Sept. 13, 1845, Faraday found the first indication of what is now called the magnetic rotation of the plane of polarisation in transparent isotropic substances, the Faraday effect. The nineteenth series of the "Experimental Researches in Electricity" labelled the discovery "the magnetisation of light and the illumination of magnetic lines of force". His discovery showed that while the vibrations of linearly polarised light propagated parallel to the lines of magnetic force are always normal to the ray of light, the vibrations of the emergent beam make an angle with those of the incident light. The first substance giving a positive effect was Faraday's own "heavy glass"—boro-silicate of lead—which had been found by him in attempts to improve the qualities of optical glass. These investigations (1825–1829), dating from the first period of his scientific life, undertaken conjointly with Dollond and Herschel, had cost him nearly four years of precious labour, and had not led to the object aimed at, which was only attained much later by Schott and Abbe. In the brilliant discovery of a relation between magnetism and light, he now obtained the reward for all the patience and energy bestowed on this early work.

The theoretical views which guided Faraday in his experiments are given in the opening paragraphs of Series XIX. of his "Experimental Researches":

> § 2146. "I have long held an opinion, almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or, in other words, are so directly related and mutually dependent, that they are convertible, as it were, one in another, and possess equivalents of power in their action. In modern times the proofs of their convertibility have been accumulated to a very considerable extent, and a commencement made of the determination of their equivalent forms."

Faraday knew what a delicate means for investigating the structure of transparent bodies we possess in the use of polarised light. Already, at the very beginning of the nineteenth century, Arago (1811) and Biot (1813) discovered the natural rotation of the plane of polarisation in quartz and other substances, and soon afterwards Brewster (1815) found the phenomena of accidental double refraction.

Faraday's arrangement may be described in his own words (§ 2150 "Exp. Res."):

> § 2150. "A ray of light issuing from an Argand lamp, was polarized in a horizontal plane by reflexion from a surface of glass, and the polarized ray passed through a Nicol's eye-piece revolving on a horizontal axis, so as to be easily examined by the latter. Between the polarizing mirror and eye-piece two powerful electro-magnetic poles were arranged, being either the poles of a horse-shoe magnet, or the contrary poles of two cylinder magnets; they were separated from each other about 2 inches in the direction of the line of the ray, and so placed, that, if on the same side of the polarized ray, it might pass near them; or if on the contrary sides, it might go between them, its direction being always parallel, or nearly so, to the magnetic lines of force. After that, any transparent substance placed between the two poles, would have passing through it, both the polarized ray and the magnetic lines of force at the same time and in the same direction."

Then comes a reference to the "heavy glass", and then in § 2152 the experiment with a positive result:

> "A piece of this glass, about 2 inches square and 0·5 of an inch thick, having flat and polished edges, was placed as a *diamagnetic* [a term used by Faraday strictly analogous to *dielectric*], between the poles (not as yet magnetized by the electric current), so that the polarized ray should pass through its length; the glass acted as air, water, or any other indifferent substance would do; and if the eye-piece were previously turned into such a position that the polarized ray was extinguished, or rather the image produced by it rendered invisible, then the introduction of this glass made no alteration in that respect. In this state of circumstances the force of the electro-magnet was developed, by sending an electric current through its coils, and immediately the image of the lamp-flame became visible, and continued so as long as the arrangement continued to be magnetic. On stopping the electric current, and so causing the magnetic force to cease, the

light instantly disappeared; the phenomena could be renewed at pleasure, at any instant of time, and upon any occasion, showing a perfect dependence of cause and effect."

Faraday then goes on making all kind of control experiments and investigating other transparent solids and a number of fluids and solutions. They all exhibited the effect, which apparently is a general property of matter. With air and other gases Faraday could not ascertain any effect. Relatively late (about 1880) H. Becquerel, and Kundt and Röntgen, by means of special appliances could demonstrate the small effect. Accurate measurements are due to Siertsema (1899) and M. de Haas.

A very large rotation in a gas was observed in 1898 by Macaluso and Corbino, when they passed plane polarised light, differing but little in frequency from that of the *D*-lines, through sodium vapour in a magnetic field, along the lines of force.

It is interesting to note what Faraday tells us in § 2182:

> "With some degree of curiosity and hope, I put gold leaf into the magnetic lines, but could perceive no effect. Considering the extremely small dimensions of the length of the path of the polarized ray in it, any positive result was hardly to be expected."

This last observation reminds us of the observations of Kundt (1884). With thin transparent films of iron, Kundt found that in a distance of 0·02 mm. the rotation already amounts to a full revolution. The exceptional position of iron (also of nickel and cobalt) as to magnetic rotation disappears if referred to the same magnetisation.

The essential difference between the natural rotation of quartz and the magnetic rotation of light was, of course, immediately ascertained by Faraday and applied in his multiple reflection method in order to increase the effects with the magnet.

In § 2224, Faraday makes the interesting remark that "the magnetic forces do not act on the ray of light directly and without the intervention of matter, but through the mediation of the substance in which they and the ray have a simultaneous existence". All future experience is in agreement with Faraday's remark.

In 1876, Dr. Kerr showed that a magnetisation of an iron mirror modifies the properties of incident polarised light.

In most cases the reflected light becomes elliptically polarised. The ellipticity is rather small, and the effect can be regarded approximately as a rotation of the plane of polarisation. The rotation of red light from the magnetically saturated mirror amounts to 23′ for iron, 21′ for cobalt, 3′ for nickel. These amounts are small but, nevertheless, would have been within reach of Faraday's means, at least for iron, if only a plane well-polished iron mirror had been at his disposal. The publication of Faraday's diary probably will give us details about this point.

A complementary phenomenon to the Faraday effect was found in 1910 by Cotton and Mouton by their discovery of the magnetic double refraction of pure liquids.

We now come to a discovery which undoubtedly would have been made by Faraday, if the times had been ripe for it. I mean the phenomena produced in spectroscopy by a magnetic field. These involve the splitting up of the lines of a line spectrum of a substance, when immersed in a strong magnetic field, each line being resolved into several components, each of characteristic frequency and characteristic polarisation and intensity. This effect has proved a most powerful means of discovering the nature of the forces in the atom.

In 1862, Faraday made the relation between magnetism and light the subject of, it is said, his last experimental work. He endeavoured, but in vain, to detect any change in the lines of the spectrum of a flame when this is under strong magnetic influence. The technique of obtaining strong magnetic fields and powerful spectroscopes was, however, inadequately worked out at the time. But in 1881 the Rowland grating was discovered, and its great resolving power enabled physicists to see details of spectra hidden to a former generation.

During several years I was occupied (for my thesis) with experimental work on the Kerr effect and studied the theories proposed to account for this phenomenon. Stimulated by the reading of Maxwell's sketch of Faraday's great life, I was able to discover in 1896 the magnetic resolution of the spectrum lines. Quite independently of a special theory, I had the idea that when the forces acting during the propagation of light in the Faraday effect were also present in a radiating flame under magnetic influence, possibly some new effect would manifest itself. It might have been otherwise indeed. At a much later date (1918) Lorentz said: "Then Zeeman could discover, as he has done, quite independently of any special theory, and without any previous consultation with myself, the magnetic resolution of spectrum lines ; he could not have succeeded, if the mass of the electrons had been ten times greater with the identical electric charge".

Indeed, guided by Lorentz's theory I made a rough determination of the specific charge at a very early stage (*Proc. Roy. Acad. Sci.*, Amsterdam, October, November, 1896), when the effect was only seen as a slight broadening of the sodium lines ; I found for the ratio of charge to mass the high value 10^7 c.g.s., quite different from the electrolytic ratio for hydrogen. I may be permitted to mention here that having come to this conclusion, I immediately went to Lorentz to tell him. He remarked : "That looks really bad ; it does not agree at all with what is to be expected".

I now propose to give a rather long quotation from an extremely interesting lecture, delivered in May 1929 to the Institute of Metals (*Jour. Inst. Met.*, vol. 41, No. 1, 1929) by Sir Oliver Lodge, entitled "States of Mind which make and miss Discoveries, with some Ideas about Metals". This paper contains several remarks of importance about metals, but still more instructive are perhaps those where Sir Oliver Lodge speaks to us as educator and philosopher. All young physicists should read his words, often expressed with deep humour, and try to formulate his lessons for themselves.

"*Zeeman's Discovery.* The Zeeman effect, too, is rather instructive from my present point of view in its incipient stages. Larmor's theory of radiation, before the era of electrons, had shown virtually that if a source of radiation were plunged in a magnetic field, the lines of the spectrum ought to be broadened, because a radiating atom would be influenced by any magnetic field in which that revolving or vibrating atom constituted an electric current. It was well known that an electric current was perturbed by magnetism, and this perturbation ought to show itself in the lines of the emitted spectrum. Instead, however, of getting an experimenter to try this with modern devices, that is, with a Rowland grating and a very strong field, Larmor—perhaps deterred by the knowledge that Faraday without theoretical clue had looked for some such effect by the aid of prisms and other inadequate devices known in his day, and had failed to find it in spite of his experimental skill—Larmor, I say, proceeded in a state of mind which I may call that of super-theoretical knowledge, to calculate quantitatively how much effect was to be expected ; i.e. how much could be expected from any reasonable field, acting, let us say, upon sodium light. He found it surpassingly small, and therefore gave up the quest. He had no idea at that time of anything smaller than an atom that was likely to radiate ; and if it were the whole atom that radiated, the effect of a magnetic field would be hopelessly small ; for theory showed that it would depend on the ratio of charge to mass, and the mass of an atom is much too big : nearly 2000 times too big.

"Zeeman, however, undeterred by super-theory and quite independently of it, proceeded to repeat Faraday's old experiment, by examining the spectrum of a sodium flame immersed in a strong magnetic field, by means of a Rowland grating. He found the effect—small indeed, but not null ; the lines were slightly broadened. Directly this preliminary observation was announced, Larmor wrote to me at Liverpool asking me to repeat Zeeman's experiment, which (having a concave Rowland grating in the cupboard and a three-inch telescope) I promptly did. In about a week I had verified it, and showed the broadening of the lines at a Royal Society soirée [May 20, 1897] immediately afterwards. By that time we knew the reason why Zeeman had succeeded, for the rough measurement admitted an estimate of the amount of broadening. The ratio of charge to mass, instead of being something under 10^3 or 10^4, came out 10^7, or about 2000 times bigger than any atom could have shown. In fact, the radiating particle, thus perturbed by the magnetic field, could not be an atom but only the charge of an atom.

"This illustrates that an experimenter should seldom be deterred by a theoretical difficulty ; for the data on which the theory is dependent *may* be erroneous. The theory mathematically may be right enough, but the data, the essential physical machinery, may be different from what had been anticipated. Zeeman's effect was observable because the radiating particle was a unit electric charge, and because the minute mass of the electron was soon afterwards brilliantly ascertained by Sir J. J. Thomson ; and so the outstanding difficulty was removed. The magnitude of Zeeman's effect, in fact, proved that the electron was the real radiator—a far-reaching discovery applicable to light of all kinds.

"Then came H. A. Lorentz, who applied his super-theoretical knowledge to an electron revolving like an electric current in a magnetic field ; and predicted that the lines should not merely be broadened but should be doubled or trebled according to the way the source of light was looked at, whether along the lines of force or across them, and further, that the lines would be polarized in certain definite fashion. Zeeman immediately proceeded to re-examine the phenomenon with still greater power, and verified every detail of Lorentz's prediction, subsequently finding out many other details about the lines—one of the sodium *D*-lines being quadrupled, and the other sextupled, for instance ; all which is now explained by a further elaborated theory, and has become part of modern physics."

In the second volume of Sir Joseph Larmor's "Mathematical and Physical Papers" we find a historical footnote concerning the beginning of the new chapter. I must resist the temptation to reproduce it here, because I want to say something about the more recent developments of the subject.

The theory of the triplication of the lines is most conveniently described by a beautiful theorem of Larmor (*Phil. Mag.*, December 1897), which affirms that the magnetic field is equivalent to a rotation. The standard triplet as foreseen by Lorentz's theory soon proved to be the exception rather than the rule. The great majority of spectrum lines are resolved into patterns with many components (as many as 21 components have been observed). The 'anomalous effect' is the collective name of all the cases of complicated resolution. When the magnetic field is increased, the anomalous effect degenerates in a remarkable manner, discovered by Paschen and Back. A rearrangement of the components takes place which, for very strong fields, ends with the standard triplet.

The general theory of these effects has a long and complicated history. Landé, on the basis of quantum theoretical results and the exact experimental data of Back, derived a formal theory culminating in a vector model. The introduction into the theory by Goudsmit and Uhlenbeck of the hypothesis that the electron is itself a magnet, made it possible to explain the anomalous effect.

The anomalous effect has proved of the utmost value in disentangling the structure of spectra. Many examples could be given, but I mention here the work done in the Amsterdam Laboratory by de Bruin on ionised potassium and ionised neon and other gases. We now can predict the anomalous effect in many cases by a formula due to Landé. This formula is remarkable because it contains different quantum numbers, but none related to the magnetic field, yet the resolution in the field comes out surprisingly well. Deviations occur, however, for the 'heavier' elements.

Bakker, working in Amsterdam, very recently published the results of experiments on the effect in the noble gas spectra in connexion with 'anomalous' coupling of quantum vectors.

The magnetic resolution has been applied to two recent physical problems. The first relates to the mechanical moment of the *nucleus* of the atom. It was shown by Pauli that in order to explain the hyperfine structure of spectrum lines, intensity variations of band spectra (Heisenberg, Hund), and related problems, it is necessary to ascribe a nuclear spin moment to the nucleus of the atom. In a strong magnetic field, the different orientations of the nucleus are exhibited by a hyperfine structure of each line of the magnetic pattern, and the spacing of the hyperfine structure immediately gives the mechanical moment of the nucleus.

The second problem relates to the question of 'forbidden' transitions between spectral terms. The resolution pattern from a transition arising by quadripole radiation is quite different from that by electrically disturbed dipole radiation. The green auroral line has been proved to be of quadripole origin by its behaviour in magnetic fields.

Jean Becquerel (1907) in Paris, afterwards in collaboration with Kamerlingh Onnes and W. J. de Haas in Leyden, and independently H. du Bois and G. J. Elias, then in Berlin, made beautiful experiments at low and extremely low temperatures on the magnetic resolution of absorption spectra of crystals of the rare earths, of their salts, and of some artificial gems.

Recently Jean Becquerel, working with W. J. de Haas in the Leyden Laboratory, at temperatures near the absolute zero, were able to give decisive proof of the existence of the paramagnetic rotation of the plane of polarisation, resolving the Faraday effect into two effects of different origin. Their curves for tysonite and xenotine illustrate admirably the existence of a saturation rotation.

A practical application of the magnetic resolution of the spectrum lines is the proof by its means of the existence of powerful magnetic fields in sunspots and of a general magnetic field of the sun, two discoveries made by Prof. G. E. Hale at Mt. Wilson. When Lorentz visited Pasadena he made a trip to Mt. Wilson, and he tells us about his impressions there: "We had a glorious sunset and enjoyed the view on the plain stretching toward the Pacific with the thousands of lights of Pasadena and Los Angeles, and when night had wholly fallen, Mr. Hubble allowed us to see in one of the giant telescopes some of the marvellous nebulæ which he is constantly examining in all their details. But the spectacle that, perhaps, impressed me most of all was the Zeeman effect in the sunspots."

Of course, no attempt has been made to make this survey complete. Attention has been directed to some of the fruits which have grown on the tree planted by Faraday. We may be sure that he would have enjoyed their development. They exhibit a richer variety than he could ever have conceived.

Dynamical Aspects of Electromagnetism.

By Prof. V. K. F. Bjerknes, University, Oslo, Norway.

SCIENCE develops side by side with a number of fundamental questions, some of which, if not all, are answered differently or even in an entirely contradictory manner by different investigators and at different periods. They return in ever-changing form; they will perhaps never get their final answers, and precisely for that reason always stimulate investigation. One such question, formulated by the natural philosophers of antiquity, is this. Is space empty or filled?

Anaxagoras and Demokritos gave opposite answers, Demokritos postulating empty space in which his atoms were free to move, Anaxagoras believing that space was full, and that the medium filling it would not prevent the motion of bodies any more than water prevents the motion of fish. When modern science began, Descartes and his school demanded the filled space. But, if perhaps not Newton himself, then at least his followers for more than a century, denied the possibility of the medium claimed by Cartesians, as its resistance would retard the motion of the celestial bodies, and spoil the harmony of the Newtonian world system. The theory of empty space and of action at a distance through it seemed to be secured for ever.

Still Young and Fresnel returned to the need for a space-filling ether-propagating light. Faraday joined them, demanding a 'dielectric medium' as a carrier of the electric and magnetic fields, which his mind's eye saw in the space between the visible bodies. Maxwell united the separate demands of Young, Fresnel, and Faraday in a single one through his electromagnetic theory of light. Finally, the experiments of Hertz brought their brilliant confirmation of the Faraday-Maxwell theory. The doctrine of an ether filling space and propagating effects which have the aspect of action at a distance, seemed to be definitely established.

The victory was not, however, a complete one. No positive theory had been given for gravitational action at a distance, and even within the domain of electromagnetism the most central question remained unanswered. It had been proved that the field produces a force, but nobody could answer the question of how the field produces the force. Faraday's suggestive idea of a tension along the lines of force combined with a mutual repulsion between them, and Maxwell's admirable mathematical transcription of this idea in his stress theory remained *ad hoc* hypotheses. Maxwell did not succeed in incorporating these dynamical views organically in the field theory contained in his equations, which would have cleared up the dynamical side of electromagnetism. To quote in his own words this fundamental defect of his theory:

> "It must be carefully borne in mind that we have made only one step in the theory of the action of the medium. We have supposed it to be in a state of stress, but we have not in any way accounted for this stress, or explained how it is maintained. . . . I have not been able to make the next step, namely, to account by mechanical considerations for these stresses in the dielectric."

This next step has not yet been taken. Electromagnetism and dynamics are interconnected in the most intimate way, but we do not know how. Concerning the importance of clearing up this question we may quote Planck ("Elektricität und Magnetismus"):

> The whole of electric and magnetic or electrodynamic phenomena constitute a self-contained unit, which is clearly separated from mechanics or the movement of material particles. . . . The final and complete fusion of these two classes of phenomena, which alone would set the crown to theoretical physics, must still be left to the future.

Other difficulties also remained, especially in connexion with optical phenomena observed on or from the moving earth. But here Einstein's 'special' theory of relativity gave a convenient means of escape, and his 'general' theory of relativity opened a new way of approaching the central problem of action at a distance, making gravitation depend upon the properties not of a space-filling medium but of space itself, or more precisely of the generalised space-time. The existence of the ether claimed by Faraday and Maxwell was denied, if perhaps not by Einstein himself at least by his most ardent followers. The problem became the development of a general field theory from the properties not of a medium filling space but of space-time itself.

The development from antiquity up to the present time thus shows oscillations like those of a pendulum between two extremes, full space and empty space. Each oscillation has been connected with some great advance in our knowledge, or in our way of formulating the fundamental questions. But no advance has been so decided that one could say if or where the oscillations would stop: at a Faraday-Maxwell ether, of which we may hope some day to know the dynamical properties, or at an Einstein space which makes this ether superfluous, if it does not perhaps ultimately identify itself with it.

For the answer to questions of this kind, namely, the power of a medium to produce action at a distance, or how a field can produce a force, the hydrodynamic phenomena discovered by C. A. Bjerknes (1825–1903)—the complex of hydro-electric and hydromagnetic phenomena—may some day become of importance. By reading as a young man the polemics which in the eighteenth century Euler had conducted in vain against the victorious theory of action at a distance, C. A. Bjerknes was inspired by ideas remarkably analogous to those of Faraday and Maxwell. Studying abroad and listening to Dirichlet's lectures on hydrodynamics at the University of Göttingen in 1855, he was struck by that result of mathematical analysis which shows that a body can move with uniform velocity through a perfect fluid without experiencing any resistance. This seemed to him to refute the fundamental argument of the Newtonians against the Cartesians, that the existence of a medium in interstellar space would necessarily retard the motion of the stars, and contradict Newton's first law of motion, that of inertia. This induced him to take up the problem which occupied him for the rest of his life: the examination of the motion of any number of bodies in a fluid, in order to see if there would or would not appear mutual influences from body to body, comparable to the actions at a distance observed in Nature.

The conditions of his life did not allow him to advance very quickly with his great problem. A quarter of a century was to pass before he was able to show experiments which gave a complete verification of his mathematical results. He never succeeded himself in working out for final publication the results of his combined mathematical and experimental investigations. For this reason his researches were not able to exert any direct influence during his own time.

The main result of his investigations may now be stated thus. When seen from the proper point of view, a moving fluid system presents during every phase of its motion a most striking and most peculiar analogy to a perfectly definite electrostatic or magnetic system. The analogy consists of two inseparably joined partial analogies, a direct geometric and an inverse dynamical one: the hydrodynamic field has identically the geometrical structure of the corresponding electrostatic or magnetic field; and it produces forces equal in magnitude but opposite in sign to those produced—in an unknown way—by this electric or magnetic field.

We can thus compare on one hand the electric or magnetic field, the internal structure of which is unknown to us, with, on the other hand, the hydrodynamic field of which, in virtue of the hydrodynamic equations, we know everything, and which we describe by vectors as familiar to us as velocity (corresponding to electric displacement or magnetic induction) and the product of velocity and density, that is, specific momentum (corresponding to electric or magnetic field intensity). From the hydrodynamic equations, or even from remarkably elementary dynamical considerations, we derive both the geometrical structure of the field and the forces produced by it. The simple hydrodynamic pressure does both, no stresses of the complicated Maxwell type being required, either for maintaining the field or for producing its forces.

C. A. Bjerknes thus succeeded in showing how Nature with the greatest ease knows how to realise a field which produces a force, though in the case discovered by him it was a force equal but opposite to the force of the analogous electrical or magnetic field. But the importance of this contrast should not be overestimated. To an acting force always belongs a reacting force, and in connected systems the kinetic energy of one part of the system may play the part of the potential energy of the other part, making the reacting force (thus a force of the same direction as that of the electric or magnetic field) that one which produces the visible motions. The analogy provided by C. A. Bjerknes also gives only a first example of deep analogies existing between the electromagnetic fields and the fields of motion in material media. Already in pure hydrodynamics a second very remarkable analogy exists, which, by generalised properties of the medium, extends practically to the whole of electromagnetism. Nobody knows how far one may proceed still further along this line, not for inventing or constructing models, but of *discovering* deep analogies between dynamics and electromagnetism. The future will show whether we can advance far enough along this road to find the bridge joining these two vast domains of physics, just as the analogy discovered by Maxwell between electromagnetic and optical phenomena led ultimately to the discovery of the bridge joining these two provinces of physical science into one great domain.

What here seems promising is the depth of the analogy discovered by C. A. Bjerknes, a depth which is proved by the fact that it contains no suppositions or hypotheses, but merely the discovered *fact*, showing that the fluid system cannot move in any other way than in full conformity with this analogy.

In spite of this universality of the analogy, the motion of a fluid system only exceptionally takes such a form that the analogy presents itself *visually* to our eyes. Such an exceptional case presents itself when the motion consists of synchronous oscillations. In that case the analogy can be illustrated by striking experiments. Pulsating bodies (that is, bodies changing volume periodically) attract each other when in the same phase, and repel each other when in opposite phase, the law of distance being that of Newton. Thus, if space be filled with a homogeneous incompressible fluid, and if atoms were pulsating all in the same phase with intensities proportional to their masses, we should have a world in which all bodies attracted each other according to Newton's law for gravitation. When both phases come into play, we have the complete analogy to the law of Coulomb, with the difference that like attract and unlike repel each other. Further, in all mutual positions, and if free to perform any kind of translational or rotational motion, oscillating bodies interact precisely as if they were electric dipoles or magnets, of which like poles attract and unlike repel. Finally, the pulsating or oscillating bodies set up in neutral bodies induced oscillations corresponding to the induced magnetism acquired by neutral bodies in the magnetic field. As a consequence of these induced oscillations and the reversed pole law, a body lighter than the fluid moves in the direction of decreasing field intensity, and a body heavier than the fluid moves in the direction of increasing field intensity, just the opposite of what the corresponding ferromagnetic or diamagnetic bodies do according to Faraday's law.

This series of experiments shows visibly both the field and the forces produced by the field, as phenomena perfectly understood in virtue of the laws of dynamics. They seem to contain a promise that we shall some day, even if the way may still be long, arrive at a corresponding understanding of the electromagnetic field and its dynamical properties.

Faraday's "Chemical Manipulation".

By Sir ROBERT ROBERTSON, K.B.E., F.R.S., and B. A. ELLIS.

CHEMISTS, in view of the immense strides which have been made in their science during the past few decades, are rather apt, unless they have delved into the historical side of the subject, to overlook the fact that much of the present-day technique was known and practised by their colleagues of a hundred years ago; indeed, in many ways their relative skill was greater then, since facilities for learning were very much less, and at the same time they themselves had to construct much of their own apparatus. The excellence of much of their work is no small tribute to their skill as craftsmen.

These thoughts devolve from the forthcoming Faraday celebrations, coupled with the fact that in 1827 Faraday published a book on "Chemical Manipulation" running into well over six hundred octavo pages; this passed in the course of fifteen years into a third edition, the text of which, however, from a variety of circumstances, differed but little from that of the original. This was somewhat unfortunate, since the intervening years were not unfruitful, particularly in the analytical field.

There is no single modern volume quite corresponding with this by Faraday, who, it is interesting to note, offered it with an apology for adding "a new work on chemistry to the many excellent productions which previously existed". Faraday described himself as an experimental philosopher, and chemistry as an experimental science involving a constant appeal to facts; as the number of these presented to us naturally is so small, it is necessary to compensate for this deficiency by experiments, which have first to be devised and then performed. The description of methods for this "mere performance" or "manipulation" is the particular *raison d'être* of Faraday's book, which was to inculcate practice, not principles, the art of experimenting and not the habit of reasoning; it was thus to serve as a supplement to all the other books.

The modern student would find the text rather wordy, whilst some of the detail would appear unnecessary and over-elaborate; the latter must largely be attributed to differences in conditions, in particular of facilities and of teaching. Nevertheless, no exception can be taken to the clearness with which the details of instructions for the use of students are set out, to the wise maxims regarding procedure and the performance of operations, with especial reference to whether they are exploratory or of a final character, to the insistence on immediate and systematic noting of experiments—in short, to the general soundness of the advice on details embodied in much of the technique of the chemical laboratory of to-day.

These features are the more remarkable when the limitations then imposed upon the experimenter are considered. Thus heating was for the most part by means other than gas, and there was no bunsen burner, though certain matter, excluded from the third edition, showed that Faraday had experimented with burners embodying an air-supply, but with limited success. There was no rubber tubing for the conveyance of water, but only such small lengths, suitable for making connexions, as could be made in the laboratory from sheet rubber. There was no Liebig condenser for distillations, although by suitable devices cooling water was used for effecting condensation of vapours. There was no wash-bottle of the modern type, no water-oven for drying precipitates, nor were there glass taps. Despite all these drawbacks, the accuracy which Faraday attained in quantitative analysis is exemplified in his research on the composition of benzene, involving weighings, combustion, and measurement of gases, the whole forming a sequence of operations, often involved but of a perfectly logical character, and in the result, of surprising accuracy.

Let us, therefore, take a hasty stroll through these century-old pages: among the points to be considered in the general lay-out of a laboratory regard must be paid to lighting; a side light is necessary for observing the action of reagents and direct sunlight for promoting many chemical effects. One chair is permissible; more might encourage persons not engaged in the laboratory operations to remain. A separate room is recommended for housing balances, for the care, testing, and use of which excellent directions are given; weights and measures must be calibrated, and the methods are carefully described.

The mouth blow-pipe was an instrument much in favour in those days, and many pages are devoted to describing the mode of obtaining an even blast, and to bending, joining, and sealing glass tubing. The effect which we now call ' correction for emergent thread ' of a thermometer was realised, but was regarded more in the light of an error than as a correction. Thermo-electric junctions were just coming in.

The subject of comminution, usually now dismissed in a paragraph or so except in books dealing expressly with rock analysis, is very fully reviewed, and special hints are supplied for powdering such diverse materials as flint, charcoal, and camphor. Simple elutriation was effected in a mortar, and the method for dividing certain metals is essentially that now used for making aluminium powder.

No practical distinction was drawn between physical and chemical solution. Variations in solubility arising from the presence of other substances were realised; tartaric acid served to prevent the precipitation of many metallic hydroxides by ammonia; oxidation was effected by nitric acid and *aqua regia*, and reduction by alcohol, sugar, and the like.

Distillation and sublimation, being essentially the same phenomenon, are described together; they were carried out in retorts or flasks. Essential oils and naphtha were distilled in a current of steam.

Reflected light was recommended for the comparison of colours or turbidities; this is used in our modern photometric methods. Various devices, described for the coagulation of such precipitates as silver chloride, barium sulphate, prussian blue are still utilised.

Special paper for filtering purposes was not manufactured ; it was necessary to search among stationers' stocks for material of suitable quality, and the advice to ' look-through ' the paper is still not always in vain. Crystallisation served for purification and for the purpose of identification by means of the goniometer; crystalline form was known to be affected by the presence of other substances in solution. Evaporation was hastened in an exhausted vessel containing sulphuric acid or other desiccating agents.

Volumetric analysis was, it must be admitted, in a somewhat primitive state at that time, being confined to simple acidimetric and alkalimetric titrations with vegetable indicators such as red cabbage, litmus, and turmeric, and a very crude form of burette, in which the thumb was used to regulate the flow of solution from a tube when inverted. It was about this period that Gay-Lussac laid the foundations of the more extended applications of volumetric methods, and, even so, it was many years before these were fully appreciated and generally adopted.

Crucibles of various forms and materials, including platinum and silver, were available; among the fluxes used were potassium carbonate (for decomposing silicates), bisulphate, borax, and, for effecting reduction, charcoal. Liebig employed tubes of potash glass in his analyses of organic bodies, and it was appreciated that the pyrolytic decomposition of vapours was favoured by increasing the surface of contact and by the presence of certain other bodies. The catalytic power of spongy platinum is also recorded, though not under that name.

The advantages of mercury as a confining medium for gases had been put forward by Priestley. The mean conditions for computing gas volumes were taken as 60° F. and 30 inches of mercury; the correction for temperature is slightly different from that in use to-day; a table is provided to correct the volume of the gas for saturation with water vapour. The manipulation of gases is very fully described, covering some eighty pages.

Of all the branches of chemistry, we are apt to look on that of micro-chemistry as belonging almost entirely to this century. To read the chapter on " Tube Chemistry " in Faraday's volume is, therefore, quite salutary, for, whilst this includes the description of ordinary test-tube work, it continues with the application of tubes to the performance of all the usual procedures of chemistry, the tubes being suitably moulded for the various purposes. Faraday called this " minute chemistry ", and it is interesting to note that despite the primitive macro-burette mentioned above, a forerunner of a modern micro-model is recorded.

It would be surprising, indeed, had Faraday neglected to consider the application of the powers of electricity to chemistry, and, though the electrical apparatus to hand at that time was simpler than to-day, it was usefully applied to the analysis of gases and to the decomposition of electrolytes; both electrical machines and voltaic cells were available in various forms.

An account of lutes and cements, rendered more necessary then by reason of the more primitive apparatus, served to facilitate the selection of that most fitted for a particular purpose; an important treatise on glass-blowing is included.

Cleanliness was insisted upon in every direction, and detailed instructions are given for cleaning mercury and all kinds of apparatus. In a series of general rules for young experimenters, the importance of entering observations immediately is reiterated; some early forms of nomograms are described. The modern chemical student who worked conscientiously through the series of exercises with which Faraday's volume concludes could face any problem with equanimity so far as actual manipulative skill was involved.

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Letters to the Editor.

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Superconductivity a Polarisation Phenomenon.

WITH the collaboration of my research associates, Messrs. A. C. Burton, A. Pitt, and J. O. Wilhelm, evidence has just been obtained that an orientation effect of some kind must be involved in the phenomenon of superconductivity in metals either directly or in its demonstration in ordinary direct current experiments.

We have been investigating the high frequency resistance of lead wires, and have found that while this resistance steadily decreased with lowering temperature, no abruptness occurred when the critical temperature of lead, 7·2° K., was reached. The experiments were carried down to 2° K. without any superconductivity discontinuity being observed. In these experiments frequencies as low as 12×10^6 per second have been used, and other experiments with lower frequencies are now in train.

The experiments show that 'the time of relaxation' of the orientation phenomenon for lead is large compared with the time period of the longest of the oscillations used, namely, 10^{-7} sec.

It seems clear that with lead maintained at the temperature of liquid helium, 4·2° K., superconductivity must appear with the application of electric fields with a frequency somewhere between 12×10^6 seconds and zero. The results obtained would seem to indicate a promising path to follow for the elucidation of the phenomenon of superconduction in metals.

J. C. MCLENNAN.

Physical Laboratory,
University of Toronto,
Aug. 1.

Chemical Effect of a Mendelian Factor for Flower Colour.

IN a letter published in NATURE of June 27, 1931, Miss Scott Moncrieff mentions an interesting case of flower-colour inheritance in *Pelargonium*. On selfing, a rose-pink variety gave seventeen offspring like itself and three others producing salmon-pink flowers. The rose-pink petals contained the anthocyanin pigments, cyanin and pelargonin (the latter only as a trace); the salmon-pink petals, pelargonin only. That is, the dominant factor in colour inheritance causes cyanin to be formed almost entirely instead of pelargonin. This factor, therefore, as pointed out by Miss Scott Moncrieff, brings about the insertion of a hydroxyl group in the phenyl ring, which process may be regarded as one of oxidation.

Such a phenomenon as that outlined above is not necessarily limited to colour-varieties. Among the higher plants, one finds, for example, in some phyla, the dihydroxy grouping (characteristic of catechol) dominant among the compounds formed in the metabolism of aromatic substances. In others, apparently, the trihydroxy grouping (characteristic of pyrogallol) prevails. Thus, there is, on the whole, a restriction of catechol tannins to some genera and orders and of pyrogallol tannins to others. Again, in regard to the flavone pigments—compounds closely resembling the anthocyanin pigments in structure—apigenin (one hydroxyl group in the phenyl ring) is found in some genera, luteolin (two hydroxyls in the phenyl ring) in others, and so forth. Or, in regard to varieties, the ivory-flowered variety of *Antirrhinum majus* contains apigenin, the yellow-flowered, luteolin. Here, again, a difference of one hydroxyl in the structure of the molecule represents a factorial difference, as in the case of *Pelargonium*. In the flavone pigments of *Antirrhinum*, however, in contrast to the anthocyanin pigments of *Pelargonium*, the dominant factor suppresses oxidation.

It is a natural desire to interpret such Mendelian factors in biochemical terms. Such an interpretation has apparently defied the biochemist for many years. Some seventeen years ago, Willstätter had identified the anthocyanin of the type of the cornflower (*Centaurea cyanus*) as cyanin; of the pink variety, as pelargonin. To students of genetics, it is clear that here, between type and variety of *Centaurea*, there is, in all probability, one Mendelian factor. The biochemical interpretation of factors for colour is, however, part of a greater problem, namely, that of the origin of anthocyanin in the plant. Clearly defined cases of factorial differences between anthocyanin types and albino varieties have been known for many years in the sweet pea, stock, *Antirrhinum*, and other plants. Here, different varieties incapable of producing anthocyanin exist which, on crossing together, give types fully coloured with this pigment. In these well-known varieties lies the secret, as yet unrevealed, of the biochemical reactions which control the formation of anthocyanin.

From more general considerations, some suggestions may be made. Here they can only be mentioned in outline, and many subsidiary points remain unexplained. Anthocyanin pigments are found, on the whole, in flowers, fruit, young leaves, autumnal leaves, and leaves subjected to drought and injury. They are, apart from varieties such as the copper beech, not found in the normal green assimilating leaf. Two fundamental conditions are characteristic, in general, of organs producing these pigments as contrasted with those from which the pigments are usually absent.

First, in flowers, fruits, young leaves, and autumnal leaves, photosynthesis is less than in the normal leaf, or may have ceased altogether. This, as recent work on nitrogen metabolism has demonstrated, leads to hydrolysis of proteins and subsequent de-amination, with production of the residues of amino-acids, both aliphatic and aromatic. Secondly, in some of the organs quoted above, there is relatively little protection against loss of water; and, moreover, in the case of petals, fruits, and autumnal leaves, approaching separation from the parent plant and other causes render supply of water increasingly difficult. The connexion of appearance of pigment with lack of water from the soil may be very obvious. I have at the moment under observation a young plane tree, a few feet high, growing in a very dry situation. All the developing leaves are brilliantly red, giving the effect, from the distance, of a plant in flower. Such an abundance of pigment is not usual in the normal young leaf of the plane.

The deduction drawn from many observations connected with the two conditions mentioned above is that anthocyanin pigments are produced from the residues of aromatic amino-acids after de-amination. Under conditions of relative desiccation, condensation among these residues takes place with formation of anthocyanin pigments. As recently shown from the researches of Ruhland and his co-workers, de-amination of amino-acids occurs both in young leaves in active growth and in leaves in which photosynthesis has ceased; the latter state, moreover, is characteristic of petals, fruits, and autumnal leaves.

How then may such an interpretation bear on the problem of genetical factors? The aromatic amino-acids affording a benzene ring residue are phenylalanine and tyrosine. An attractive supposition to explain the presence, in one group or variety, of a *p*-hydroxy grouping (pelargonin) and, in another, of the *o*-dihydroxy grouping (cyanin) would be that dihydroxyphenylalanine is a component of some proteins. Then, by segregation, this amino-acid might be missing from the protein molecule of a variety. But, though dihydroxyphenylalanine is found in certain plants, it can scarcely be so widely distributed a component of proteins as such a hypothesis demands without hitherto being detected. Moreover, even the inclusion of this substance in the protein molecule would leave unexplained the existence of a trihydroxy grouping (delphinin).

We then fall back upon the hypothesis of oxidation as being the cause of the existence of the dihydroxy and trihydroxy groupings in condensation products from aromatic residues.

From investigations upon the oxidation of aromatic acids by Dakin and others, it would appear that, on oxidation of monohydroxy acids, a hydroxyl group is inserted in the *ortho* position to the group already in the molecule: that is, *p*-hydroxy benzoic acid is, by oxidation, converted into protocatechuic acid. Such a change may be brought about in many ways, as by hydrogen peroxide, or by a catalyst. The catechol oxidase cannot, it would appear, be connected with anthocyanin formation, since it is absent from many plants which develop anthocyanin. Any number of catalysts of the dehydrase type may be postulated which, on addition of a molecule of water and subsequent removal of two atoms of hydrogen, might insert a hydroxyl group into the benzene ring. Or the extent of oxidation in the phenyl ring resulting in cyanin or delphinin may be controlled by the reaction of the tissue before condensation takes place. Then, after condensation, there would be no further fundamental change in the anthocyanin molecule, though the colour might be modified by acid or salts. The amount of oxidation, moreover, need not be rigidly maintained, and mixtures of pigments may sometimes ensue. Or, finally, the position of insertion of subsequent hydroxyl groups may be controlled by the nature and position of the substitution groups already attached to the molecule. M. W. ONSLOW.

Cambridge, July 30.

A Hard Component of the β-Radiation of Potassium.

THE investigations made up to now on the radioactivity of potassium have brought to light a very inhomogeneous β-radiation. The absorption coefficients derived by various workers vary from 27·2 to 11·2 cm.^{2}/gm., and it is difficult from these discordant data to deduce its spectral distribution; all one can say is that the velocity of the harder component, derived from absorption measurements, is about $0{\cdot}82c$. On the other hand, the feeble activity of the element does not admit of our using any of the methods of magnetic analysis, which has already given us accurate measurements of stronger radioactive radiations.

The method recently adopted by Occhialini[1] for studying rubidium is so powerful that, by sacrificing some of its resolving power, it can be applied to potassium. Fig. 1 shows the apparatus in section. A Geiger-Müller tube-counter *C*, made of a sheet of aluminium 0·0007 cm. thick, 1·5 cm. high, and 1·5 cm. in diameter, is placed in the centre of a brass cylinder *B*, 2 cm. high and 7·2 cm. in diameter; the ends are closed with ebonite stoppers, and the air inside is exhausted to a pressure of 4 cm. of mercury. The potassium salts are spread over the inner surface of the cylinder, which is then placed in a magnetic field, the lines of force of which are parallel to the axis of the counter. The β-particles emitted are deflected in circular arcs, and can only reach the counter when their radius of curvature exceeds half the distance between the active deposit and the counter. By increasing the intensity of the field, the softer rays will be gradually eliminated, so that the derivative of the intensity curve as a function of the field gives, approximately, the spectral distribution of the β-radiation (*vide* Occhialini *l.c.*). When the field is sufficiently intense, no electron reaches the counter, so that it only records the spontaneous impulses, that is, those due to the penetrating radiation and to the radioactivity of the apparatus and its surroundings. By protecting the apparatus with a lead shield, the number of spontaneous impulses could be reduced to 1·5 ± 0·1 per minute, as found by actual experiment without the salts. The impulses were amplified by a system of thermionic valves and were recorded automatically.

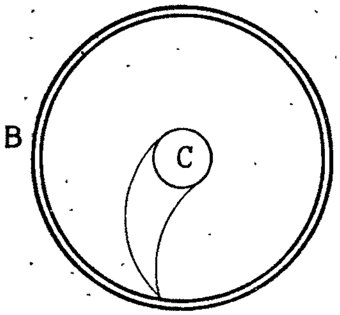

FIG. 1.

The first experiment was carried out with a thin layer of potassium chloride, about 0·014 gm./cm.^{2}, on a silver lamina. It was found that, as the field increased, the intensity, as recorded by the counter, was constant at first, and then decreased rather rapidly between 580 and 1810 gauss, showing a large number of β-rays with a velocity less than $0{\cdot}83c$. The frequency of the impulses decreased slowly with fields of still greater intensity, but even with a field of 2200 gauss, the maximum available, the frequency was sensibly greater than that of the spontaneous impulses. From this it appears that there is a component less intense but much harder associated with the known β-radiation, and that its velocity is certainly greater than $0{\cdot}90c$.

To confirm this result, the analysis of the lower end of the curve was repeated, using a thicker layer of salts, about 0·1 gm./cm.^{2}, on an aluminium plate. The results were as follow:

Field (gauss) . .	0	1870	2100	2200
Impulses/minute .	18·31 ± 0·32	7·62 ± 0·39	6·35 ± 0·35	5·80 ± 0·33

They show that the impulses recorded with maximum field exceed the spontaneous ones by more than twelve times the mean error. A layer of potassium bromide of the same thickness gave concordant results.

Although it appears to be highly improbable that the impulses observed with a field of 2200 gauss are due either to an α- or a γ-radiation, yet, to make certain, a rough absorption test was made by covering the counter with a silver leaf, 0·1 gm./cm.^{2} thick. Under these conditions, the potassium chloride gave a mean of 4·21 ± 0·2 impulses without the magnetic field and 3·64 ± 0·2 with a field of 2100 gauss. It will be noted that while the silver leaf absorbs the softer part of the β-radiation very strongly, it reduces the intensity of the component, which is not deflected by nearly one-half. The results obtained are not sufficiently accurate to determine the absorption coefficient of this radiation, but they appear to confirm very definitely that it is to be considered a β-radiation.

The probable existence of a hard component of the β-radiation of potassium has been recently put forward by Behouneck as the result of his researches on the γ-radiation of this element. The results above seem to confirm his suggestion.

I wish to express my warmest acknowledgments to Prof. Rossi, who has afforded me valuable assistance and advice in my experiments.

Daria Bocciarelli.

Physical Institute, University of Florence,
Arcetri, Italy, July 18.

[1] G. Occhialini, *Rend. Lincei.* In the press.

The Atomic Weight of Fluorine.

There is a good deal of evidence from chemical sources that the atomic weight of fluorine is greater than 19·00. In recent years the ratio of sodium fluoride to sodium chloride has been determined by McAdam and Smith,[1] who find the value 19·009. In addition, from the limiting density of silicon fluoride, Germann and Booth [2] find the value 19·010, assuming that the atomic weight of silicon is 28·06. The only work which supports the value 19·00 is that of Moles and Batuecas [3] on the limiting density of methyl fluoride. Since methyl fluoride is a difficult gas to prepare in a state of purity by the method employed by Moles, and since, moreover, his density determinations show divergences far in excess of the experimental error, we have recently carried out a redetermination of the limiting density, using the same microbalance method as that employed for xenon.[4]

Methyl fluoride was prepared by Collie's method, that is, the action of heat on tetramethyl ammonium fluoride, and after purification with potash was liquefied and fractionally distilled several times until no alteration in density could be detected on further fractionation. The balancing pressures of oxygen and methyl fluoride were then compared at two densities giving the mean ratios 1·06726 and 1·06550 for pressures of oxygen of 335·61 mm. and 156·86 mm. respectively at 21° C. On extrapolation to zero pressure the limiting ratio is found to be 1·06395, corresponding to a molecular weight of 34·046. If now we assume for the atomic weight of carbon 12·010, a value which we obtained a few weeks ago from the limiting density of highly purified ethylene, we get for the atomic weight of fluorine 19·013. It may be noted that any probable alteration in the atomic weight of carbon would make that of fluorine higher.

From our results, the compressibility coefficient $1 + \lambda$ of methyl fluoride at 21° C. is 1·00823. We can calculate the corresponding value of $1 + \lambda$ at 0° C. with a very fair degree of approximation by assuming a slightly higher coefficient of thermal expansion than that of carbon dioxide, which is well known. Such a calculation carried out on our results for ethylene gives a compressibility coefficient in excellent agreement with the accepted value. For methyl fluoride, on the other hand, we find a value 1·0109 at 0° C., in complete disagreement with the value found by Moles, namely, 1·0180, but in general accordance with those for gases of similar critical constants. It may be remarked that, even if we assume that methyl fluoride has as large a coefficient of expansion as sulphur dioxide, it would be impossible to bring our coefficient higher than 1·012. In view of the fact that the critical temperatures and pressures of carbon dioxide and methyl fluoride are 31° C. and 45° C. and 73 atmos. and 62 atmos. respectively, whilst those of sulphur dioxide are 158° C. and 78 atmos., there can be little error in the compressibility coefficient which we have calculated at 0° C. Moreover, if we calculate the coefficient of thermal expansion of methyl fluoride from Moles's value for the normal density and our value for the density at 21° C., we get the highly improbable value of 0·0042. We may say that a similar calculation applied to ethylene gives the value 0·00369 for the coefficient of expansion. We must therefore conclude that Moles's values for both the density and compressibility coefficient are far too high, though by a partial compensation of errors they lead to an atomic weight of fluorine in accordance with mass spectrograph measurements. It seems likely that Moles's gas was contaminated with a few per cent of methyl ether, an impurity which he himself recognises as being possible, but which cannot occur in our method of preparation.

There seems to us, therefore, to be strong evidence that the atomic weight of fluorine lies in the neighbourhood of 19·010 rather than of 19·000. This would appear to indicate the presence in small quantities of a higher isotope.

H. S. Patterson.
R. Whytlaw-Gray.
W. Cawood.

The University, Leeds,
July 23.

[1] Carnegie Institution Report, No. 267, p. 47; 1918.
[2] *Jour. Phys. Chem*, vol. 21, p. 81; 1917.
[3] *Jour. Chim. Phys.*, vol. 18, p. 353; 1920.
[4] Nature, vol. 127, p. 970; 1931.

Acromegaly in the Far North.

The question raised by Prof. Seligman [1] tempts me to proffer some speculations which I have for some time entertained. They are drawn from the field of experimental zoology, and would not merit consideration if it were not for the circumstance that they are capable of being tested experimentally. The determination of seasonal changes in animals is closely akin to the question which Prof. Seligman propounds. I suggest that inquiry directed to elucidate the significance of the pituitary gland to functional changes which exhibit a seasonal periodicity might provide the answer. The following circumstances suggest that there may exist a close relationship between pituitary secretion and seasonal states.

(1) It is now known that the co-ordination of amphibian colour change is determined by the reflex secretion of the pituitary gland. The effective stimuli are light, temperature, and humidity—the three chief agencies through which seasonal influences presumably act upon the animal body. In addition to a hormone secreted by the pars intermedia, a second hormone secreted by the pars tuberalis of the gland now seems to be involved (Hogben and Slome, 1931) in amphibian colour change.

(2) Work in my laboratory at Cape Town recorded in a paper now in the press (Hogben, Charles, and Slome) shows that removal of the pituitary in amphibia brings about drastic retrogression of the ovaries, while injection of anterior lobe extracts produces ovulation. Thus the pituitary has the same functional relationship to the ovaries in amphibia and mammals. It was further found that perceptible retrogression of the ovaries occurs in eyeless animals. Taken in conjunction with the fact that continuous illumination stimulates egg production in fowls, there is some encouragement for the supposition that the reflex stimulation of the pituitary by light is not restricted to the secretion of the hormone or hormones which

evoke melanophore response, but that light reflexly activates secretion of the pituitary gland as a whole.

(3) Functional changes associated with seasonal periodicity in mammals are of two principal types. One is the anœstrous inactivity and partial retrogression of the gonads. The other is winter sleep, which involves a greatly reduced basal metabolism. Both these phenomena have features which are highly reminiscent of the results of removing the pituitary gland. Dr. Charles obtained some evidence that amphibia have a low basal metabolism in darkness.

On the basis of these indications and others which we obtained during the past four years at Cape Town, it had been my intention to probe more deeply into the possible significance of the pituitary in connexion with seasonal phenomena. This body of investigations has now been interrupted, and I proffer these somewhat speculative remarks for the encouragement of others who are interested in the same problems. I believe that our work provided substantial evidence that the reflex activation of the pituitary by light is not confined to the secretions which control colour change. Perhaps the prolongation of the day in the arctic regions might suggest a clue to Prof. Seligman. The growth principle of the anterior lobe involved in acromegaly is not the same substance as that which activates the ovary, nor is it the same as that which influences basal metabolism by activating the thyroid. However, it is now certain that the functional relations of at least four of the six or more hormones secreted by the pituitary gland are alike in mammals and amphibia. A comparison of the effect of continuous illumination and total darkness respectively upon growth and metamorphosis in the latter would be well worth undertaking.

LANCELOT HOGBEN.

Department of Social Biology,
University, London, Aug. 10.

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[1] NATURE, 128, p. 221, Aug. 8, 1931.

Biological Effects of Cosmic and γ-Radiation.

ACTINIC rays have been an important normal factor in the environment of organisms during the course of evolution, and now it is clear that rays of another category, the cosmic rays, must be regarded as having formed part of the normal environment. It is a working assumption in all bionomical investigations that every factor in the environment must be considered in regard to its possible effect upon the life of an organism : it is also possible—or even probable—that every factor in the environment has an effect upon, or is utilised by, some organism. Hence the practical demonstration of the continuous earthly incidence of the so-called cosmic rays brings a 'new' factor into the field of biology, and its effect needs to be assessed. Since it may now be accepted that these rays are and have been continuously incident upon and in the surface layers of waters (although the degree of their penetration into sea-water has apparently not yet been determined) as well as upon the land, most organisms are, or have been in time, subjected to them, and it is reasonable to look for some biological response.

It is difficult to connect any definite biological processes with the new kind of radiation now described, but the resemblance of the cosmic rays to hard γ-radiation[1] gives us one preliminary approach to an estimation of the biological effects of these rays ; for it is known that one important effect of γ-rays is to inhibit such pathological growths as occur in mammals in cancerous tissues. The effect of the addition of γ-rays to an organism—which is exhibiting abnormal growth—suggests that possibly these rays are supplying and substituting a deficiency in that organism, and that the deficiency is some kind of ray similar to the γ-rays. The likeness of these to cosmic rays further suggests that the rays entering the earth from space may be a normal biological requirement of certain organisms, for example, mammals.

The occurrence of pathological growth in an organism, which *ex hypothesi* requires and is being subjected to a bombardment of cosmic rays, may be explained by a peculiar and pathological shielding or absorbing effect of parts or the whole of that organism.

Preliminary experiments indicate that γ-rays of such an intensity as will inhibit pathological growth, that is, as emitted from a radium needle, have little or no effect on adults or developing eggs of the few invertebrates which we have so far examined, though many more experiments are needed to provide a satisfactory basis for such an important statement. The failure of γ-rays of low intensity to affect tissues is perhaps to be expected if these rays are not markedly different from the normally incident cosmic rays. On the other hand, the simple experiment of shielding animals normally subjected to cosmic rays from these rays has not yet been tried. The occurrence, however, of animals on the sea-bottom at depths which are possibly too great to be affected by such rays[2] gives us either a natural negative experiment or an instance of adaptation to the absence of these rays comparable with that of animals living in darkness. The variation of these rays in intensity with depth may very well provide an important environmental factor in the life of aquatic animals.

Research on this new and recondite biological factor will be expensive and will require close collaboration between the biologist and physicist, but there can be little doubt that it is worth undertaking, even if it should happen that only negative results are obtained.

J. H. ORTON,
S. T. BURFIELD.

Zoology Department,
Liverpool University.
June 28.

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[1] NATURE, 128, Supplement, July 18, 1931.
[2] NATURE, 126, p. 29, July 5, 1930.

Mineral Content of Eyes.

IN the course of an investigation into the mineral content of vertebrate tissues, mostly human, by the spectrographic method of analysis already described in NATURE,[1] the choroids of an ox's eyes were found to contain a notable quantity of barium, the percentage in the tissue dried at 100° being estimated at nearly 1·5 ; a trace of strontium was also present. The choroids of a sheep's eyes analysed at the same time gave no indication of barium, though a trace of strontium was present.

Many analyses of parts of vertebrates' eyes have since been made and certain facts have been ascertained ; it is evident, however, that much remains to be done on these lines in extension of the work. The chief facts so far ascertained are as follows :

Human choroids and the choroids of sheep, pigs, horses, dogs, and the common commercial varieties of sea fish gave no indication of barium, neither did the choroids of calves contain the minimum amount detected by this method of analysis. Traces of strontium were nearly always present, the fishes' choroids containing more than those of the land animals.

The choroids of all the cattle, 13 in number, of three years old and upwards, so far analysed contain barium, and the quantity increased with the age of the animals ; it is present in oxen, cows, and bulls.

The barium is present in largest quantity in the choroid, but it has been detected in irises and in the dark pigment separated from the choroid by rubbing. The retinas (minus the back pigmented layer, which adheres to the choroid) contain none; they contain more phosphorus than the choroids, similar proportions of magnesium, sodium, and potassium, but less calcium and iron.

Comparing the choroids of cattle of different ages from about three to seven years, the barium, as stated above, increases with the age, and, generally, as the barium increases the quantities of sodium, potassium, magnesium, calcium, iron, and copper appear to decrease: further work on this point is necessary and we hope to obtain eyes from much older animals. The first choroids analysed came from an ox of unknown age, and they contained the largest proportion of barium so far found and the smallest quantities of the other elements named.

Zbinden [2] did not find barium in cow's milk, but the strongest barium lines do not lie in the region of the spectrum in which he worked. Messrs. Adam Hilger, Ltd., in a recent letter to one of us on another subject, state that barium has been detected in cow's milk which had turned sour in glass bottles but not in fresh milk. Barium, to our knowledge, has not previously been detected in animal tissues, and its occurrence in quantity in the choroids, etc., of cattle is all the more remarkable. We are hopeful that the work described and projected may give information bearing on the mechanism of colour vision.

HUGH RAMAGE.
J. H. SHELDON.

Carrow Hill, Norwich.
Regis Road, Wolverhampton,
July 30.

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[1] NATURE, April 20, 1929, p. 601.
[2] *Le Lait*, 11, No. 102, pp. 113-124; 1931.

The Double Lateral Line of *Lepidosiren*.

A FEW days ago when examining a small male specimen of *Lepidosiren*, one of three which I brought alive on May 1 from the island of Marajo at the mouth of the Amazon River, and which are now living in the Zoological Society's Aquarium, I noticed that it had two lateral lines on each side, one slightly dorsal to the middle of the side, the other near to the mid-ventral line. Since then I have examined more thoroughly a much larger female specimen, and have observed a few more details. The course of the sensory tubes is marked by lines of intense black, contrasting sharply with the light brown of the rest of the skin when the colour is in its pale phase. The principal lateral line, which may be described as dorso-lateral, branches out over the head into the usual three tracts, one above the eye, one between the eye and the mouth, and one below the mouth, or supra-ocular, maxillary, and mandibular. The ventro-lateral line at its anterior end anastomoses with the mandibular branches of the dorso-lateral. Each of the lateral lines is associated with short branches which are obliquely transverse to its course, but these short streaks are slightly separated from the main dorso-lateral line and dorsal to it; in the case of the ventro-lateral line, they are ventral to the line, and arise directly from it. A series of similar short oblique streaks occur on either side of the mid-dorsal line of the fish, but not a continuous line.

The description of Paraguay specimens by Sir Ray Lankester, published in 1898,[1] does not mention the lateral line, but the large figure of the entire fish which illustrates the description shows only one lateral line without branches. This is surprising, because in Lankester's paper special attention is given to a paper by E. Ehlers, published in 1894,[2] and Ehlers' paper contains a detailed description of the double lateral line in specimens from Paraguay. This description agrees very closely with that which I have given above, except that he does not mention the short streaks on either side of the mid-dorsal line of the fish, which suggest a third line of the dermal sensory system. Ehlers believed that *L. paradoxa* was a distinct species, to which some of the Paraguay specimens belonged, and in these the system of lateral lines was not distinctly recognisable. My own observations appear to constitute the first recognition of the multiple lateral line system in specimens of *Lepidosiren* from the Amazon region, and tend to confirm the opinion that there is no specific difference between the *Lepidosiren* of that region and those of the swamps of Paraguay. I am much indebted to Mr. R. H. Burne of the Royal College of Surgeons Museum for his kind help in investigating the literature of the subject.

J. T. CUNNINGHAM.

35 Wavendon Avenue,
Chiswick, W.4,
July 22.

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[1] *Trans. Zool. Soc.*, vol. 14, p. 11.
[2] *Ann. and Mag. Nat. Hist.*, Ser. 6, vol. 14, 1894, p. 6.

Age of Certain Gravels in the New Forest Area.

WHILE I rejoice to learn that Mr. Burkitt and his pupils are studying the Hampshire gravels,[1] I hope he will forgive me if I question whether his letter adds materially to our knowledge of the sequence of events in this difficult area.

The separation of the gravel into two layers, with or without a sandy layer between, is of frequent occurrence throughout the district, from Stoney Cross to the coast; and often, but by no means always, the upper layer is the coarser and less stratified. Since the lower has a fluviatile aspect through a considerable range of level above the existing rivers, I infer that it belongs to a period of depression of the land, with consequent aggradation: and we can date this period by the fact that unrolled Acheulean implements have been found under the gravel. Implements found in the gravel itself are usually more or less rolled, especially perhaps those from the upper layer, but we can seldom say definitely (and certainly not at Stoney Cross or Pickets Post) from which horizon the tools come. Mousterian specimens are extremely rare, but not, I think, entirely absent.

Facts have been published [2] pointing to the erosion of the main valleys down to about 50 ft. above the present rivers in, or before, Acheulean times; but Mr. Burkitt appears to go further, and to imply that the sea on the south coast of England (and even in the Solent River as far as Hordle) had reached its present level in late Chellean times; in which case the main valleys, in such soft strata, must inevitably have followed suit. But I do not see that he offers any evidence for this, or for his second postulate of a submergence "to a depth of at least 100 ft." before Acheulean times.

Finally, his correlation of the layer of sand (*c*) at Hordle with the 100 ft. raised beach at Brighton must be received with caution, (1) because a similar layer is found in neighbouring gravels (Setley, Beaulieu Heath, etc.) up to 140 ft. O.D.; and (2) because, unless there is clear proof that the sand is marine, we must make allowance for a possible gradient of the Solent River, the mouth of which was many miles farther east.

HENRY BURY.

The Gate House,
Bournemouth West.

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[1] NATURE, 128, 222, Aug. 8, 1931
[2] *Proc. Prehist. Soc. E. Anglia*, pp. 23 et seq., 1923.

I was much interested in reading Mr. Burkitt's letter under the above heading,[1] since some of his conclusions coincide with those that I had formed after a study of similar deposits in the basins of the Thames and Kennet in Berkshire.[2] He suggests that implements of St. Acheul type were deposited in the gravels when the coast-line stood about 100 ft. above its present level. It is reasonable to suppose that at that time our rivers were flowing about the same height above their present beds. Gravels about 100 ft. above the present rivers occur in the Upper Thames basin and beside the Kennet, but have produced no implements. East of the Goring Gap, however, where the terrace is usually 80 ft. above the river, and is known as the Boyn Hill terrace, they are numerous.

It may be open to doubt whether these spreads are of exactly the same age, since there appears to be a slight difference in level between some of the Maidenhead gravels, and the implements that they produce vary in type. It is possible that in this region we should distinguish two distinct layers, much intermixed, at 100 ft. and 80 ft. respectively above the river. Both of these terraces, if there are two, have produced implements in large numbers, mostly of St. Acheul type, but also some that have been described as Chelles, though these are more probably ruder implements of the later industry.

In the Kennet valley a few St. Acheul implements have been found in gravel beds lying 140 ft. above the river; unfortunately it is not known at what depth these were found. It is, however, possible that they were left in hollows in a gravel bench, then 40 ft.–50 ft. above the river-level, and afterwards covered by rain-wash. A similar implement, from a corresponding level, found in a gravel-pit at Boldre in the New Forest, is in the Newbury Museum.

Harold J. E. Peake.

Westbrook House, Boxford,
Nr. Newbury, Berks,
Aug. 8.

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[1] Nature, 128, 222, Aug. 8, 1931.
[2] See "Arch. Berks", Chaps. 1 and 2.

Unusual Lightning.

In Nature for Aug. 1, p. 189, Messrs. H. E. Beckett and A. F. Dufton describe "Unusual Lightning". From their description it appears that what they saw was the illumination of a cloud by lightning taking place inside it; the discharges were probably very high up, and went from one part of the cloud to another. Such discharges, which may perhaps be in the nature of a series of discharges through the clouds, often last a second or more and are sometimes many miles long. Lightning may take place very high up in the clouds, sometimes in the hybrid cirrus. In the 'Guildford storm' of Aug. 2, 1906, the lightning, at the time the storm crossed the South Downs, was almost entirely in the hybrid cirrus about two miles above the surface, and the thunder was quite faint even when the discharges were vertically overhead.

Another storm which occurred in the summer of 1917 seems to have resembled somewhat that seen by Beckett and Dufton. Seen from high ground near London, flames seemed to shoot up from the horizon, and a soldier on leave told a member of the staff of the Meteorological Office that it was "Haig blowing up the whole . . . line". At Bedford they thought that a violent air raid was in progress over London; and it was seen from all over the south-east of England. The actual storm was tracked down to a region about five miles to the east of the Kentish coast; the lightning was high up and the thunder faint even on the coast. The farthest points from which records came were Winchester, and Benson, Oxon, each about 130 miles away, and Husbands Bosworth, Leicestershire, about 140 miles away. Even at these distant places the lightning was noticed as something unusual; and so in a way it was—the lightning high up in the clouds lit up the hybrid cirrus plumes, which looked like flames. Most of the places from which the storm was visible were much too far off for the thunder to be audible. Beckett and Dufton seem to have seen something of the same kind, though on a smaller scale. The flame colour described by them may have been due to the distance of the storm and to the state of the atmosphere through which the light had to pass.

I am afraid that 'Flachtenblitz' is new to me, but the light of an electric discharge inside a cloud can produce all the appearances noticed by Beckett and Dufton, namely, glows which extend over the whole cloud or only over a portion of it; flashes starting at one end of the cloud and moving to the other; the flashes may occur at regular intervals of time, and may last a second or more. There is no need to suppose anything more than cloud to cloud lightning.

C. J. P. Cave.

Stoner Hill,
Petersfield, Hants,
Aug. 16.

Conservation of Rainfall as Carbohydrates.

When a good rain falls on arid country of high temperature, the growth of plant life is truly remarkable. But in a short time this verdure loses its moisture to dry winds and hot sunshine and becomes well desiccated. A point I have not seen mentioned is that a fraction of the rainfall (which I hope to determine approximately) is locked up in carbohydrate molecules, safe from sun and wind and available for animal life. Thus, anhydrous glucose when oxidised in the body will furnish 60 per cent of its weight as water and cellulose 56 per cent. Unless this is taken into account, animal life in the desert remote from water-holes is inexplicable.

W. A. Osborne.

Faculty of Medicine,
University, Melbourne,
July 8.

Occurrence of Dulcitol in a Red Seaweed.

The occurrence of mannitol has long been recorded in seaweeds, but, so far as the literature reveals, its distribution is confined to the brown algæ, and hitherto it has been the only representative of the sugar alcohols known to occur in the algæ. We have recently had occasion to examine extracts of the red seaweed *Bostrychia scorpioides*, which grows on the salt marsh at Blakeney Point; from this material we were able to isolate, in crystalline form, the isomeric alcohol dulcitol. As this is the first recorded observation of this substance in algæ, we are proposing to examine a number of other red algæ, with the view of determining whether they also contain dulcitol, or whether we were dealing with an exceptional case. A fuller account of the experimental work will, it is hoped, appear before long in the *Biochemical Journal*.

P. Haas.
T. G. Hill.

Botanical Department,
University College, London,
July 30.

Research Items.

The Hadzapi or Watindega of Tanganyika.—In *Africa*, vol. 4, pt. 3, Miss D. F. Bleek describes a tribe of hunters living in the northern part of the central province of Tanganyika, near Lake Eyazi, who speak a clicking language related to the Bushman and Hottentot tongues. In physique, colouring, and physiognomy the Hadzapi are entirely different from the Bushman, for they are tall, black, and very prognathous. They live by hunting. Arrow heads are made by the men themselves from bits of iron bartered with neighbouring Bantu tribes. Paint is not worn by the men, but many showed on their faces and bodies an elementary kind of tattooing used to cure illness. For cooking their food, which consists of roots, bulbs, and fruits collected by the women, the Hadzapi use clay pots which are bought from neighbouring tribes. The sun is their god, but he is not addressed, and is feared. He makes the people well and ill as he desires. If an invalid's relatives bother the sun with prayers, he will certainly die. Most men own two wives. Girls marry at sixteen, the men a little older. There does not appear to be any initiation ceremony for young people or any marriage ceremony. Dancing and singing is part of the daily life of the men, especially when there is plenty of meat. Their dancing and singing resemble that of the Bantu more than that of the Bushmen. The sounds of the language are less difficult than those of the Hottentot and Bushmen.

Shoshonean Linguistics.—Dr. Edward Sapir has published in the *Proceedings of the American Academy of Science and Arts*, vol. 65, pts. 1-3, a sketch of the Southern Paiute language, a number of Kaibab Paiute and Uintah Ute texts, and a Southern Paiute dictionary. The Shoshonean languages, to which Paiute belongs, comprise four groups—the Plateau Shoshonean languages; Tübatulabal of south-central California; Hopi; and a group of southern Californian languages comprising the Serrano dialects, the dialects of the San Luiseño-Cahuilla branch, and the Gabrielino dialects. The differences between the groups are considerable. All these languages, taken as a whole, comprise the northernmost representatives of the Uto-Aztekan stock, which includes, besides Shoshonean, Nahuatl or Aztekan and the Sonoran or Piman languages spoken in the long stretch of country between the Mexican State of Jalisco and the Rio Gila. So far as is at present known, the Uto-Aztekan languages are not generically related to any other American group. The dialect with which Dr. Sapir deals chiefly is Kaibab Paiute of south-west Utah and north-western Arizona, Kaibab being an anglicised form of an Indian expression signifying 'mountain-lying plateau'. They belong to a number of tribes loosely grouped as Southern Paiute, Paiute belonging to the Ute-Chemehuevi branch of Plateau Shoshonean. Southern Paiute and Northern Paiute must be carefully distinguished as distinct and mutually unintelligible languages.

Breeding from Colour Varieties.—Two examples of breeding from colour varieties, of interest to students of genetics, are given in the *Avicultural Magazine* for August. On p. 209, Mr. J. C. Laidlay records breeding, from hen-pheasants that had been bred white for four generations, and a cock which was white but for some red on the breast, three, among about twenty chicks, marked like the melanistic variety, a form which has come much into notice of late years. In it the chicks are very dark in the down; if males, they assume a dark purple-and-green glossed plumage with no red, and, if females, most strikingly resemble red grouse in colour. The production of this dark form from white parents reminds one of the occasional occurrence of the proverbial black sheep among our white flocks; in neither bird nor beast is the new colour ancestral, though less abnormal than white. The other instance is in Mr. D. Seth-Smith's editorial notes (p. 235) and concerns the breeding from birds reared at the zoological gardens from a blue mutant of the Masked Love-bird (*Agapornis personata*) paired to a normal specimen. One pair have had a brood of two blues and one green, while another had four greens and one blue—rather too many recessives for Mendelian expectation, but future broods may restore the balance, though it may be mentioned that two nests last year, respectively gave two greens and one blue, and one of each colour.

Growth of the Cockle.—A. C. Stephen (*Jour. Mar. Biol. Assoc.*, **17**, No. 2, 1931) records observations on the growth of the cockle on the Scottish coast. He found on the Ayrshire coast that small cockles appear about the beginning of August, a fact which points to the breeding season being in summer and not in spring, as is usually stated. Further evidence on this point is afforded by examination of the reproductive organs, which, at Millport, appear to be ripe from about the end of July. Spawning was observed only once; cockles collected on July 1, 1930, spawned on the following day in the laboratory, but the eggs did not develop. By the end of the first autumn a few of the young cockles in the sand are 10 mm. in length, but most are less than 6 mm. The first winter ring on the shells is faint and easily overlooked; the first of the several well-defined rings is therefore not the first but the second winter ring. The first ring is seen in young specimens up to one or two years of age, but in older shells, especially if there has been any erosion, is often obliterated. The size of cockles increases regularly from high-water mark to low-water mark, due to an increased rate of growth. The scattered cockles living in the *Tellina* ground, that is, seawards of the cockle-beds proper, grow very fast.

Insect Vectors and Virus Diseases of Plants.—The first virus disease to be detected was mosaic disease of tobacco. It was discovered by Iwanowsky in 1892, and in 1901 Takami provided the earliest evidence of the insect transmission of such diseases when he showed that the mosaic disease of rice was carried from plant to plant by the leafhopper, *Nephotettix apicalis*. Since these discoveries a large and increasing number of virus diseases of plants have been made known, and, in many cases, insects have been shown to be the vectors responsible for their spread. In *Biological Reviews* of the Cambridge Philosophical Society, Vol. 6, July 1931, Dr. K. M. Smith gives a comprehensive survey of knowledge respecting these various plant viruses and the insect carriers with which they are associated. With few exceptions these vectors are sucking insects belonging to the order Hemiptera, and, among the latter, the Aphididæ are by far the most important. The single species, *Myzus persicae*, is an aphid that is now known to be associated with the spread of fourteen different viruses. The data collected together by Dr. K. M. Smith seems to point to the conclusion that a relationship, other than a merely mechanical connexion, exists between plant virus and insect vector in certain cases. Thus, there is evidence that points to the conclusion that the virus is capable of multiplying within the body of the insect. The whole subject of the nature of plant viruses, and the factors governing their transmission by means of insects, is one of great difficulty. The problem is further complicated by the fact that, in two cases, different symptoms are known to be produced in the plant by the same virus when the latter is inoculated by needle and insect respectively. This carefully prepared review of the subject, which is provided with an extensive bibliography, should be read by all interested in plant pathology.

Crust-Movements after the Tango Earthquake of 1927.—In 1929, a fourth series of levellings was carried out across the central area of the Tango (Japan) earthquake of Mar. 7, 1927. The results of this and the preceding series have been studied by Prof. C. Tsuboi (Nature, vol. 126, pp. 923-924). Nearly a year later, June-Sept. 1930, a fifth series along the same route was made and the results again examined by Prof. Tsuboi (*Tokyo Imp. Acad. Proc.*, vol. 7, pp. 234-237; 1931). Generally speaking, after the lapse of three years, the ground seems to have become nearly stable, the greatest change during the preceding year amounting to only two-thirds of an inch. Prof. Tsuboi gives two curves, one showing the changes along the route before and immediately after the earthquake, the other the total change during the three years since the earthquake. When the vertical scale in the latter curve is taken ten times that for the other, the two curves are very similar in form. The principal difference between them is in the neighbourhood of the two faults produced at the time of the earthquake. Instead of the discontinuities along the faults in the earlier curve, the later shows a sensible drag upwards along the faults, suggesting that, after the earthquake, the land-blocks on opposite sides of the faults have adhered to one another.

Articulation of Isolated Sounds.—The issue of the *Zeitschrift für Experimentalphonetik* for July 1 contains an account by Messrs C. E. Parmenter, S. N. Trevino, and C. A. Bevans, of the Phonetics Laboratory of the University of Chicago, of the methods they have adopted to determine the motions of the median outline of the mouth and throat during the articulation of isolated sounds. The head of the speaker is clamped to a board between the X-ray tube and the photographic plate, the median section of the head and the plate being at right angles to the axis of the X-ray beam. The outline of the median section of the face is secured by means of a streak of powdered barium in vaseline on the nose and lips, that of the hard palate by a strip of lead foil ⅛ in. broad pasted on it from the front teeth to the uvula. The outline of the tongue is secured by means of a fine gold-plated locket chain, one end of which is fastened to the lip and the other end swallowed by the speaker. The chain is long enough to allow about three inches of it to be tucked under the tongue. Six examples of photographs obtained are reproduced.

Mechanism of Drying.—Owing to the large number of variables concerned in the process and to the variability in condition of the material as the process advances, analytical treatment of the drying of a solid substance involves considerable difficulty. Two communications on this subject by Dr. G. Bozza are published in the issue of the *Rendiconti della Reale Istituto Lombardo di Scienze e Lettere* for the current year (parts 6-10). The errors into which previous authors dealing with this question have fallen are indicated, and complete differential equations for the process, and also those corresponding with the surrounding conditions, are deduced. For the simplest case, when the substance does not suffer deformation, and when the coefficient of diffusion remains invariable during the drying, the differential equations are integrated for non-hygroscopic materials for the two periods when the surface moisture is respectively above and below the critical proportion. In this way, quantitative relationships between the moisture content of each point of a strip or parallelepiped and the time are obtained. Methods are given for the experimental determination of the necessary coefficients, as also are the results of a large number of experiments, made in conjunction with I. Secchi, to establish the relation between the coefficient of evaporation and the air velocity, knowledge of this being necessary for the further development of the investigation.

Krypton and Xenon.—A method of extraction of krypton and xenon from liquid air residues and determinations of some physical constants of these elements are described by F. J. Allen and R. B. Moore in the July *Journal of the American Chemical Society*. The method of separation avoided the use of large gasholders and the elements were obtained in a very pure condition. Preliminary density determinations indicated that the atomic weights at present assigned to krypton and xenon are too low, in agreement with Aston's mass spectrograph results. The average density of krypton was 3·733 gm./lit., that of xenon 5·887 gm./lit., and these give, with Watson's compressibility values, the atomic weights, $\mathrm{Kr} = 83{\cdot}6$ and $\mathrm{Xe} = 131{\cdot}4$. The possible errors are $\pm 0{\cdot}2$ and $\pm 0{\cdot}3$ respectively. The boiling points were found to be: Kr, $-152{\cdot}9°$, and Xe, $-107{\cdot}1°$, in each case $\pm 0{\cdot}3°$; and the triple points were Kr ($-156{\cdot}6°$; 557 mm.) and Xe ($-111{\cdot}5°$; 600 mm.). The values for the boiling points differ from the accepted values. It is clear that a revision of the properties of these two elements is indicated.

Molecular Weight of Insulin.—Sjogren and Svedberg, in the July issue of the *Journal of the American Chemical Society*, describe a determination of the molecular weight of insulin by the ultracentrifuge method. The crystalline insulin was supplied by Dr. Jensen, of Johns Hopkins University, and had been prepared from commercial beef pancreas insulin by crystallisation. Previous studies have shown that insulin is of protein nature, giving several protein reactions, having an empirical composition resembling that of proteins, being an amphoteric electrolyte and possessing an isoelectric point and ultra-violet absorption spectrum in the same region as most of the proteins. It is now shown that insulin is stable from *p*H 4·5 to about *p*H 7, and possesses a molecular weight of 35,100; at lower and higher *p*H values its molecule disintegrates into smaller units, the process being reversible near the borders of the stability region. The constants of insulin are, within the limits of error, identical with those of egg albumin and Bence Jones protein. It is very probable that insulin is a well-defined protein, and that its physiological activity is a property of the insulin molecule itself or some special group within it.

Utilisation of Atmospheric Electric Fields.—The *Zeit. für Physik* for June 20 contains a report by A. Brasch and F. Lange of their work upon the production of high potentials. Part of this has been done in the laboratory by the method in which a battery of condensers is charged in parallel, and the connexions rapidly changed to the series arrangement. A study has already been made in this way of the most suitable forms of discharge tubes for use with high voltages, and X-rays have been produced with an exciting potential of two million volts, and hydrogen positive rays with an accelerating potential of almost a million volts. A generator is now being built which it is hoped will give a potential of seven million volts. An even more interesting part of their work has, however, been carried out on Monte Generoso, in northern Italy. The district is very liable to thunderstorms, and use has been made of the large vertical fields which then occur in the atmosphere. To do this, a collector consisting of a large number of points suitably mounted was suspended in a small valley between two peaks. The whole had to be heavily insulated, as potential differences of more than ten million volts were encountered, and at the same time, as is evident from the photographs of the installation, its construction must have called for considerable mountaineering experience. The exact magnitude of the high potentials which were obtained from the apparatus is not certain, but sparks twenty-five feet in length were measured, and the corresponding potential difference estimated to be eighteen million volts.

Radio Observations during a Solar Eclipse.—In the *New Zealand Journal of Science and Technology* for June, Dr. M. A. F. Barnett gives a summary of the results obtained by the Radio Research Committee in New Zealand during the total solar eclipse of Oct. 21 and 22, 1930, by means of radio observations. As the path of totality passed across the Pacific Ocean, the observing stations near it were necessarily limited. The results agree well with those obtained during other eclipses. Observations were made on long waves (11,500 metres), on medium waves (850 and 800 metres), and on short waves (52 to 16 metres). In most cases the transmission path crossed the line of totality. The signal strength was estimated by aural methods. The strength of the long waves between Rugby and New Zealand was increased during the eclipse period, but nothing definite was obtained from the other long wave observations. On the medium wave transmissions, an effect equivalent to a partial return to night time conditions was observed. With short waves the only eclipse effect observed was a partial return to night time conditions in a few cases of the 52-metre transmission. Test records were made of the strength and persistence of atmospherics during the eclipse, but only in a few cases was a slight increase in their strength observed. It is concluded that in general the effect of the eclipse was to produce a partial return to night-time conditions. The resultant changes in signal strength follow fairly closely the equivalent changes in the amount of solar radiation reaching the atmosphere. There are indications, however, of a slight time-lag between the effects produced and the amount of solar radiation between the transmitter and the receiver.

Astronomical Topics.

Comet Ryves, 1931 *c*.—This comet was first seen by Mr. Ryves at Zaragoza on Aug. 10; he observed it almost daily up to Aug. 17, and noted that it was growing brighter. The only observation of position made elsewhere, so far as we know, was on Aug. 14 by Prof. G. van Biesbroeck, at Yerkes, who saw a tail one degree in length.

A telegram from the U.A.I. Bureau at Copenhagen has circulated the following parabolic orbit, computed by Mr. F. E. Cunningham, which indicates that it approached the sun within seven million miles on Aug. 25; it is quite likely that it would be visible in daylight about the time of perihelion:

$$\begin{array}{rl} T & \text{Aug. } 25{\cdot}900 \text{ U.T.} \\ \left.\begin{array}{r} \omega \\ \Omega \\ i \end{array}\right. & \left.\begin{array}{l} 168^\circ\, 26' \\ 101 \quad 4 \\ 169 \quad 11 \end{array}\right\} 1931{\cdot}0 \\ \log q & 8{\cdot}8633 \end{array}$$

Ephemeris for 0 h. U.T.

	R.A.	N. Decl.	log *r*.	log Δ.
Aug. 27	$10^h\ 37^m\ 49^s$	7° 47′	8·9987	0·0150
„ 31	10 44 22	5 36	9·4339	0·1028
Sept. 4	10 45 56	4 54	9·6070	0·1489
„ 8	10 45 30	4 32	9·7388	0·1895
„ 12	10 46 14	4 13	9·8228	0·2172

It will be seen that the comet remains near the sun in the sky, and observation in a dark sky will not be possible until it has become much fainter. If the above value of the perihelion distance is correct, this comet approached the sun more closely than any other comet observed in the present century, but less closely than the great comets of 1843, 1880, 1882, 1887.

Harvard Card No. 169 gives the following observed position of Nagata's comet by Prof. G. van Biesbroeck at Yerkes Observatory:

	R.A. 1931·0.	N. Decl.	Mag.
Aug. 12 10313 U.T.	$12^h\ 17^m\ 57{\cdot}25^s$	10° 8′ 18·4″	7·5

He noted that "A sharp nucleus is visible; the round coma is followed by a broad tail visible for 25′ in position angle 110°": as the comet is moving south more slowly than the sun, the conditions for observation are improving slightly.

John Harrison's Third Time-keeper.—The *Observatory* for August contains an article on this interesting old time-piece, on which Harrison was engaged from 1740 until 1757. It has been cleaned and repaired by Commander Gould, and was restarted in March last. All the four time-pieces of Harrison will shortly be in going order; the last to be undertaken is No. 1, on which Commander Gould is now at work. Harrison evidently bestowed more care and thought on No. 3 than on No. 4, which is much smaller. Yet it was the latter that won the Government award of £20,000. No. 3 was the first time-piece that contained a bimetallic compensation; it also anticipated the modern idea of a master clock and a slave one; it consists of an inner clock that is wound every thirty seconds by an outer clock. Being intended for use at sea (though it seems never to have actually been tried there), it is controlled by two large slowly-moving balances, instead of a pendulum. All Harrison's time-pieces will live in history, from the important part they played in solving the ancient problem of finding the longitude at sea.

Another Large Reflector in America.—A Science Service *Bulletin* from Washington, D.C., dated Aug. 10, announces the successful completion of the 69-inch mirror for the Perkins Observatory of Ohio Wesleyan Observatory, Delaware. It is stated to be the first very large mirror made entirely in America; in other cases the glass had been obtained from Europe. The mirror has been figured in the works of J. W. Fecker, at Pittsburgh. The tests of figure are stated to have been satisfactory; nearly 16,000 hours of work have been spent upon it. It has a central aperture, and will be used as a Cassegrain. The mirror is 10·3 inches thick and weighs 3790 pounds.

Stainless Metals.

THE economic and mechanical advantages which result from the use of the steels and cast irons are so important that, despite their low resistance to corrosion, they are used more extensively than all other metals put together. The inevitable result of this is an enormous wastage, resulting in the expenses of replacements and, even more, of the necessity of their protection by greasing, painting, etc. Sir Robert Hadfield has estimated that the annual cost throughout the world due to corrosion amounts to more than £500,000,000. Sir Harold Carpenter, in a lecture delivered before the Royal Society of Arts (*Jour. Roy. Soc. Arts*, May 8, 1931), reviewed the whole question of stainless metals, mainly ferrous ones, both from a fundamental and from the technical points of view.

Passivity and corrosion resistance appear to be due to the formation of invisible films of oxide, and it is to Evans that the credit is due of actually isolating such films. Most of the common metals have the property of forming protective oxide skins within certain ranges of temperature, and the production of a blue oxide coat on iron is one of the ways of protecting it. Unfortunately, however, the skin thus formed on iron at ordinary temperatures is not continuous and does not, therefore, constitute adequate protection. Where, on the other hand, the film is automatically repaired, efficient protection is provided, and in some cases this condition is realised in certain alloys used at high temperatures. Passivity resulting from immersion in concentrated nitric acid, potassium chromate solution, concentrated solutions of sodium carbonate, etc., is in all cases due to the formation of such skins, which, however, afford only a temporary protection. The films produced on chromium, on the other hand, are continuous and adherent, and the addition of that metal to iron greatly increases the tendency to passivity already possessed by it. The corrosion-resisting properties of the high chromium steels are due to this fact.

Various types of stainless steel have been developed with different degrees of resistance and mechanical properties. In general, the resistance increases with the chromium content and with the homogeneity of the material. The ordinary material is least attacked in the quenched condition, and if the same degree of resistance is to be obtained in the softer, tempered state the carbon content must be reduced or the chromium increased. Unlike the normal stainless steel, the alloy with 0·1 per cent of carbon and some fourteen per cent of chromium is stainless even in the annealed condition, and may be cold-worked to a considerable extent without serious diminution of its resistance.

The addition of nickel is, for many purposes, a further improvement. Such austenitic nickel-chromium steels are, in general, more resistant to corrosion, may be cold-worked without ceasing to be stainless, have remarkable ductility and resistance to shock stresses, and possess great resistance to oxidation at high temperatures. They are used, to choose one or two typical examples, in bridge construction, in refrigerating plant, for superheated steam valves, in acid mixing tanks, bathroom and stove fittings, etc. It has not yet been found possible to produce wire of the same strength as that of the strongest carbon steel wire, or to devise a steel which will withstand hot hydrochloric acid. Resistance to acids, other than nitric, appears to be associated with nickel; and nickel-chromium steels of one kind or another can be prepared which will resist attack by cold dilute hydrochloric acid, and by both hot and cold dilute sulphuric acid.

Apart from cost, however, such materials are available for almost all ordinary, and many quite special, purposes.

F. C. T.

Death and Development.*

THE paper before us embodies a rather novel theory of growth. The author tries to show that in both animals and plants, as the germ grows up into the adult, there are periods of rapid growth separated by intervals of slow growth or, especially in plants, of complete quiescence. He maintains that there are corresponding periods of mortality—a very high death-rate being correlated with each period of rapid growth—except at the end of life when old age degeneration sets in.

A priori, there is no inherent improbability in this hypothesis, but we have a right to criticise severely the kind of evidence which is brought forward in support of it. The author himself experimented with the snail *Agriolimax*, which he reared in captivity: he cites results by numerous other workers in confirmation of his own results, such as those of Pearl on *Drosophila*, Ford on the mollusc *Spisula*, Putter on the herring, Gates on the white mouse, Quetelet and Donaldson on man. Now, the obvious objection to the manner in which these results are utilised is that the author fails entirely to discriminate between natural and accidental death. Of course it may be retorted that in the last resort every death is accidental; but there is a wide difference between death as a failure of metabolism in old age and death due to the seizure of an individual by an enemy. Pearl's experiments on *Drosophila*, the author's on *Agriolimax*, and those of Gates on the white mouse, were performed on animals kept in captivity under what appeared to the experimenters to be a close approximation to natural conditions, but in which the experimental animals were carefully guarded from the assaults of their natural enemies, and in which they were supplied with their natural food. The calculations of the death-rates in the herring, on the other hand, were based on statistical studies of the number of herring larvæ in a given area. Now, as Dr. Lebour has shown in her studies at Plymouth, the herring whilst a larva is devoured by a large number of foes to which it is immune in later periods of its life. Thus, ctenophores, medusæ, and *Sagitta* have been found gorged with herring larvæ, and at a later period haddock have been found full of post-larval herring. Death from these causes bears no analogy to the death of mice from old age after about two years of life.

Death from old age, indeed, appears to be an event unknown amongst teleostean fish. When a new fishing area such as the White Sea is opened up, fish belonging to well-known species are found which have reached a remarkable size. It is obvious that when one of the principal causes of death is the attentions of one's fellow-tribesmen, the expectation of life will increase rather than diminish with the

* "Absterben und Entwicklung". By István Szabó (Kaposvár). From "Biologia Generalis," Bd. 7, Lief. 2. (Wien und Leipzig: Emil Haim and Co.)

attainment of a great age and a correspondingly great size.

Pearl's conclusions about the natural term of life in *Drosophila* are probably broadly correct, but as he had perforce to keep his insects in confined spaces, there are certain factors incident to overcrowding which he apparently overlooked. For five or six years a skilled experimenter in my laboratory has been rearing the tadpoles of the common frog with the view of testing their reactions to certain changes in the environment. Rearing tadpoles has been a schoolboy sport since time immemorial, but the average experimenter finds that he begins with a large amount of spawn from half of which tadpoles hatch out; these steadily diminish in number as they grow older, until in the end the triumphant schoolboy points to a dozen or half a dozen young frogs as the outcome of the experiments. But in my laboratory it is now possible to start with a culture dish containing 50 tadpoles and to bring 48 successfully through the metamorphosis. Sometimes extensive mortality occurs in a particular dish; when this case is investigated it is found to be due to some chemical contamination of the water. There is no inherent reason why tadpoles should die at any stage in their growth.

It is noteworthy that marine mammals, in spite of the fact that some of them such as the fin whale attain the largest dimensions (100 ft. in length with corresponding girth) ever attained by any animal living or extinct, nevertheless have a definite limit to their growth and presumably to their lives. For it has been shown (1) that when fin whales are born they are 20 ft. in length, (2) that they attain a length of 50 ft. in about a year, (3) that the union of the epiphyses with the bodies of the vertebræ, which sets a definite limit to growth and ultimately to life, occurs when the animal is eight years old.

In conclusion, we may say that Mr. Szabó's paper is interesting and suggestive of further experiments, but that his thought needs clarifying. The probable truth contained in it is that at various stages in the life history the coming into action of new powers of development, involving very active metabolism and often a resorption of old tissues, impose such a strain on the whole of the animal economy as temporarily to weaken the constitution, and that at such periods the weaker individuals succumb to adverse environmental influences. Szabó mentions such a period of weakness in the human race at the end of the first year. Apart from the strain involved in weaning and the adaptation to a new diet, there is the strain involved in cutting the teeth. Once we ourselves had startling light thrown on this subject. When resident in Canada, we met with an American Indian woman who was the mother of numerous offspring, all of whom she nursed for the full period. But as she pathetically explained to us, "she lost them all". Further investigation revealed the fact that the infants died when one year old or thereabouts, and that the cause of death was the strain of cutting a large number of teeth at one time. The simultaneous cutting of the teeth was due to the fact that when nursing one child she was in her sixth month of pregnancy with another, and Nature could not supply sufficient food to nourish the child in the womb and at the same time develop the teeth of the suckling child: these were held back in development, with catastrophic results to the child.

As to why some germs are more vigorous than others is a question too large to be discussed in this article, but it is, in our opinion, a subject of transcendent importance both for animal and human life, and is certainly not to be explained by 'chance'.

E. W. MacBride.

Pharmacology of Thallium.

THALLIUM salts have been used chiefly as a depilatory in ringworm of the scalp in children and as a poison for the extermination of rodents. Munch and Silver have recently reviewed the literature on the use of thallium, reporting at the same time some personal experiments on its toxicity and use as a rodent poison.* The salts most usually employed have been thallous acetate or sulphate.

Thallium is extremely toxic to animals but has less action on bacteria. In acute poisoning in man and animals, there is marked interference with locomotion, paresis or paralysis of the lower limbs, loss of appetite, decreased gastric activity, emesis, diarrhœa changing to obstinate constipation, a blue line on the gums; albuminuria, nephritis, and marked respiratory depression. Death occurs from respiratory failure, the heart and circulation not being involved. Post-mortem hæmorrhages into the lungs and marked irritation of the gastro-intestinal tract have been recorded. In chronic poisoning, the kidneys and central and sympathetic nervous systems are affected, leading to pains in the muscles and nerves, changes in the endocrine organs, and loss of hair: disturbances of calcium metabolism have also been reported. The action of thallium is cumulative: elimination is slow, two to three months being required for complete removal from the body of medicinal doses.

Thallium has been abandoned for treatment of night sweats in phthisis owing to its toxicity. It is still used as a depilatory in the treatment of ringworm in children: the maximum permissible as well as minimum effective dose is 8 mgm. per kgm. body weight, but even with this dose, toxic reactions frequently occur. The lethal dose for rats and mice by oral administration and for rabbits by intravenous injection is about 25 mgm. per kgm. body weight: dogs are more sensitive, 10–15 mgm. per kgm. causing death. Rats usually die in three days after eating poisoned food: increasing the dose does not accelerate the fatal issue. Thallium is therefore a comparatively slow poison.

Poisoned bait was readily consumed by laboratory rats, but when tested in the field, prairie dogs did not consume different samples with equal avidity. The reason for the difference between different samples was not determined: presumably prairie dogs are more susceptible to foreign tastes or odours than rats; both the thallium salt and the nature of the food material with which it is mixed probably play a part in making the bait attractive.

Although thallium is as toxic to rodents as strychnine and several times more toxic than arsenious oxide or redsquill powder, Munch and Silver advise that it should not be used indiscriminately as a rat poison, owing to its extreme toxicity to human beings. Where its use is found necessary for the control of highly resistant species of rodents, such as prairie dogs or ground squirrels, which refuse strychnine bait, it should be entrusted only to those who will exercise appropriate care in handling it.

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* "The Pharmacology of Thallium and its Use in Rodent Control." By James C. Munch and James Silver. *Technical Bulletin*, No 238. United States Department of Agriculture, Washington, D.C., 1931.

Swedish Ironfields.

TWO important monographs recently published by the Geological Survey of Sweden[*] describe the geology of two interesting Swedish ironfields. Both contain excellent English summaries.

Dr. Per Geijer in "Gällivare Malmfält" gives an excellent account of the field and its rocks and ore deposits, accompanied by a detailed map, three plates of mine plans and bore-hole sections, and 71 figures in the text. This field consists mainly of sheets of leptite and gneiss with large masses of intrusive granite, dykes from which are associated with the ores. The leptite is shown by Dr. Geijer to be highly metamorphosed lavas or shallow intrusions; the silica percentage in the leptites varies, as shown by the series of analyses, from 70 to 47 per cent. The ores are non-titaniferous magnetite, with some hæmatite. The ore is often well banded and interlaminated with apatite and granite.

Dr. Geijer again advocates the view that the ores are eruptive, and interprets the field as similar to that of Kiruna, but more highly metamorphosed. The differences between the two fields are obvious and striking, and several features are difficult to reconcile with the eruptive origin of the ores. Several of the photographs of the mines, for example, Fig. 39, p. 56, Fig. 52, p. 69, and Fig. 59, p. 87, show ore resting on a footwall fault. The 'ore breccia' consists of blocks of the country rock isolated by confluent veins of ore; and as the blocks appear in their original position, as in those exposed in the open-cut of the Hermelins mine in 1907, the ore was apparently introduced in solution and not as a molten intrusion. The low percentage of titanium and the regular banding of the ore, which occurs in places in thick bands parallel to the stratification and elsewhere interleaved with such thin layers of granite that Dr. Geijer compares them to *lit-à-lit* injection, also agree with the metasomatic formation of the ore.

That origin is established by Nils H. Magnusson for the very complex ores of the Långban mining field, which is west of Stockholm and north-east of Lake Wener. The ores, like those at Gällivare, are Pre-Cambrian. The field consists of a series of leptites, dolomites, and limestones, followed by an upper series of slates, graywackes, halleflintas, and spilites. The leptitites are altered lavas and tuffs, which have been metamorphosed by the older series of granites: a later series of granites was followed by the intrusion of sheets of diabase.

The field is famous for its very complex mineral composition and the occurrence of many rare and some endemic species. The author gives a list of 110 mineral species, to summarise their paragenesis. The minerals include a great variety of manganese silicates, with lead silicates, species containing arsenic, antimony, beryllium, boron, fluorine, etc., and native metals; sulphides are of minor importance. A new manganese amphibole, tibergite, is founded. The ores are associated with skarn, which passes through a transitional layer, the skol, into the leptite. The author shows that the primary ores are metasomatic: after their formation the country was subject to thermometamorphism by the intrusions of older granites; the skol was formed metasomatically, and at the same time as the fissure veins and subsequent filling of the vugs.

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[*] Sveriges Geologiska Undersokning. Ser. Ca, No 22: Gallivare malmfalt geologisk beskrivning. Av Per Geijer. With a Summary: Geology of the Gallivare Iron Ore Field Pp 115+4 tavlor. 10,00 kr. Ser. Ca, No. 23: Långbans malmtrakt geologisk beskrivning. Av Nils H Magnusson. Summary: The Iron and Manganese Ores of the Långban District. Pp 111+5 tablor 8 00 kr. (Stockholm: Sveriges Geologiska Undersokning, 1930.)

Weather Foreshadowing.

THERE is an increasing number of people nowadays who have not specialised in physics, yet possess enough knowledge of the subject to be able to understand the broad principles underlying the forecasting or —to use a more suitable word that is coming into use— the 'foreshadowing' of future weather by means of synoptic weather charts. Those who are prepared to take the trouble to do this will probably find that the value to them of the official forecasts is greatly increased.

The official forecaster's many difficulties include one which arises from the large variety and extent of country to which his necessarily brief statements must refer. The intelligent recipient of these forecasts, with some knowledge of local peculiarities of weather, can often make the adjustment to the general statement that may be necessary in order to make it apply to his own neighbourhood. If he possesses, in addition, a barograph, showing the variations of barometric pressure as a continuous curve, something can also be done to correct the forecast so as to meet unforeseen movements of anticyclones or depressions. If a depression fails to advance in the expected manner, or begins to fill up, a fall of the barometer may be checked, or even be replaced by a rise. The barograph is extremely effective in showing such changes of barometric tendency.

To meet the needs of this class of person, the Meteorological Office of the Air Ministry has issued a number of pamphlets in recent years. Two that should assist in the same direction have been added this year. They are entitled "The Fishery Barograph" (2*d.*) and "Examples of Weather Maps showing Typical Distributions of Pressure" (3*d.*) (London: H.M. Stationery Office). The "Fishery Barograph", though primarily designed to help seamen to anticipate gales, contains much information that is of general interest, for it includes notes about the behaviour of the wind and the barometer on the approach of stormy weather, and certain important but not generally known facts about the nation's wireless weather forecasts. The "Examples of Weather Maps" are taken from the larger official work entitled "The Weather Map". There is little that appears to call for criticism in either pamphlet; both fulfil their task of explaining in simple language various mysteries of meteorological method and terminology.

University and Educational Intelligence.

FROM the University of Colorado we have received a bulletin containing abstracts (of 500-1500 words each) of 108 theses for higher degrees conferred in 1930. A noteworthy feature of these abstracts is the evidence they afford of the predilection of advanced students of this university for regional studies, a circumstance attributable in part, perhaps, to the publication in 1927 of a series of university studies of local geology, botany, zoology, and social history. Of the 1930 theses, more than one-fifth were regional surveys: for example, "Colorado in the Civil War", "History of a County", "Vegetation of a Mountain in Arkansas National Park", "Microzoology of Boulder Creek", and so on.

DR. K. T. COMPTON, president of the Massachusetts Institute of Technology, has announced that the Rockefeller Foundation has appropriated the sum of 170,000 dollars for research work in physics, chemistry, geology, and biology, to be spread over a period of six years. The number of students at the Institute is the greatest in its history, with the exception of the two abnormal post-War years. It is significant that of the total number (3209), 17 per cent are post-graduate students drawn from other engineering schools and State universities. This tendency has been very marked of late years. The establishment of the loan fund of 4,250,000 dollars, by which assistance is afforded to deserving students, has been of great value; during the past year 226 students have benefited by it. The establishment of special honours courses has been so successful in such departments as have tried them, that it is permissible now for any department to establish them, leading up to a severe comprehensive examination at the end of the course. A new physics and chemistry building and a spectroscopic laboratory are now in course of erection. The main laboratory will be 300 ft. × 60 ft. and will have four stories and a basement, and the spectroscopic laboratory will be 100 ft. × 60 ft. The foundations are exceptionally heavy, more than 3000 piles having been driven for the two buildings. The spectroscopic laboratory is placed upon a mat composed of alternate layers of sand, felt, transite board, ground cork, and reinforced concrete, and it is so well insulated against changes of temperature that if the outside temperature were suddenly to change 100°, it would take the interior of the building about a month to change one degree. Plans have also been drawn for a naval tank combined with a hydraulic laboratory. This has been made possible by the generosity of Mr. J. E. Aldred.

The "Purpose of a University" is discussed in an article contributed by Prof. S. Alexander to the July-September number of *The Political Quarterly*. The work of a university cannot be divorced from its practical issues in life and it would be misleading therefore to define its purpose as the acquisition, communication, and advancement of knowledge without adding that it pursues the sciences not for their own sake alone, but also, so far as the larger part of its members are concerned, in preparation for the professions or higher occupations of life. The distinguishing mark of university studies is the pursuit in each subject, not only the older and well-established aspects but also the newer, more obviously professional —of the 'science' of the subject—meaning thereby its underlying rational principles and its relations with other subjects. In England much of the work done in universities lacks this characteristic, being such as in France or Germany is done in the lycées or the gymnasia: the student is still too much of a schoolboy or schoolgirl to entertain the true spirit of academic life and needs more than mere guidance. Admitting this immaturity of undergraduates in the early part of their university course, Prof. Alexander nevertheless inveighs against the overteaching of students as a glaring defect of our universities in general and of Oxford in particular. This sins against the ideal of a university not only by incompatibility with training the student in intellectual independence and with the cultivation of the scientific spirit, but also by engrossing time which ought to be devoted by the teacher to scientific research. The Oxford tutorial system, which has so often been held up for admiration as a model of university teaching, has, in his eyes, become a positive evil; and he holds that the new studies of the natural sciences are fortunate in that the system has not taken root strongly in them. To it he ascribes Oxford's failure to keep its place in the front rank of the advancement of science: nor is there, he says, any sufficient evidence that the over-taught undergraduates of Oxford are better fitted for the work of life than those of Cambridge who have not been so tutored.

Birthdays and Research Centres.

Aug. 30, 1871.—The Right Hon. Lord **Rutherford of Nelson**, O.M., F.R.S., past president of the Royal Society; Cavendish professor of experimental physics, University of Cambridge; and chairman of the Advisory Council of the Department of Scientific and Industrial Research.

For many years, I have been engaged in researches to throw light on the structure of atomic nuclei. Several lines of attack on this problem are being actively pursued by different workers in the Cavendish Laboratory, including the determination of isotopes, the artificial disintegration of elements by α-particles, measurement of the wave-length of γ-rays, and the effect of high frequency γ-rays on the nucleus. At the moment my co-workers and I are studying in detail with the aid of new counting methods the groups of long range α-particles—about one in a million of the main group—expelled from certain radioactive substances. There is strong evidence that these rare groups of particles are closely connected with the emission of γ-rays. In an excited nucleus it is supposed that some of the α-particles are raised to a high level of energy. The majority fall back to a lower level, emitting γ-rays in the process, but in the short time before this happens a few of the α-particles are able to escape through the potential barrier and issue as long range α-particles. By a study of these particles, it is hoped to account for the origin of the γ-rays and their complicated spectrum.

In order to increase our knowledge of artificial disintegration of atoms and for other investigations, it is desirable to have available for laboratory purposes sources of high speed atoms and electrons. It is of first importance that the best method of generation of very high voltages for this end and their application to produce swift particles should be actively investigated.

Sept. 1, 1877.—Dr. F. W. **Aston**, F.R.S., fellow of Trinity College, Cambridge, and Nobel laureate for chemistry (1922).

One of the problems I have been attacking with my mass-spectrograph is the photometrical determination of the relative abundances of the isotopes of complex elements. During this investigation atomic weights have been checked and many new species of atoms discovered. Work has advanced sufficiently far to show that there is little hope of discovering any simple laws connecting these ratios of abundance. I am also making experiments on possible improvements to the apparatus to increase the accuracy of its determination of atomic masses even further. Theoretical investigators of the structure of nuclei ask for an accuracy of 10^5 and I have every hope that in the near future this will be approached.

The crying need in this work is a means of obtaining and controlling really intense beams of high speed positive ions. I hope that all engaged in research in this field will bear this in mind and neglect no byway likely to lead towards this end.

Sept. 2, 1877.—Prof. F. **Soddy**, F.R.S., professor of chemistry in the University of Oxford and Nobel laureate for chemistry (1921).

I have this year re-determined the rate of growth of radium from uranium. The attempts directly to prove that radium is a product of uranium began simultaneously with those, immediately successful, to detect the production of helium from radium. But, owing to ionium intervening, the growth proceeds according to the square of the time and is infinitesimal for the first few years. Four uranium preparations, purified from radium and ionium a quarter of a century ago, now have from 10^{-9} gm. to 10^{-10} gm. of radium, as much as it is convenient to measure accurately, and they give a very consistent value for the product of the periods of the average lives of ionium and radium, namely, $2{\cdot}44 \times 10^8$ $(\text{years})^2$.

"Money *versus* Man", published this year, gives a popular account of my theory of virtual wealth—a slight but upsetting modification of the quantity theory of money—and of the problems which confront civilisation owing to the growth of the physical sciences.

I have also applied for a patent for a form of centrifugal reversing and reducing mechanism which I am hopeful will one day find application to turbine-propelled vessels.

Sept. 3, 1882.—Dr. W. L. Balls, F.R.S., chief botanist of the Egyptian Ministry of Agriculture, and formerly chief of the Experimental Department, Fine Cotton Spinners' and Doublers' Association, Bollington, Cheshire.

A slow development of technological research on spinning quality is taking place concurrently with the isolation, testing, propagation, renewal, and bulk control of pure lines of Egyptian cotton, which occupies much of the time of my staff at Cairo, but my chief personal interest is subterranean, developed from my pre-War studies of the root and its environment. In the Templeton observation-pits we have watched sequences of events and then found them in the open field; roots growing a metre a month and remaining alive for months after the plants had been uprooted; colour changes in soil round the roots demonstrating chemical stages of deterioration through water-logging and re-aeration. We now use the crops as indicators of soil structure, and are interested in the development of aerial survey repeated through a full rotation of crops, with reference to drainage projects. At the moment I am writing up water-table observations which have accumulated on our experimental farm at Giza since 1909.

Societies and Academies.

Paris.

Academy of Sciences, June 29.—The president announced the death of Friedrich Becke, *Correspondant* for the Section of Mineralogy.—**A. Lacroix**: New observations on the tectites of Indo-China. Discussion of their origin. From the examination of a large number of fresh specimens it is concluded that the tectites result from the vertical fall of fused material possessing a high temperature. This agrees with the hypothesis of a meteoric origin of the tectites.—**Emm. de Margerie**: The last sheets of the *Carte Générale Bathymétrique des Océans* (*Panneau du Pôle Nord*).—**Paul Montel**: Functions of several linearly dependent variables.—**E. Kogbetliantz**: New observations on the orthogonal system of Hermite polynomials.—**Lucien Féraud**: Completely stable systems in the neighbourhood of an equilibrium point.—**H. Guillemet**: The evolution of the wake behind an obstacle for small values of Reynolds's number.—**Mme. V. Popovitch-Schneider**: The extension of Hele-Shaw's method to cyclic movements. The results of the experiments, in spite of the wall effect due to the small dimensions of the apparatus, show good agreement with theory. Four reproductions of photographs accompany the paper.—**Emile Bélot**: The double origin of the small planets and their emission by the rings and vortices of the large planets.—**Louis Gérard**: Reflection on a moving mirror and relativity.—**A. Damiens** and **L. Domange**: An electric furnace made of fluorspar. Details of construction of an electric tube furnace in which the inner tube is made of fluorspar. It permits of working with fluorine or hydrofluoric acid at a temperature of 1000° C.—**B. Decoux**: A piezoelectric quartz frequency meter with synchronous modulation. The meter described is transportable and is capable of high accuracy. It can also be used as a stable receiver by using the apparatus as a heterodyne.—**P. Fleury**: A precision luxmeter with homochrome regions.—**Léon** and **Eugène Bloch**, **F. Esclangon**, and **P. Lacroute**: The observation of the Zeeman effect with high frequency. High frequency discharges in rarefied gases, already proved to be of great service for the production and separation of higher order spectra, can also be utilised with advantage for the study of the Zeeman effect. The results of experiments with neon and with mercury (field 26,250 gauss) are given.—**D. Malan**: The absorption spectrum of oxygen at high temperatures. This work was undertaken with the view of detecting the formation of ozone in oxygen at a high temperature. At 1400° C. no ozone could be detected by the absorption method, and it is concluded that unless the absorption of ozone is diminished at the high temperature, the quantity of ozone produced, if any, must be very small.—**P. Daure** and **A. Kastler**: The Raman effect in some gases. The gases studied were hydrogen, acetylene, cyanogen, and steam.—**François Reymond** and **Tcheng da tchang**. The separation of polonium and of protactinium fixed on tantalum oxide. To the tantalic acid gel in solution in hydrofluoric acid some selenious acid is added, followed by sulphuric acid and sodium bisulphite. The reduced selenium produced by boiling carries down with it the whole of the polonium present.—**F. Bourion** and **E. Rouyer**: The cryoscopic study of paraldehyde in solutions of lithium chloride and magnesium chloride.—**Francis Perrin**: Molecular association and the optimum for fluorescence of solutions. The influence of salts.—**Maurice Curie** and **M. Prost**: The radiation accompanying the hydration of quinine sulphate. In water vapour at the pressure of 1 mm. the path of the radiation is about 1 mm.; at atmospheric pressure the path would be of the order of 0·001 mm.—**Mlle. Sabine Filitti**: The determination of the charge of the micelle. It is possible to determine the granular charge of a non-ionised colloid of known micellary weight by measuring the fall of *p*H produced in the dispersing medium by a given mass of dissolved substance.—**P. Mougnaud**: The estimation of fluorine. A detailed examination of the methods of Rose and of Carrière and Rouanet. The latter is rejected as inaccurate; the former is capable of improvement.—**Mlle. M. L. Delwaulle**: The action of hydrogen upon potassium permanganate.—**P. Carré** and **P. Mauclère**: The chloride of acid ethyl sulphite and the neutral mixed alkyl sulphites. The observation of Michaelis and Wagner on the production of $(C_2H_5O)\,SO.Cl$ by the interaction of neutral ethyl sulphite and phosphorus pentachloride, with subsequent separation by distillation, is shown to be inaccurate. This compound is formed by treating thionyl chloride with alcohol in the presence of pyridine, but commences to decompose at 18° C. and cannot be distilled.—**Paul Jodot**: The diffusion of silica during the formation of Corsican jaspers.—**Conrad Kilian**: The age of the Harlania grits, and the extension of the Silurian in the eastern Sahara.—**Couvreur**: Comparison of the testa of lamellibranchs and gastropods.—**Louis Dangeard**: The presence of coccolith and coccosphere beds in the laguno-lacustral Oligocene of Limagne.—**H. Colin** and **P. Billon**: Potash in the sugar beet.—**Émile Saillard**: Sugar beets and molasses (nitrogen and raffinose).—**L. Bordas**: The comparative anatomy of the ovaries of some Hymenoptera.—**Charles Pérez**: The successive replacement of the visceral sacs in *Chlorogaster*.—**Jules Amar**: Vital capacity and pulmonary ventilation.—**Léon Binet** and **M. V. Strumza**: The hæmatopoietic power of carotene. In anæmic dogs the administration of carotene by the digestive tract has a marked influence in increasing the proportion of hæmoglobin.—**Jean Saidman, Jean Meyer**, and **Roger Cahen**: The local effects in the rat due to electric fields of very high frequency. Regional irradiation causes a relatively slight rise in the general temperature, but causes a sharp rise in the temperature of the irradiated region. Abdominal irradiation produces death when the temperature reaches 43·5° C.—**Boris Ephrussi**: The factors limiting the increase of cultures of tissues *in vitro*. Meaning of the residual energy.—**Delherm** and **Laquerrière**: A new electrotherapeutic apparatus for the production of long period alternating waves and undulatory currents.—**C. Levaditi, A. Vaisman, Mlles. R. Schoen** and **Y. Manin**: The calcifying action of bismuth.

LENINGRAD.

Academy of Sciences (*Comptes rendus*, No. 26, 1930).—**E. Voronovskaja**: The transformation of a series of functions by the differences of its terms.—**K. Nikolskii**: The geometry of the Dirac equation.—**G. Laemmlein**: The regular formation of twins in porphyro-quartz of Samshvildo. The author believes that the orientation of the composite parts of a twin is not accidental but occurs according to some definite laws of crystallisation.—**L. Kamanin** and **V. Slokevitch**: A discovery of *Spaniodontella* strata and of deposits of the first Mediterranean stratum in the Nikopol area of manganese deposits.

Comptes rendus, No. 27.—**V. Chlopin** and **A. Ratner**: The distribution of a dissolved substance between the crystalline and the fluid phase. An experimental study of the distribution of radium between crystals of lead nitrate and their solution at 0° and at 25°. The distribution occurs strictly according to the Berthelot-Nernst law.—**N. Gutkova**: A new titanosilicate, the murmanite of the Lovozero tundras. Physico-chemical, optical, and crystallographical characteristics of the mineral are given.—**M. Korsakova** and **E. Nikitina**: The influence of the associated bacteria on the nitrogen régime of *Granulobacter pectinovorum*. When *Granulobacter* is associated with various ærobic bacteria, the latter not only create the anærobic conditions required by *Granulobacter*, but also alter the conditions of its nutrition by providing it with the necessary organic nitrogenous compounds.—**M. P. Korsakova**: The mechanism of the reduction of nitrates (3). A species of bacterium, not identified exactly, was found by the author to be able to reduce nitrates, but the reduction does not reach the stage of free nitrogen.—**T. Ščegoleva-Barovskaja**: New Mordellidæ (Coleoptera) in the collections of the Zoological Museum of the Academy of Sciences. Descriptions of *Mordella fallaciosa* and *M. curvipalpis*, spp. nn., from Turkestan, *Mordellistena similis*, sp. n., from European Russia, and *Silaria antennalis*, sp. n., from Yakutsk province.

SYDNEY.

Linnean Society of New South Wales, June 24.—**C. Deane**: Trichopterygidæ of Australia and adjacent islands. Descriptions of twenty new species of this family under ten genera, five of which are new.—**J. W. Evans**: Notes on the biology and morphology of the Eurymelinæ (Cicadelloidea, Homoptera). The Eurymelinæ are found principally on Eucalyptus trees, the eggs being laid in incisions made by the females in the bark of these trees. There are five nymphal instars, the nymphs being gregarious, as are the adults of many species. Both nymphs and adults are attended by ants; the latter feed on the 'honey-dew' or excreta of their charges. In spite of the ubiquity of their food-plants, their distribution is localised, due to the control effected by their many parasites and predators.—**F. A. Craft**: The physiography of the Shoalhaven River valley. (2) Nerrimunga Creek. Nerrimunga Creek and its tributaries drain an area of tableland to the west of the Shoalhaven River, into which they flow. The western divide between the Wollondilly and Shoalhaven waters is a level ridge varied in places by monadnocks. This falls to an extensive plain of the order of 2000 feet above sea-level, across which the streams flow in shallow valleys. Tertiary deposits are found extensively on this surface, and towards the east of the area stream channels filled with Tertiary drift are found down to 300 feet below the plain, which has been partly dissected by the deep gorges of Nerrimunga Creek and the Shoalhaven River.—(3) Bulee Ridge. Bulee Ridge, to the east of the Shoalhaven River at the head of the coastal fall, consists of horizontal sandstones, and rises from 2000 feet above the Shoalhaven south of Tallong to 2600 feet in its highest portion. On the west it falls away to the Shoalhaven Plain at 2000 feet, but the western slopes have been considerably dissected. The ridge is of considerable age, and protects the tableland from the destructive erosion of the coastal slopes.—**E. Le G. Troughton**: Three new bats, of the genera *Pteropus*, *Nyctimene*, and *Chearephon*, from Melanesia. The genus *Pteropus* is recorded for the first time from Ongtong Java, Lord Howe's Group. The range of the genus *Nyctimene*, not hitherto recorded southward of Guadalcanar in the Solomons, is extended some 350 miles to the Santa Cruz Group, while the third species, an insectivorous bat of the wrinkle-lipped genus *Chaerephon*, from the island of Ysabel, records the first known occurrence of the family Molossidæ in the Solomons.

Official Publications Received.

BRITISH.

Ceylon. Part 4: Education, Science and Art (G). Administration Report of the Marine Biologist for the Year 1930. Pp. G10. (Colombo: Government Record Office.) 10 cents.

Proceedings of the Royal Society. Series A, Vol. 132, No. A 820, August 1. Pp. 353-706. (London: Harrison and Sons, Ltd.) 18*s*.

Annual Report of the Auckland Institute and Museum, 1930-31, adopted at the Annual General Meeting held on 27th May 1931. Pp. 45. (Auckland, N.Z.)

Ontario Research Foundation. Report for the Year 1930, presented by the Chairman to the Lieutenant-Governor in Council, December 1930. Pp. 31. (Toronto: Herbert H. Ball.)

Transactions of the Mining and Geological Institute of India. Vol. 25, Part 4, May. Pp 307-382+xiii 2.8 rupees. Vol. 26, Part 1, July. Pp. 68+viii. 2 8 rupees. Member List. Pp. 26. (Calcutta.)

Indian Lac Association for Research. Reports of the Committee and of the Director, Indian Lac Research Institute, Nankum, Ranchi, for the Year 1st April 1930 to 31st March 1931. Pp. ii+53. (Nankum.)

Bulletin of the Department of Zoology, Panjab University, Vol. 1. Fauna of Lahore. 1: Butterflies of Lahore. By D. R. Puri. Pp. 61+4 plates. (Lahore.) 3.8 rupees.

Committee on National Expenditure. Report (Cmd. 3920.) Pp. 282. (London: H.M. Stationery Office.) 4*s*. net.

Proceedings of the Cambridge Philosophical Society. Vol. 27, Part 3, 31 July. Pp. 291-489. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

FOREIGN.

Comptes rendus de la cinquième séance de la Commission Géodésique Baltique réunie à Copenhague du 13 au 18 octobre 1930. Redigés par Ilmari Bonsdorff. Pp. 275. (Helsinki.)

Field Museum of Natural History. Botanical Series, Vol. 11, No. 1: Spermatophytes, mostly Peruvian—III. By J. Francis Macbride. (Publication 288.) Pp. 35. Zoological Series, Vol. 18, No. 3: Birds of the Kelley-Roosevelts Expedition to French Indo-China. By Outram Bangs and Josselyn Von Tyne. (Publication 290.) Pp. 31-119+3 plates. Botanical Series, Vol. 7, No. 3: The Rubiaceae of Bolivia. By Paul C. Standley. (Publication 292.) Pp. 253-389. Zoological Series, Vol. 18, No. 4: The Painted Turtles of the Genus Chrysemys. By Sherman C. Bishop and F. J. W. Schmidt. (Publication 293.) Pp. 121-139. Botanical Series, Vol. 8, No. 5: Studies of American Plants. By Paul C Standley. (Publication 294.) Pp. 293-398. (Chicago.)

Proceedings of the Imperial Academy. Vol. 7, No. 6, June. Pp. xvii-xviii+211-240. (Tokyo.)

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1930. Pp. lxx+211+11 Tafeln. (Bern: Paul Haupt.)

Catalogues.

Askania Vibrograph with Photographic Record. (Pamphlet Geo 105E.) Pp. 12 The Prismatic Derivator designed by v. Harbou for graphically determining Tangents and Normals to Mathematical Curves. (Pamphlet Geo 106E.) Pp. 2. (London: O. G. Karlowa; Berlin-Friedenau: Askania-Werke A.G.)

Diary of Societies.

CONGRESSES.

September 1 to 19.

International Illumination Congress.

Friday, Sept. 4 (at Glasgow).—O. Hopcke: Über die Brauchbarkeit von Modellen bei lichttechnischen Vorfuhrungen.

C. A. Atherton: Organisation for the Development of Electric Lighting.

C. Clerici. Progress and Teaching of Illumination in Italy.

A. M. Baidaff: Lighting Progress in Argentina.

C. Zwikker and Collaborators: L'exactitude de la photométrie.

L. Simek: Some Observations on Errors in Photometric Measurements.

E. Ferencz and J. Urbanek: Sur la précision de la photométrie.

R. Koveshgethy and P. Selényi: Über die Genauigkeit der subjektiven Photometrie von Gluhlampen stark verschiedener Lichtfarbe.

P. J. Waldram: The Provision of Adequate Daylight in Building Regulations

C. G. Moller: Daylight Illumination and Town-Planning.

H. G. Fruhling: Uber Leitsatze fur Tagesbeleuchtung.

K. Y. Tang: Visual Performance of Various Levels of Daylight Illumination.

T. Hirayama: Daylight Illumination of Art Galleries with Overhead Lighting.

A. Angstrom: On the Influence of the Surface of the Ground on the Illumination from the Sky.

C. Haslett and N. E. Miller: Home Lighting.

C. W Sully. Lighting Activities of Supply Undertakings.

G. H. Stickney. Adequate Wiring—A Problem of the Illuminating Engineer.

G. S. Merrill: Voltage and Incandescent Electric Lighting.

A. K. Taylor: Accuracy of Portable Photometers.

J. Hrdlička: Contribution à l'étude de la précision en photométrie

W. F. Little: Precision of Photometry.

B. P. Dudding and G. T. Winch: Accuracy of Commercial Photometry. Comparison of Visual and Photo-electric Measurements.

J. Wetzel and A. Gouffé: Sur la precision des photomètres portatifs.

Z. Yamauti and K. Hisano: Photo-electric Measurements of Daylight Illumination by the Use of a Model Room.

H. F. Meacock and G. E. V. Lambert: Efficiency of Light Wells

A C. Stevenson: On the Mathematical and Graphical Determination of Direct Daylight Factors.

H. H. Higbie and A. D Moore: Prediction of Natural Illumination in Interiors and on Walls of Buildings.

Monday, Sept. 7 (at Edinburgh).—A. P. Allan and J. M. Campbell: The Lighting of Seaside Resorts.

A. Gouffé: Calcul de l'eclairement moyen des espaces circulaires et elliptiques.

W. S. Stiles: Mass Experiments in Street Lighting.

Sir Francis Goodenough: Notes on Recent Developments in Gas for Street Lighting in Great Britain as Illustrated by the facts relating thereto in the Cities to be visited by Delegates to the International Illumination Congress, 1931.

W. J. Jeffery: Modern Public Lighting by Electricity.

J. S. Preston: The Properties of Diffusing Glasses, with Special Reference to Surface Effects.

J. W. Ryde and B S Cooper: (*a*) The Theory of Diffusion of Light by Opal Glasses; (*b*) Practical Applications of the Theory of Opal Glasses.

L. Bloch: Durchsichtigkeit und Durchlassigkeit lichtzerstreuender Glaser.

S. Schonborn: Klasseneinteilung fur Beleuchtungsglaser.

M. Cohu: Rapport sur quelques propriétés de certains matériaux diffusants.

F. Born: Zur Frage der Vertikallichtverteilung von Flugstreckenfeuern.

v. Goler and M. Pirani: Über die Anwendung von Leuchtrohren.

H N. Green: The Light Distribution of Navigation Lamps.

British National Committee: Ground Lighting Equipment for Aviation.

M. M Exelmans: Appareils pour l'éclairage des routes terrestres et le balisage des routes aériennes.

M. Franck: Feux de position des avions.

F. C. Breckenridge: Transmission of Light through Fog.

C. C. Paterson: The British Standard Specification for Street Lighting.

E. J. Stewart: British Street Lighting in the Lower Classes of the Standard Specification.

W. S. Stiles and J. F. Colquhoun: The Street Lighting Requirements of Different Types of Street.

Public Lighting Department, South Metropolitan Gas Co.: Street Lighting by Gas in South London.

L A. S. Wood: American Street Lighting Practice

J. Wetzel: Sur l'établissement d'un projet d'éclairage de voie publique.

R. Kurosawa: (*a*) A Simple Method for Testing Diffusing Material; (*b*) A Study on the Light Distribution of Diffusing Globes.

S. Seki: Distribution of Reflected Light from Test Plate of Macbeth Illuminometer and Proper Direction of Measurement.

M. M. Exelmans: Les glaces moulées diffusantes comparees aux glaces claires

H. Eguchi: (*a*) Course of Improvement of Visual Acuity during Light Adaptation: (*b*) Über die Sehscharfe unter starker Helligkeit.

H. Klein: Beschreibung eines neuen Sehleistungs-Prufapparates.

V. Pospisil: L'origine des sensations visuelles.

J. Dourgnon and P. Waguet: Remarques sur la non-réciprocité de certains phénomènes optiques: conséquences pratiques relatives à l'art de l'éclairage.

S. Maisel: Uber die Grundbegriffe der Lichttechnik.

Thursday, Sept. 10 (at Buxton).—H. Lux: Die Leitsatze fur die Beleuchtung mit kunstlichen Licht.

M. Luckiesh and F. K. Moss: Humanitarian Footcandles.

N. Goldstern and F. Putnocki: Webstuhlbeleuchtung.

Society of British Gas Industries: The Lighting of Factories and Large Buildings.

K. Norden: Schatten und Halbschatten.

R. W. Maitland and H. Robertson: Electric Light as related to Architecture.

H. Maisonneuve and J. Wetzel: L'éclairage artistique en France de 1928 à 1931.

Comité de Direction des Grandes réseaux de Chemins de Fer Français: Eclairage des gares de triage.

A. Cunnington: Railway Lighting in Great Britain.

L. Schneider: Bergwerksleuchtung.

W. Maurice: A Standard of Illumination for Mines.

W. A. Villiers: Incandescent Lighting in British Cinema Studios.

Z. Yamauti: Construction and A.C. Luminous Intensity of Standard Vacuum Tungsten Filament Lamps.

E. Lax and M. Pirani. Kunstliches Tageslicht und Sonnenlicht.

E. Cheliotti and B. P. Dudding: Precision in Incandescent Lamp Manufacture.

A. Blondel: Sur un photomètre binoculaire à coins et ses applications aux phares et projecteurs.

L. Kalff: Illumination and Architecture.

W. J. Jones: Engineering Aspects of Architectural Lighting.

J. Dourgnon and P. Waguet: (*a*) Note sur la détermination des dimensions des corniches des volets ou des ailettes à masquer la vue directe des sources ou des appareils; (*b*) Remarques sur les surfaces réfléchissantes mates de brillance uniforme.

B. Matthews: Electric Light on the Farm.

K. Vogl: Kunstliches Beleuchtung im Gewachshaus.

S. Odén, G. Kohler, and G. Nilsson. Plant Cultivation with the aid of Electric Light.

Friday, Sept. 11 (at Birmingham).—Z. Ishii and T. Takeshita: Some Fundamental Experiments on Signal Glasses.

T. Abe: An Improved Optical System for Japanese Railway Coloured Light Signals.

K. Fuwa: On the Selenium Ruby Glass.

I. Inaba: Tests of Coloured Signal Glasses.

T. Abe and T. Takegami. Apparatus for Obtaining the Light Distribution Curve and the Rousseau Diagram.

L. Schneider: Ein Beitrag zur Kennzlichnung der Lichtstromverteilung.

J. Wetzel: Sur une nouvelle méthode de calcul des coefficients d'utilisation.

W. Arndt: Über den Stand der Arbeiten-Beleuchtung raumlich zu bewerten.

Report of Committee on Motor Vehicle Headlights: An Experiment on the R.A.C. Disc.

F. Born: Zur Frage der internationalen Regelung der Automobilbeleuchtung.

A. Monnier: Les lampes électriques françaises employées dans les projecteurs d'automobiles.

J. D. Morgan: Motor Vehicle Lamps.

M. Roge: Les derniers perfectionnements apportés sur les projecteurs électriques d'automobiles.

A. V. Blake and W. M. Hampton: The Development of Traffic Control by Light Signals in Great Britain.

E. Schuppan: Lichtsignalregelung.

J. P. Bowen: Lighthouses.

A. Blondel: Brilliance apparente des surfaces de sortie des appareils optiques éclairés par des sources le lumière.

Z. Yamauti: Notes sur la mesure de lumière à couleurs différentes.

B. P. Dudding and G. T. Winch: Photometric and Spectrophotometric Comparison of White and Coloured Light Sources.

J. Escher-Desrivières: La colorimétrie des sources lumineuses ponctuelles.

August 31 to September 4.

International Congress of Neurology (at Berne).

September 7 to 10.

International Psycho-Analytical Association (at Interlaken)

September 7 to 10.

International Congress for Studies regarding Population (at Rome).

September 7 to 12.

International Congress of Orientalists (at Leyden).

September 9 to 12.

International Professional Association of Medical Practitioners (at Budapest).

SATURDAY, SEPTEMBER 5, 1931.

CONTENTS.

	PAGE
An International Congress of Prehistory	389
Agriculture and Physics. By R. T. G.	391
Vocational Guidance	393
German Glaciation	394
Short Reviews	395
Influence of Modern Hydro-Electric Power Development on the British Coal Trade. By Dr. Brysson Cunningham	397
Periodic Physico-Chemical Phenomena. By Dr. Ernest S. Hedges	398
Obituary :	
Prof. W. E. Dixon, O.B.E., F.R.S. By F. B. P.	401
Prof. J. W. Hinchley. By J. S. S. B.	402
Group-Capt. Martin Flack, C.B.E. By Sir Leonard Hill, F.R.S.	402
Mr. David Davies. By F. J. N.	403
Dr. W. E. Downey	403
News and Views	404
Letters to the Editor :	
The Corpuscular Explanation of Cosmic Rays.—Prof. Frederick Soddy, F.R.S.	408
Measurements on the Absorption of the Penetrating Corpuscular Rays coming from Inclined Directions.—Prof. Bruno Rossi	408
Isotopic Displacement in Hyperfine Structure.—James H. Bartlett, Jr.	408
Hyperfine Structure of Thallium II.—Dr. J. B. Green and John Wulff; Dr. H. Schuler and J. E. Keyston	409
Evidence for the Spin of the Photon from Light-Scattering.—Dr. G. Placzek	410
Group Rotation in Solid Ammonium and Calcium Nitrates.—F. C. Kracek, S. B. Hendricks and Dr. E. Posnjak	410
Apparent Dissociation Constants of Carbon Dioxide in Sea-water of Different Salt Contents.—Dr. Kurt Buch, Dr. H. Wattenberg, and H. W. Harvey	411
Hydrolytic Adsorption of Activated Charcoal.—Prof. J. N. Mukherjee and S. P. Roychoudhury	412
Orientated Deposits of Copper on Bismuth.—Prof. Yosimiti Hori	412
Rotation of 'Dust Devils'.—J. Durward	412
Constitution of Anthocyanins.—G. M. Robinson and Prof. R. Robinson, F.R.S.	413
Reaction between Hydrogen Sulphide and Sulphur Dioxide.—Prof. Basrur Sanjiva Rao and M. R. Aswathnarayana Rao	413
A Method of Studying Surface Films.—Prof. E. Gorter and W. A. Seeder	413
Insectivorous Snakes.—Prof. F. J. Meggitt	413
Research Items	414
Astronomical Topics	416
Echinoderm Larvæ. By Dr. F. A. Bather, F.R.S.	417
The Artificial Coniferous Plantation and its Place in Forestry	417
The Mellon Institute	418
Rock-Paintings in North-West Australia	419
Radioactivity and Earth Movements	419
Acceleration of Fermentation by Algæ and Sea-water	419
University and Educational Intelligence	420
Birthdays and Research Centres	420
Societies and Academies	421
Official Publications Received	423
Diary of Societies	423

An International Congress of Prehistory.

SCIENCE unquestionably is greatly indebted to France for the part she played in the efforts to re-establish relations between the scientific workers of different countries after the War. Anthropologists, in particular, should be grateful to their French colleagues for the initiative which led to the foundation of the Institut International d'Anthropologie (even though the Institut failed to attain internationality) and the organisation through that body of a congress of anthropology and prehistoric archæology at Liège, which was the first post-War common meeting-ground for some, though not all, of the anthropologists of different nationalities who had been kept apart for so many years by stress of circumstance. Yet curiously enough, France has failed to carry matters to their logical conclusion. Notwithstanding the admission of countries formerly enemy to participation in the later congresses which have followed that at Liège, the international status of these meetings has been called seriously into question, while in its organisation the Institut, which has made itself responsible for these assemblies and virtually has retained supreme control, is, for practical purposes, predominantly of one nationality.

The efforts of anthropologists outside France to ensure that these congresses in future should be truly, and not merely nominally, international in status and composition, has led to a counter-movement which was referred to in the leading article of NATURE of Mar. 1, 1930. This is manifest in the revival, ostensible rather than real, of the Congrès International d'Anthropologie et Archéologie Préhistoriques, which met last at Geneva in 1912. In theory it sat in joint session with the Institut at Lisbon in 1930. Long before that meeting, it was made evident that this measure would not satisfy everybody. It was, therefore, decided at the meeting to appoint a small committee consisting of nine members, to consider and report to an adjourned meeting in Paris in September 1931 on the future relations of the old Congrès and the Institut. This report will be presented on Sept. 20 next, the day on which the recently announced Congress in connexion with the Colonial Exhibition will open. In that report, a majority of the surviving members will recommend that the Congrès International d'Anthropologie et Archéologie Préhistoriques should be resuscitated, but entirely apart from the Institut and as a free and independent, migratory body, functioning "selon ses anciens statuts". The terms of the report have been known for some time; but the Institut shows no sign that it will acquiesce.

In the meantime, the informal conference of representative archæologists of various nationalities, summoned on the personal invitation of Dr. Bosch-Gimpera, of Barcelona, has met at Bern. This conference, it will be remembered, follows up a movement initiated at the International Archæological Congress held at Barcelona in 1929. It met on May 28 last. The British archæologists present, Prof. J. L. Myres and Prof. V. Gordon Childe, were charged with messages from the Royal Anthropological Institute and its Joint Committee for Research and Teaching urging the re-establishment of the old Congrès and pressing for a wide general scope in future congresses.

The significance of the latter recommendation lies in the fact that there is a strong and growing body of opinion on the Continent in favour of broadening, and at the same time defining, the archæological side of the future congress, so as to take in the whole group of related studies bearing on the problems comprised in what is now known as prehistory, while limiting its scope in other branches of anthropology to their bearing upon prehistory. As there is no congress in existence which covers anthropological studies broadly, the Royal Anthropological Institute naturally desired that advantage be taken of the opportunity to bring together students in all branches of the subject.

A report of the proceedings at Bern on May 28, by Prof. J. L. Myres, appears in *Man* for July. Although the invitations were issued to archæologists individually, the meeting may be regarded as fairly representative from the point of view of nationality. Archæologists from fourteen European countries were present. The conference sat under the chairmanship of Dr. Bosch-Gimpera.

It is clear from Prof. Myres's report that, although alternative proposals were carefully considered, there was an overwhelming majority in favour of following a certain course. A strong preference was shown for a specifically prehistoric congress rather than any general combination of prehistory with anthropology or ethnology. It is clear also that there was a very strong desire for a quite fresh congress without any connexion with previous organisations. The suggestion of the Royal Anthropological Institute that the old Congrès should be revived as an independent body was put to the vote; but the resolution found three supporters only. Thereupon, on the motion of M. Lantier, of the Musée des Antiquités Nationales, St. Germain-en-Laye, it was unanimously resolved to establish a new Congrès International des Sciences Préhistoriques et Protohistoriques. This congress will include all the studies which contribute to prehistory—geology, palæontology of animals and plants, anthropology, ethnology, folk-lore, archæology, etc., in their application to prehistory and protohistory.

Statutes for the new congress were drafted and adopted on the spot. On general lines they resemble those of the old Congrès. It will meet once in every four years, and each meeting, before adjourning, will fix the date and place of the next meeting and elect a president and general secretaries for that occasion. In certain respects the new organisation differs from the old. The following provision, which will give a certain permanence and stability lacking in the older organisation, is especially worthy of note:—The congress will be managed by a permanent council consisting of one or two members for each country, chosen in the first instance by the Bern meeting. These may be assisted by one or two secretaries. Vacancies hereafter will be filled by the congress on the nomination of the council. In any country which invites the congress, these members, with their secretary or secretaries, will act as the nucleus of the organising local committee, this local executive being confirmed and completed by the congress when it meets. Obviously this organisation opens up unlimited possibilities in the way of securing agreement and continuity in an international policy in archæology. Sir Charles Peers and Prof. Myres have been appointed members of the council for Great Britain, with Prof. Gordon Childe and Mr. C. F. Hawkes, of the British Museum, as secretaries. Finally, to ensure continuity with the old Congrès, surviving members of its permanent council have been invited to act as an honorary committee with other distinguished persons and, eventually, all retired members of the permanent council.

The British representatives had been authorised by the Society of Antiquaries of London and the Royal Anthropological Institute, in the event of it being decided to resuscitate the Congrès International d'Anthropologie et Archéologie Préhistoriques, to proffer an invitation for the congress to meet in London in 1932. In view of the event, this invitation could not be tendered. It has since been decided that the invitation should hold good, and the Royal Anthropological Institute and the Society of Antiquaries of London, with the support of the Joint Committee for Anthropological Research and Teaching, the Royal Archæological Institute and other learned societies, have invited the new congress to meet in London at the end of July 1932.

This cannot be regarded as the most happy ending of a protracted and tiresome series of negotiations extending over some years. The best that can be said for it is that the result, however deplorable, is inevitable. The French Institut has shown itself unwilling, or as it declares, unable under French law, to enlarge its management so as to become truly international. Nor has it shown itself ready to offer as a solution a dignified withdrawal from an impossible situation by a voluntary surrender of control of the congress and co-operation with others in reviving the old Congrès as an entirely independent organisation. The situation now created cannot endure; but, as a result, prehistorians must, for a time at any rate, submit to the imposition of two congresses, with the resulting dissipation of energy and division of interests. On the other hand, as general anthropology and ethnology are left without a congress of their own to cover the rest of these subjects on inclusive lines, the suggestion of another independent organisation has been favourably received—a further burden on an already overburdened world.

Agriculture and Physics.

The Physical Properties of the Soil. By Dr. Bernard A. Keen. (The Rothamsted Monographs on Agricultural Science.) Pp. vii + 380 + 2 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 21*s.* net.

STOKES'S paper on the theories of the internal friction of fluids in motion was published in 1845, and in it he discussed the motion of a sphere falling through a viscous liquid and arrived at a well-known equation. That result has become the basis of important experimental results in widely differing branches of physics: for example, in Wilson's cloud expansion apparatus for the determination of the electronic charge or in Millikan's researches in the same subject, or again as a viscometer, while towards the end of the last century it was applied to estimate the size of the particles in a sample of soil. How this is done is explained in detail in the earlier pages of the book under review, and the account is both interesting and instructive.

The physics of the soil is a comparatively new subject, complex to an alarming extent, and yet, as the book shows, of great importance. Results of marked value have already been reached by workers in the field, who, had they done nothing else, and this is far from being the case, have deserved our gratitude by directing attention to the complex nature of the subject and the field it opens for fruitful investigation. As a simple example of this complexity, take the effect of water on the heat conductivity of soil.

The conductivity of dry soil is about one-third to one-half that of water; hence the addition of water should increase its value. This was found to be the case, but as the soil is moistened its conductivity rises much beyond that of water. As the amount of water is increased, the conductivity falls again to about that of water.

The soil is composed of grains of material which in a solid form have a conductivity much in excess of that of water. When water is added to the dry grains of sand, it fills the narrow interstices and by its surface tension draws the grains closer together, increasing the area of contact of grain to grain, and where they are not in contact, replacing air by water. Thus in the damp mass there is a substance more nearly representing the solid form of the material, with a conductivity above that of water. As the water content is increased, the grains move apart; the water becomes the medium through which the heat passes. The apparent paradox is solved by an elementary application of physical principles. And so it is with a number of other more complicated problems. The book gives an admirable account of the application of physics to many of very real importance to the agriculturist and indicates one direction in which science can aid agriculture; a few examples may be given.

Soil differs from one part of the country to another and on the nature of its constituents depends its fertility; the grains of which it is composed vary in size, and a first step in the examination of any soil is its mechanical analysis, the determination of the sizes of the particles of which it is composed, for on these its characteristics largely depend. This analysis aims at dividing the soil into a series of groups of particles, each within some prearranged limits of size, and determining, by weighing, the percentage weight of each group. It is here that Stokes's law comes in; separation by sieves is possible when dealing with the larger particles, but the smaller grains are far too small for this. After the largest particles are removed, the remainder is mixed with water and allowed to settle; the larger particles fall more quickly; after settling for a specified time—the time in which a sphere of a given radius r_1 takes to fall from the top to the bottom of the beaker of liquid—the turbid liquid is poured off; it contains no particle of larger radius than r_1; the sediment is treated in a similar way, and thus, by varying the height and time of settling, the soil is divided into as many fractions as are required. Each of these is then weighed.

This is a long and tedious process; the result is best represented by drawing a summation curve, in which the abscissæ represent the radius of the particles, and the ordinates the percentage of particles having a radius equal to or less than the corresponding abscissa.*

Now this percentage can be obtained more rapidly by mixing the soil and water as above, allowing it to settle for a specified time t, taking a sample of known volume of the liquid mixture at a depth x, and determining the weight of its solid contents as a percentage of the whole weight. For at the time t, all the particles at a less distance from the top than x which have a velocity as great or greater than x/t, will have passed below the level at which the sample is taken; it will contain no particles of a size greater than that corresponding to this velocity, while smaller particles will be distributed in the same proportion as in the soil originally. A series of such samples enables a complete mechanical analysis to be made. The book gives a detailed account of the method, with a discussion of the errors to which it is liable, and the accuracy attainable.

Or to take another illustration: the motion of water in the soil is clearly of the utmost importance to plant life. What are the laws which regulate this? And what knowledge can physics give of these laws?

In the first attempts to answer this question the soil was treated as a bundle of capillary tubes in which the water rose and fell in accordance with the pressure changes and the ordinary laws of surface tension; another attempt was based on the supposed analogy between the flow of water in a porous space and the conduction of heat or electricity. Briggs in 1897 abandoned the capillary tube hypothesis, and, taking the porous space as an assemblage of cellular spaces, worked out the moisture distribution on the principle that the surface energy of the films distributed over the particles of soil tends to become a minimum. It was not realised until later that the shape and volume of the spaces between the grains rather than the surfaces of the grains themselves were the essential factors of the problem, and a chapter in the book gives a most interesting account of Haines's work at Rothamsted, both theoretical and experimental. He deals, as had been done earlier by Schlicter, with an ideal soil, a large number of small equal spheres, examining the shape and volume of the interstitial spaces which correspond to different modes of packing, and the air and water distribution within this cellular structure for different moisture contents. At first the water is distributed in discrete rings round each point of contact—this was called by Versluys the pendular stage; later the rings come into contact; the water is continuous throughout the volume but air still occupies some of the spaces; finally the air is entirely expelled, the spaces are filled with water, and the capillary stage begins. Experiments by Haines and others have verified this in a remarkable way, and while, of course, soil is not the ideal medium of the theory, there is no doubt that it does represent the processes actually in operation.

Or again, a primary object in cultivation is to secure a good tilth, and for this purpose the soil is broken up into finely divided particles by various implements, of which the plough is the most important. This leads naturally to the question: What are the forces required for disintegration and how does the soil respond to the action of these forces? A further question, discussed later, is: What should be the form of plough which will disintegrate the soil most satisfactorily? Now the finer particles of soil are mostly clay, and clay when wetted forms a plastic mass. Thus we have a discussion of the motion and changes of shape of a plastic mass under pressure and the modifications in Poiseuille's equation for the motion of a viscous liquid to fit it to represent the motion of a cylinder of plastic material forced along a tube. Four stages are recognised: at first there is no motion, as the pressure increases the paste moves forward as a rigid plug, then we find a central portion moving as a rigid body surrounded by a cylindrical shell in stream-line motion, and finally the composite motion is replaced by stream-line throughout. From this we pass on to the behaviour of these fine clay particles as the moisture content of the soil is increased, the properties of soil and clay suspensions, leading to problems of colloid physics; to the agriculturist the properties of clay particles of most interest are those concerned in the coagulation of a suspension, because the surface forces concerned in this probably operate in field conditions in connexion with the formation of compound particles, and thus we find in the book much valuable information as to theories of the mechanism of coagulation.

A most interesting chapter discusses the physical properties of soil under cultivation, and the application to practice of some of the principles considered in previous pages.

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* The abscissa might be the velocity acquired by a particle of radius r in falling, or the logarithm of either of these quantities.

An important question for the farmer is what power does he require to plough a field, and the ingenious dynamometer designed for this purpose is fully described. But experiments at Rothamsted in this connexion have led to one or two important results. A whole field may to the eye or to any other cursory examination appear of uniform character; a dynamometer test may, however, show over its surface marked variation in its resistance to the plough: the dynamometer records for various plots of a field of six acres selected for its apparently uniform character indicated variation on the dynamometer scale between 1150 and 1500, and these variations remain over a number of years.

Or again, what should be the form of ploughshare which will do its work with a minimum expenditure of energy? This has been discussed by W. R. Bousfield, among others, in a paper which was read before the Institution of Mechanical Engineers in 1880. One of the earliest to solve the problem was Thos. Jefferson, the third president of the United States.

Consider a plough cutting a furrow in a field in which the unploughed portion lies to the left of the ploughman. His object is to cut a continuous rectangular sod or ribbon from the ground and turn it over so that it may lie with the side uppermost which was originally below and at some suitable angle against the ridge of the furrow on his right. The working surfaces of the plough consist of the coulter and the ploughshare; the former of these is a vertical knife which cuts the left edge of the sod, the front edge of the ploughshare is a horizontal knife at the same depth as the bottom of the coulter; this cuts the under surface of the sod; as the plough proceeds, the sod thus produced moves up the mould board, the continuation of the ploughshare which is formed so as to rotate it, at first about its bottom right-hand corner until it has turned through 90°, and then about the point which was the top right-hand corner but has now become the bottom until, after turning through a further 40° or so, the sod passes off the end of the mould board and comes to rest against the preceding ridge.

From considerations such as these Bousfield developed the fundamental form of the mould board and discussed modifications required by practice.

In the United States, White found that the standard form of mould board used was either a portion of a hyperboloid of one sheet, or was composed of portions of two such surfaces.

Concluding chapters of this most interesting book, covering the history of the subject from ancient days to the present time, deal with meteorological questions, the temperature of the soil and the conduction of heat, the atmosphere of the soil, and the gases it contains; according to figures obtained in Sweden, there is, at a temperature of 15° C., an estimated production of from 7·5 to 10 litres of carbon dioxide per square metre per day.

Dr. Keen is to be congratulated on having written a book of very real value; few persons have any idea either of what has been achieved by the labours of a few interested workers with a knowledge of physics and the conviction that by careful application that knowledge could be used to solve some of the difficulties of the farmer, or of the opportunities which remain—and they are many—to gain from a study of the physical properties of the soil new knowledge which may help man in his struggle to make two blades of grass grow where there was one before.

R. T. G.

Vocational Guidance.

Methods of Choosing a Career: a Description of an Experiment in Vocational Guidance conducted on Twelve Hundred London Elementary School Children. By F. M. Earle, and other members of the staff of the National Institute of Industrial Psychology. Edited with a Preface by Charles S. Myers. Pp. 334. (London: Chapman and Hall, Ltd., 1931.) 12*s.* 6*d.* net.

THE volume just issued by the National Institute of Industrial Psychology provides an account of the most extensive investigation carried out hitherto in the field of vocational guidance. Nearly ten years ago the Institute, in collaboration with the Industrial Health Research Board, carried out a preliminary research on a limited scale—the first of its kind in Great Britain. The experiment was too small to be conclusive, and was intended only as a preparatory trial. The data, however, were sufficient to indicate that the methods proposed were feasible and that the results were likely to be of value both theoretically and practically. As a consequence, with the generous aid of the Carnegie United Kingdom Trust, the Institute undertook a large co-operative inquiry in a number of elementary schools under the London County Council. Six hundred boys and girls were examined by a small band of psychologists. On the basis of the results, advice was given to each of the children, indicating what kind of employment was most suited to their capacities; and their subsequent history was closely traced during a period of three or four years. Another 600 were taken as a control group. These were left to seek employment in the usual way, but were carefully followed up like the others. The primary object of the experiment was to compare the after-careers in the two cases.

The first section of the book describes in detail the procedure adopted. In their final form, the psychological methods employed show a great advance on those usually followed in making a vocational study of an individual child. The inquiries into home circumstances, physical condition, mental state (including intelligence, temperament, character, and predominating interests) are all fully discussed. Occupations and trade processes are classified; and the psychological requirements of each are analysed in detail. Together with the sample tests and record-forms printed in the appendix, the whole review furnishes a workable and scientific scheme of case-study.

The second section of the book describes the inquiry into the after-careers, and draws a detailed statistical comparison between the control group and the experimental group. Here the outstanding difficulty was the extreme complexity of the general problem. So many factors influence a child's actual choice of employment, so many conditions affect his subsequent industrial success, that it might seem at first sight an impossible task to compare two groups in this way. The analysis of the data, however, is masterly; and the final results form a striking confirmation of the value of scientific guidance. Where the boys and girls examined have been able to find occupations either identical with or similar to those originally recommended, there, it appears, they tend to keep their posts longer, their work more frequently gives satisfaction to those who employ them, and they themselves are more contented with their own situation and prospects. To some extent this happens even when the recommendations are based on the rough and ready procedure of the ordinary school conference. But the tabulated figures leave little doubt that when the advice is reached by a searching, scientific study of the needs of the individual child, then the results are far more satisfactory.

It is a high testimony to the Institute's team of investigators, and above all to Mr. Earle, who, as former head of its vocational section, has been mainly responsible for the work, that such an elaborate piece of co-operate research should be brought to so successful a termination. Dr. C. S. Myers, who, as head of the Institute, planned the general lines of the investigation and made the initial arrangements, contributes a preface and a lucid summary of the whole experiment. He puts the final conclusion in these terms: " despite unexpected difficulties, the experiment here under review does demonstrate the ability to predict vocational success in school children ".

The volume itself ends with brief practical suggestions on the organisation of vocational guidance in schools. As Viscount D'Abernon remarks in his foreword, " the day cannot be far distant when in every type of school some such scheme as that adumbrated by the writers will be established, to the lasting benefit of the individual and of the community ". For all such attempts at vocational guidance in the near future, the work carried out by Mr. Earle and his colleagues will form an invaluable model and guide.

German Glaciation.

Das Eiszeitalter: Grundlinien einer Geologie des Diluviums. Von Dr. Paul Woldstedt. Pp. xv + 406. (Stuttgart: Ferdinand Enke, 1929.) 29 gold marks.

DR. PAUL WOHLSTEDT of the Prussian Geological Survey is one of the leading authorities on German glacial geology, and in this concisely written volume he has compressed an account of the nature of glacial evidence and processes, a description of the glacial deposits in various countries, an account of the human remains associated with the glacial drifts, a discussion of the cause of former glaciations, and a long bibliography.

In his preliminary account of glacial phenomena Dr. Wohlstedt describes the various drifts and structures. Regarding the kar or corrie he gives no positive opinion as to its formation, but attributes it mainly to the action of frost. He distinguishes moraines from pseudo-moraines. Kames and osar he regards as both aqueous deposits, osar as banks laid down in narrow channels in the ice, and kames as broader sheets formed by the water that has spread over the country outside the ice. He does not mention the later British literature on these formations. He refers to the varied opinions as to the nature of drumlins, and quotes Fairchild's conclusion that they are due to the combined influence of ice, of the nature of the drift, of the local topography, and of weathering. Dr. Wohlstedt gives an excellent account of stone-polygons illustrated by those of Spitsbergen. He belongs to the school that attributes to glaciers enormous powers of excavation and regards them as the cause of fiords, which he limits to glaciated coasts. He recognises the similarity of some mountain lakes to them, and calls the Walensee a typical fiord. In the chapter on fossil man he remarks that the age of the Taungs skull is uncertain.

The most valuable section of the book is the account of the north German glacial deposits, and its digest of the extensive literature upon them will be especially useful to students in other countries. The author describes the successive concentric ridges of glacial drifts formed along the edge of the Baltic ice in its successive invasions of the north German plain. Some of those ridges are not what would be expected from their identification as moraines. Some of them are unquestionably morainic and consist of typical morainic drift; but others are wide sheets of sand, with complex false bedding, no glaciated pebbles or boulders; but hundreds of stones that have been sand-cut into dreikanters. These deposits, as near Salzwedel, show none of the ordinary evidence of glacial action, and, though they are included on the small-scale maps in the moraines, they are recognised as beds of sand deposited by streams and wind outside the ice sheet. They are fluvioglacial and subaerial sands.

The international correlation of the drifts adopted by Dr. Wohlstedt is based on the German succession. He adopts four glaciations, with perhaps an earlier one of which the evidence is indefinite and is represented in England by the 'Weiburn' Crag. He correlates the four with the Penck-Bruckner Alpine series. His classification is perhaps forced and artificial. It assigns the main British glaciation to the Riss, with the Mindel doubtfully separated from it, and represented by the Norfolk Arctic Bed. The section on the British glacial deposits is probably the poorest in the book. The evidence is mainly collected from the compilations and not from the primary memoirs. The bibliography does not mention Goodchild, Carvell Lewis, J. Smith, Bailey, or Boswell. The chapters on the glaciation of Scandinavia and Finland and of North America are valuable summaries of the evidence for those countries; some other parts of the world receive brief notice.

The author's adoption of a fourfold correlation of the drifts in America and Europe forces him to attribute glaciations to a world-wide extra-terrestrial cause, which he connects with some variation in the sun. But he recognises that solar changes do not alone explain the facts: he considers that glaciations are due to a combination of variable factors, and that, though the initial cause may be astronomical, they are the product of a complex cycle of meteorological influences. He discusses the wandering of the poles and Koppen's conclusion that during the Pleistocene glaciation the north pole was in Greenland; he rejects that view from the evidence of the extensions of the glaciers in South America, which he regards as proving that the poles were at the time in their present positions. He concludes that the problem of former glaciations is still unsolved.

Short Reviews.

Problems and Methods of Research in Protozoölogy. Contributors: Justin Andrews, M. A. Barber, H. P. Barret, E. R. Becker, G. H. Boyd, Chas. F. Craig, Frank G. Haughwout, Robert Hegner, M. J. Hogue, Francis O. Holmes, T. S. Hsiung, John F. Kessel, Harold Kirby, Jr., Charles A. Kofoid, W. H. W. Komp, R. R. Kudo, M. S. MacDougall, Reginald D. Manwell, Maynard M. Metcalf, Herbert Ratcliffe, Lowell J. Reed, C. W. Rees, Bruce D. Reynolds, Nannie M. Smith, Lucy G. Taliaferro, W. H. Taliaferro, D. H. Wenrich. Edited by Prof. Robert Hegner and Justin Andrews. Pp. ix + 532. (New York: The Macmillan Co., 1930.) 21*s.* net.

THIS volume, to which twenty-seven American workers in protozoology contribute, was designed with the laudable objects of familiarising both students and specialists with recent developments in various fields of protozoological research and of propounding fresh problems and new methods of attack. It consists of 42 chapters, of which 14 are written by the joint editors, Profs. Hegner and Andrews, of the department of protozoology at Johns Hopkins University. They cover a wide range of subjects, and are obviously written not so much to display accepted facts as to stimulate speculative interest in the economics of protozoa and their host-parasite relationships. We have, for example, chapters on the protozoa of termites that apparently assist their hosts to digest a diet of cellulose, on methods of cultivating *Amœbæ* and flagellates, on the flagellates of the latex in Euphorbiaceæ and their insect vectors, on the development of serological methods for diagnosis and classification, and on recent advances in the study of malaria in man and birds, the latter now being freely used as test objects for chemotherapeutic experiment. Throughout the work attention is directed to lines of work that might yield results of interest. The chapter on experimental malaria in birds, for example, ends with a tabulated list of no fewer than 76 questions to which investigators are invited to apply their minds.

A bibliography of text-books and monographs on protozoology, a list of journals in which papers on protozoology appear, and a list of some 800 references to original literature conclude the volume.

Elektroneninterferenzen. Herausgegeben von Prof. Dr. P. Debye. (Leipziger Vorträge, 1930.) Pp. vii + 85. (Leipzig: S. Hirzel, 1930.) 6 gold marks.

This important little book consists of seven lectures delivered at Leipzig during the summer of 1930. The first, by E. Rupp, treats of the internal potential and electrical conductivity of crystals, as manifested in the reflection of slow electrons from metallic and non-metallic crystals in such experiments as those of Davisson and Germer, Farnsworth and Rupp himself. The second lecture, by R. Wierl, describes experiments by himself and H. Mark on interference rings obtained by passing hard cathode rays through vapours like carbon tetrachloride, cyclopentane, and benzene. The third lecture, by H. Mark, discusses these experiments in the light of de Broglie's wave mechanics and Bethe's dispersion theory of electron diffraction. This is followed by a very brief discourse by N. F. Mott on the atom form-factor.

The latter half of the book is devoted to electrons in metals, and begins with a lecture by E. Grüneisen on the relation between the electrical and thermal resistances of metals and the temperature, in which he discusses recent experimental results in the light of the theories of F. Bloch and R. Peierls. The sixth lecture, by F. Bloch, deals with the interaction between the electrons in a metal, and the last, by R. Peierls, with the behaviour of metallic conductors in strong magnetic fields.

The book will no doubt prove very useful to students desiring an authoritative summary of recent experimental and theoretical researches in the fields of electron diffraction and metallic conduction, as well as to research workers seeking material for further investigations.

The Properties of Matter. By W. H. Spikes. Pp. vii + 152. (London: Sidgwick and Jackson, Ltd., 1930.) 4*s*.

Among the multiplicity of physics text-books to meet all types of students and all standards of examinations, there is little which falls under the heading of 'Properties of Matter', other than those of a fairly detailed or advanced type. In the past, a fair part of the subject matter has unfortunately fallen largely between the secondary school and the university. A work which aims at presenting a short and concise course is therefore to be welcomed, and the little book under review is stated by its author to have been drawn up to meet the needs of sixth forms in secondary schools.

A treatment under the conventional headings, in the space of some 140 pages of fairly large type, has necessarily involved considerable condensation, but the author's object appears to have been satisfactorily carried out. Emphasis is laid on the historical development, and the exposition is clear and attractive. A minimum of the simplest calculus is employed. The addition of a short section on dimensions of quantities and its illustration in the results deduced would seem desirable. On page 15, the invention of the astronomical telescope is incorrectly attributed to Kepler. A selection of test questions is appended. N. M. Bligh.

Le littoral du nord de la France et son évolution morphologique, suivi d'un appendice ; L'Évolution du rivage du nord de la France et l'activité de l'homme. Par Abel Briquet. Pp. v + 439 + 45. (Paris: Armand Colin, 1930.) 60 francs.

In making a detailed study of the changes in the coastline of Picardy and Flanders, the author has produced a valuable study in physical geography. His region extends from about the estuary of the Somme to Flanders, and so includes two areas of coastal plain and the intermediate high coastline around Calais and Boulogne. The study is very detailed, and discusses at length the processes involved, and thus may be used to throw light on coastal changes in general. Particular attention is paid to the evolution of the estuaries, the formation of dunes, and the evolution of the drainage of the plains. An appendix discusses the problems of human settlement in relation to the physical geography, and brings together various considerations that have been mentioned in the main part of the book. There are many sketch maps and diagrams.

The Works of Aristotle. Translated into English. *Physica.* By R. P. Hardie and R. K. Gaye. Pp. viii + 260. (Oxford: Clarendon Press; London: Oxford University Press, 1930.) 10*s*. 6*d*. net.

The publication of Aristotle's "Physica" is an important addition to this standard translation of his works into English. The book should be popular with men of science and philosophers alike, in so far as it refers particularly to fundamental doctrines concerning motion, space, time, and the different types of cause studied by the physicist. Aristotle's views on these topics are too well-known to be restated here. A careful study of his "Physica" would show, however, that the philosopher of Stagyra has a great deal to say with important bearings on our modified physical concepts. The translation itself, edited by Prof. Ross, satisfies the needs of real scholarship. T. G.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 331. Abt. 9: *Methoden der Erforschung der Leistungen des tierischen Organismus,* Teil 4, Heft 4 (Schluss). *Methoden und Technik der vergleichenden Stoffwechselphysiologie bei Wirbellosen.* Von H. P. Wolvekamp. Pp. 439-524 + xiv. (Berlin und Wien: Urban und Schwarzenberg, 1930.) 5.50 gold marks.

This small section of Abderhalden's great undertaking deals with the very specialised methods adopted in research into the metabolism of invertebrates. It is of especial interest to zoologists engaged in laboratory work, more particularly since the author has brought his account thoroughly up to date.

Influence of Modern Hydro-Electric Power Development on the British Coal Trade.

By Dr. BRYSSON CUNNINGHAM.

THE striking, and even astonishing, development during recent years of sources of hydraulic power for the generation of electricity, gives rise to a pertinent and interesting inquiry as to the influence this widespread creation of hydro-electric energy is having, and is likely to have, upon the output and use of coal for power production. It is a question of not inconsiderable importance to Great Britain, since exportations of coal represent a very remunerative source of revenue to colliery proprietors and shipowners, while to the country as a whole, coal, as one of its most abundant and valuable mineral deposits, is a factor of the highest importance in its industrial activities.

As regards the internal economy of Great Britain, the available supplies of water power are of minor account: they are too insignificant to affect British coal consumption in any appreciable degree. It is in regard to countries abroad, Canada, Italy, Scandinavia, and Switzerland, for example, where extensive mountainous regions afford abundant scope for the realisation of hydraulic power, that the consideration chiefly applies, and Great Britain is concerned so far as their development affects the quantities of coal which are exported to customers abroad.

The fuel equivalent of one installed horse-power produced by water wheel, or turbine, has been computed by the Canadian Department of the Interior at 5½ tons of coal per annum. This figure is, of course, variable according to conditions of a widely differing character, and it involves several assumptions which are not of universal application, but it affords some idea of relative values and may conveniently and justifiably be used in general terms for a brief review of the subject. As a matter of fact, it is based on the average annual coal consumption per kilowatt-hour of all public utility power plants in the United States. This consumption has ranged, on a gradually decreasing scale, from 3 lb. of coal per kw.h. in 1920 to 1·69 lb. per kw.h. in 1929—the last-named figure being convertible into the 5½ tons of coal per annum adopted by the Canadian Government as its standard of comparison.

In the most recent report of the Dominion Water Power Bureau, dated Jan. 31, 1931, and reviewed in NATURE of April 18, it was pointed out that, on this basis, the then existing water power installation in Canada of 6,125,012 horse-power was capable of effecting a saving of nearly 33¾ million tons of coal per annum. With the marked economies which are continually being realised in coal consumption in fuel power stations, the equivalent unit value indicated in the preceding paragraph is falling, but the saving of nearly 34 million tons of coal annually is no over-statement at the present time and is believed to be a conservative estimate.

This is for Canada only. If thereto be added the corresponding figures for all other countries in which water power development is in active prosecution, the aggregate arrived at will be of considerable magnitude, and if, furthermore, there be taken into account the potential supplies as yet undeveloped, and, in most cases, greatly exceeding the capacity of the installations in actual operation, the grand total will be of dimensions which may well be described as colossal, and even startling. The United States Department of the Interior has recently issued a statistical statement, prepared by the Geological Survey, placing the world total of potential water horse-power at 447,000,000, of which slightly more than 10 per cent is, as yet, actually developed. This estimate is by no means excessive: it is probably too low from lack of sufficient data. Previous articles in NATURE have shown that there is more than forty million horse-power available in Canada and about twice as much in the United States[1], while several European countries have resources estimated at from five to ten million horse-power each.[2]

At first sight, it might appear that such enormous actual and potential savings in fuel consumption for power producing purposes are bound to affect the coal trade very adversely and to bring about a substantial reduction in British coal exports. Yet, strange to say, this is not the case so far, and on investigation it will be found that the matter is not quite so simple a sum in subtraction as it would appear to be.

The figures in the table on p. 398 show the coal consumption in, and British exports of coal to, five leading countries during the past four years, with corresponding pre-War figures for 1913. From this statement it can be seen that, on the whole, there is remarkably little change in the situation as regards solid fuel consumption. Within not undue limits, the consumption of coal in Switzerland, Norway, Sweden, and Canada has remained approximately uniform and fairly equal to that of nearly twenty years ago. Italy, the one exception, has actually increased its coal consumption.

This unlooked-for and apparently incongruous result can be explained on several grounds, not the least valid of which is that, by reason of the natural expansion of the world's industrial activities and the increase in the amenities of civilisation, there is a corresponding augmentation in the demand for power, which affords scope for supply from sources other than fuel without diminishing the demand for the latter. Omitting other considerations, the rate of hydro-electric development in countries of stationary fuel consumption should be a measure of the natural expansion of industry, but owing to economies effected in fuel utilisation and in manufacturing processes and output, this cannot be claimed as a rigorous standard.

In considering the quantities of fuel consumed, notice should not be omitted of the increasing use of oil and natural gas as substitutes for coal. As yet, however, the gross consumption of such alternatives for power-production purposes appears to be of insufficient proportions to affect the main trend of this inquiry. The Report of the Electricity Commissioners for the twelve months ended Mar. 31, 1930, shows that for a total of nearly twelve thousand million units of electricity generated at 568 stations in Great Britain, the quantity of fuel oil used was about 0·3 per cent of that of coal. In other countries the proportions will naturally vary according to circumstances. In the United States, for example, where supplies of oil are plentiful, the percentage of liquid fuel used for generating electricity in public utility power plants during 1929 was nearly ten times as great, that is about 3 per cent. These two representative cases show that the influence of oil fuel is at present reasonably negligible and does not call for further examination.

QUANTITIES OF COAL CONSUMED IN, AND EXPORTS OF BRITISH COAL TO, ITALY, SWITZERLAND, NORWAY, SWEDEN, AND CANADA.
(Metric Tons)

Year.	1913.	1927.	1928.	1929.	1930.
ITALY :					
Consumption . .	10,643,126†	12,884,712	11,650,456	13,267,652	14,300,627*
British Exports . .	9,804,737	6,903,188	6,730,499	7,210,694	7,284,405
SWITZERLAND :					
Consumption . .	1,969,454	1,982,467	1,908,154	2,065,597	1,985,868
British Exports . .	30,358	129,244	127,262	137,324	127,180
NORWAY :					
Consumption . .	2,276,808	2,240,979	2,122,559	2,434,757	2,274,514
British Exports . .	2,335,886	1,599,818	1,135,348	1,468,061	1,221,862
SWEDEN :					
Consumption . .	5,241,786	5,265,345	4,455,852	5,389,127	5,169,141*
British Exports . .	4,637,609	2,217,836	1,564,903	2,374,009	1,795,364
CANADA :					
Consumption‡ . .	26,789,734	28,794,988	27,723,969	28,401,960	25,802,449
British Exports . .	38,445	848,325	639,320	756,989	991,031

* Estimated. † Includes coke. ‡ Excluding lignite.

Looking now at the British exportations of coal, it can be seen that, notwithstanding the uniformity of coal consumption, these exports have increased in relation to Canada, but have decreased very materially in relation to Norway and Sweden and less heavily in relation to Italy. Here some discrimination of explanation is necessary.

The decrease in coal exports to the last-named three countries is attributable mainly to foreign competition; particularly, in regard to Scandinavia, on the part of Poland, where the costs of production are much less than those of British coalfields, and where the rail haulage rate to the Baltic ports of Danzig and Gdynia is comparatively very cheap and the port and loading charges are on a lower scale than at British ports.[3] As regards Italy, the most formidable competitor of Great Britain is Germany. Before the War, 90 per cent of the coal imported into Italy was British. The percentage has since fallen to 55, while, owing to heavy deliveries of reparation coal, Germany now sends more than four times her pre-War quantity, representing 31 per cent of the total Italian imports of coal to-day.

Excluding the strike year, 1926, the annual coal output of Great Britain has not varied to any serious extent during the last ten years. In 1922, according to the Board of Trade returns, it was 249,606,864 tons; in 1930 it was 247,235,300 tons. The highest year was 1923 with 276,000,560 tons and the lowest, 1928, with 237,471,931 tons. Exports have shown a rather wider range, reaching 79,459,469 tons in 1923 and falling to 50,055,118 tons in 1928, the quantities for most of the years in the period lying between 50 and 60 million tons.[4]

The figures do not prove very much, one way or another. If there has been no progressive or ultimate increase, there has also been no appreciable decline of extended duration. Indeed, it has to be admitted that it is not possible to draw conclusions of a positive character from the official returns, and pending further evidence, the influence of current hydro-electric developments on the British coal industry must remain something of the nature of an interesting and elusive speculation.

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[1] NATURE, April 18, 1931, and May 31, 1930.

[2] NATURE, Sept. 6, 1930, gives figures for Italy and Switzerland at about the lower limit; France and Norway reach the higher.

[3] Report of British Coal Delegation to Sweden, Norway, and Denmark. H.M. Stationery Office, October 1930.

[4] Board of Trade Annual Journal, and Chamber of Shipping Annual Report, 1930–31.

Periodic Physico-Chemical Phenomena.

By Dr. ERNEST S. HEDGES.

PERIODIC phenomena of all types have a peculiar fascination to the human mind, possibly because they suggest some of the processes of life. On the largest scale, mechanical periodicity is inherent in the movements of celestial bodies and of the earth, producing secondary periodicities, which we recognise as the yearly seasons, alternating day and night, the ebb and flow of the tides, and in other ways. These time-periodicities in their turn leave their mark on earthly structures which are in the course of formation, producing spatial periodicities, such as the annual rings in the trunks of trees, and probably the bands in many geological deposits. The seismologist and the meteorologist recognise periodicities in earthquakes, in thunderstorms and other climatic conditions, but periodicity is above all familiar to the biologist. To consider the processes of breathing and the heart-beat is sufficient to indicate the fundamental importance of periodic phenomena in biological systems, quite apart from the interest attached to structures having a spatial periodicity. In fact, periodicity both in space and in time has so come to be regarded as a characteristic of the biological sciences that when it is encountered in purely physical systems it almost constitutes a link between the two.

Although, during the last hundred years or so, periodic processes in physico-chemical systems have been reported from time to time, it is only during the last decade that a systematic study of this principle has been made.[1] The results have shown that both temporal and spatial periodicities are at least as frequently encountered in purely inorganic physico-chemical systems as in biological organisms. It is proposed to apply the term 'periodic structures' to banded and other structures showing a spatial periodicity, and to restrict the term 'periodic reactions' to chemical processes in which it can be shown that the reaction velocity varies periodically.

PERIODIC CHEMICAL REACTIONS.

It is not possible within the limits of a short article to review more than a few types of the periodic reactions which have been investigated. One of the most striking is the curious intermittent action of mercury on hydrogen peroxide, which has been the subject of a considerable amount of research by Bredig [2] and several later investigators. When clean mercury is brought into contact with a solution of hydrogen peroxide, the alkalinity of which has been adjusted within certain rather narrow limits, oxygen is evolved at the interface at regular intervals of about one minute, and during the intervals between the pulses of gas the mercury becomes covered with a film of oxide. The simultaneous periodic changes of surface tension are shown by the pulsation of the mercury surface, and anyone who performs the experiment cannot but be struck with the remarkable similarity to the heart-beat. Bredig remarked upon the enormous influence of traces of catalytically active materials on the mercury-hydrogen peroxide pulse, the fact that both in this system and in the cardiac rhythm the pulse is accompanied by electrical disturbances, and also that both the biological system and its inorganic model are characterised by an unusually high temperature coefficient. He also recognised that both phenomena might be conditioned by the periodic formation and rupture of an unstable film.

The dissolution of metals in aqueous solutions of electrolytes has proved a fruitful field for the examination of periodic reactions. At the beginning of the present century, Ostwald [3] described the periodic dissolution of chromium in dilute hydrochloric acid. Certain (irreproducible) specimens of chromium gave rise to a pulsating evolution of hydrogen. The investigation had eventually to be abandoned, but the phenomenon was traced to the presence of some unknown impurity in the metal.

Hedges and Myers [4] recorded automatically and continuously the rate at which hydrogen is evolved in numerous reactions of this type, and observed a periodic rate of dissolution of zinc, iron, aluminium, magnesium, manganese, and sodium in a number of reagents, including acids, alkalis, neutral salt solutions, water, and alcohols, showing that, given the right conditions, the phenomenon is a general one and is not a special property of chromium. The cause of these periodic phenomena has never been completely elucidated, and subsequent research has been directed to the study of the anodic dissolution of metals under the external application of an electric current, where the velocity of dissolution and other factors can be kept under control. The experiments rendered it quite clear, however, that the periods are obtained only in the presence of some foreign substance, which may be present in extremely small amount. In some cases it was evident that the glass reaction vessel was capable of furnishing the required trace of 'catalyst', whilst in others the addition of colloids in so small amount as one part in a million brought about periodicity. Periodic dissolution was also brought about by placing the dissolving metal in contact with a more noble metal, which had previously been 'activated' by heating in a vacuum, by cold-rolling, by bombardment with cathode rays, or by coating with metal by electro-deposition at high current densities. The behaviour of these metallic couples is closely in line with the periodic anodic phenomena described in the next section, and may conceivably be connected with the formation of oxide films. Colloids might act by stabilising such a film, or, since they are known to be strongly adsorbed at metallic surfaces, might form a film which is broken down periodically by the reacting solution.

Small quantities of catalyst poisons (formaldehyde, potassium cyanide, or sodium arsenite) decreased the frequency of the periods greatly, and larger amounts stopped the periods, whilst not appreciably affecting the normal reaction. The periodicity was destroyed by the addition of one part in a million of chloroplatinic acid. The minuteness of the quantities involved rendered the work difficult, but it is in itself characteristic of biological systems.

Lillie [5] has pointed out the analogy between the alternating activity and passivity of iron in 70 per cent nitric acid and the cardiac rhythm. A regular rhythm is obtained when one end of an iron wire is inserted a few millimetres inside a narrow glass tube, then immersing both in the acid. It appears that the rhythm is always associated with a small local region of the enclosed part, in which the reaction between the wire and the acid is continuous, and from this region waves of activation travel rapidly and periodically over the entire specimen. The enclosed region is therefore similar to the nodal or 'pace-making' region of the heart. The transmission of a wave of activation along a passive iron wire is the nearest analogy we have to transmission along a nerve, and in both instances there follows a temporary non-transmissive or refractory period. Lillie considers that the properties of surface films are involved in both cases. In the passive iron system the spread of the wave of activation is marked by the breakdown and subsequent reinstation of the protective oxide film, which is the cause of the passivity, and in biological systems surface films are believed to underlie the response of irritable tissues to irritation.

PERIODIC PHENOMENA IN ELECTROLYSIS.

Studies of periodic phenomena at electrodes during electrolysis have established the conditions for periodicity at anodes of copper and silver,[6] magnesium, zinc, cadmium, mercury, tin, lead, and an unattackable electrode,[7] iron, cobalt, nickel, and aluminium.[8] Reactions at the cathode [9] have also been studied, and several examples of the periodic electro-deposition of metals through secondary reaction have been observed.

This electrochemical periodicity is manifested by periodic changes of considerable magnitude in electrode potential and in current density, generally accompanied by visible periodic changes at the electrode, such as the intermittent evolution of gas or the formation of a film. The investigations have made it possible to formulate the conditions necessary to secure periodic effects at the anode :

(1) A film must form over the anode.

(2) The film must be soluble in the electrolyte when the circuit is broken. It follows that the electrode may exist in one of two possible states—with or without the film.

(3) The current density must be between two well-defined limits, which depend on the temperature, concentration, and nature of the solution. Periodic phenomena can be realised by so arranging the current density that the electrode has almost equal chances of remaining in one state or passing into the other. The result is that the electrode oscillates continuously between the two states. The region over which this periodic effect can be observed is often very narrow, but is sometimes quite extensive.

In order further to elucidate the mechanism, experiments have been carried out using a rotating anode.[10] The system examined was the anodic dissolution of copper in hydrochloric acid, during which a visible film forms periodically over the anode. The principal results obtained were as follows : (1) At a rotating anode the frequency of the periods is independent of the current density over a wide range ; the frequency is not dependent, therefore, on the rate at which metal ions leave the electrode. (2) The 'characteristic frequency', which is independent of current density, increases linearly with the speed of rotation. Variation of the speed of rotation can produce two effects : (*a*) The anodic product is washed away more quickly ; (*b*) chlorine ions are supplied to the anode at a greater rate. If the frequency were determined by the first of these effects, it would no longer be independent of the current density ; consequently, it may be inferred that the frequency is controlled by the rate of supply of chlorine ions to the anode. (3) The conclusion is supported by the fact that at constant speed of rotation the frequency is directly proportional to the concentration of hydrochloric acid.

The experiments showing that the frequency depends entirely on the rate of accumulation of chlorine ions appear to leave no escape from the conclusion that dissolution of the film does not occur until a certain critical concentration is reached, but that when reaction occurs in each 'pulse' it is complete. This is analogous to the 'all-or-nothing' law so familiar in physiology, according to which a system does not respond to a stimulus until this reaches a threshold value, but the response is complete when that value is reached.

Physiologists explain the periodicity of breathing in a similar way ; respiration occurs every time the carbon dioxide content (hydrogen-ion concentration) of the blood reaches a threshold value.

Experiments on the periodic electro-deposition of metals through secondary reaction afford strong support for the critical concentration view, and are difficult to explain in any other way. For example, in the electrolysis of potassium mercuricyanide solutions, under certain conditions the potassium liberated at the mercury cathode reacts alternately with water molecules and with the complex $Hg(CN)_4''$ ions or undissociated salt, the final effect being a periodic evolution of hydrogen alternating with deposition of mercury. The supposition here is that reaction of potassium with the complex ions does not take place until the ions reach a certain critical concentration by diffusion, and in the meantime reaction with water molecules occurs. The mechanism is similar in outline to the older idea that the heart-beat is caused by alternate reaction with or adsorption of calcium and potassium ions, although that view does not appear to be greatly favoured by present-day physiologists. It may also be pointed out that in colloid systems critical concentrations of ions are required for coagulation, and such systems appear to be particularly favourable for periodic phenomena.

Independent evidence of the existence of such critical concentrations has been obtained by the progressive addition of hydrochloric acid to copper rendered passive by anodic polarisation in hydrochloric acid, and to iron rendered passive by concentrated nitric acid.

PERIODIC STRUCTURES.

The study of periodic structures dates from 1896, when Liesegang [11] made the original observation that silver chromate is precipitated in the form of concentric rings when a concentrated solution of silver nitrate is allowed to diffuse into a gelatin gel containing dilute potassium chromate. Although numerous explanations have been advanced since that time, and in spite of the vast amount of experimental work which has been performed, it cannot be said that the phenomenon is completely understood. The principal fact which emerges from the work of the past thirty years is that periodic precipitation is a very general phenomenon, and it is probable that, given the proper conditions, periodic structures can be obtained from any pair of salts which interact to give a precipitate.

Natural periodic structures resembling the Liesegang phenomenon in appearance are frequently encountered in both geology and biology, but whilst there is evidence to show that banded geological specimens, such as agates, can be traced to the diffusion of salts in silicic acid and other gels, and can thus be correlated with the formation of artificial periodic structures, it is not always safe to apply these principles to the biological specimens. This is partly because of the number of external periodic conditions which might account for their formation, such as alternating day and night, winter and summer, sleep and activity, and intermittent feeding. Typical examples are the form of starch grains and such layered concretions as gall-stones and urinary calculi. Attempts have also been made to apply the Liesegang principle to the markings on butterflies' wings and on the shells of certain molluscs.

Experiments by the author[12] have shown that the formation of periodic structures of this type can be separated into two stages: (*a*) chemical reaction without precipitation, and (*b*) precipitation by coagulation. The periodicity occurs in the second stage of the process. Similar periodic structures were obtained by the simple coagulation of colloidal solutions in gels and in glass capillary tubes. In some of the experiments in coagulation in capillary tubes the coagulum took the form of a spiral or uniplanar wavy fibre, showing an analogy with many natural colloidal fibres, such as wool. The formation of periodic structure was brought down to its simplest conditions, however, by causing concentrated hydrochloric acid to diffuse into glass capillary tubes containing sodium chloride solution, whereupon the sodium chloride was salted out in bands. The experiment eliminates both chemical reaction and colloidal phenomena, and is contrary to some of the best known theories of the formation of periodic structures.

It is concluded from this work that both in the formation of periodic structures and in the production of periodic reactions the essential condition for periodicity is the existence of some *critical condition* determining a change of state which proceeds to completion once the critical value is reached.

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[1] See Hedges and Myers, "The Problem of Physico-Chemical Periodicity", Arnold and Co, 1926.

[2] *Z. physikal. Chem.*, **42**, 601; 1903.

[3] *Ibid.*, **35**, 33, 204; 1900.

[4] Hedges and Myers, *op. cit.*, chap. iv.

[5] *Science*, **67**, 593; 1928.

[6] Hedges, *J.C.S*, 1533; 1926.

[7] Hedges, *ibid*, 2580, 1926.

[8] Hedges, *ibid.*, 2878; 1926.

[9] Hedges, *ibid.*, 1077; 1927.

[10] Hedges, *ibid.*, 1028; 1929.

[11] *Phot. Archiv.*, 221, 1892

[12] Hedges and Henley, *J.C.S*, 2714; 1928. Hedges, *ibid.*, 2779; 1929. *Rev. gén. Colloid.*, **8**, 193; 1930.

Obituary.

Prof. W. E. Dixon, O.B.E., F.R.S.

THE death of Prof W. E. Dixon at his home near Cambridge on Aug. 16 is a loss which scientific medicine in general and pharmacology in particular can ill afford to bear. He was one of the few pharmacologists in Great Britain, and under his guidance the Cambridge School of Pharmacology made considerable progress.

Walter Ernest Dixon was the son of Robert B. Dixon, of Darlington, where he was born in 1871. He was educated at Dulwich and St. Thomas's Hospital, London, and, after holding the posts of house physician and demonstrator of physiology, he was elected professor of pharmacology at King's College, London. He went to Cambridge in 1902 as assistant to the Downing professor of medicine; he was appointed University lecturer in pharmacology in 1909 and reader in this subject and assessor to the regius professor of physic ten years later. During the War, his special knowledge was placed at the disposal of his country, and for this he was created O.B.E.

Dixon's reputation as a pharmacologist was international, and he was consulted frequently by important bodies with regard to those subjects of which he possessed a peculiar and intimate knowledge. He had been a member of several Government committees, more recently those on ethyl-lead petrol and drug addiction. He was a member of the League of Nations committee on drugs of addiction, and only a few weeks before his death he visited Geneva in this connexion. In particular, the British Medical Association, the Pharmaceutical Society, and the Society of Apothecaries will deplore his passing, for he had played an important part in the work and administration of these bodies.

In his laboratory Dixon was indefatigable; he was responsible for the University teaching in pharmacology at Cambridge, while in addition to supervising research work, he himself performed a great number of experiments. His literary output was considerable; he once told the writer that he had contributed to every important British medical periodical except one. He had written upon a large number of pharmacological and physiological subjects, the most important, perhaps, being his work, in conjunction with the late T. G. Brodie, upon the nature of asthma. His book, "A Manual of Pharmacology", first published in 1907, is a standard work upon the subject, and many pages of the British Pharmaceutical Codex came from his pen. He was joint editor of the *Journal of Pharmacology and Experimental Therapeutics*, and, in addition, he was on the editorial committee of several other publications.

Many honours came Dixon's way. He was elected a fellow of the Royal Society in 1911 and a fellow of the Royal College of Physicians in 1930. During his visit to Canada last year, the University of Manitoba conferred upon him the degree of LL.D. He had been president of the Section of

Pharmacology and Therapeutics of the Royal Society of Medicine, and, in 1929, he was president of Section I (Physiology) at the Cape Town meeting of the British Association.

Dixon possessed the faculty of explaining the most difficult problem in the simplest possible way. He was a fluent and ready speaker, and was often requested to lecture upon both scientific and semi-popular subjects. His addresses upon "Tobacco" and the "Cocktail Habit" are examples of his powers in this direction.

It is impossible to enumerate all Dixon's interests and activities. He possessed a buoyant, kindly nature; he was always cheerful, always full of life and energy. He had a host of friends, and it has been remarked, with truth, that he never said an unkind word. The day before his death, he was, as usual, in his laboratory planning future work and apparently in normal health, while those with whom he was in daily contact little thought that this was the last occasion upon which they would enjoy his confidence. He died, as he would have wished, in harness; and pharmacology has sustained its greatest loss since the death of Schmiedeberg. F. B. P.

Prof. J. W. Hinchley.

John William Hinchley was born at Grantham in 1871, but at an early age was resident in Lincoln, and was a pupil at the Grammar School. He obtained valuable experience as an engineer with Ruston, Proctor and Co. and with the Reliance Ironworks at Lincoln. In 1893, Hinchley gained a National Scholarship and became a student at the Royal College of Science and Royal School of Mines, South Kensington. Here his career was brilliant, and he obtained a Whitworth Exhibition (1894) and later a Whitworth Scholarship (1896), but he did not avail himself of this. Whilst a student, those keen interests, which he maintained throughout his life, in all that would help his fellows were evidenced by his activities in the Students' Union, on the committee of the old students' rooms—indeed a dreary place compared with the premises of to-day—and the debating society.

Hinchley took a first class Associateship of the Royal School of Mines, and after a short time as junior demonstrator went to Dublin, where he was engaged under Prof. Joly in perfecting Joly's three-colour photographic process. Here Hinchley gained very valuable mechanical experience in working out the intricate details of ruling the colour screens used. Returning to London, he was for a time with the late Mr. Oscar Guttmann. This was followed by a residence of some years in Bangkok as technical head of the newly established Siamese Mint. This period abroad, in a climate which did not suit him, undermined his health for some time.

On his return to England, Hinchley took up consulting work, and about this time developed his ideas of the association of the chemist and engineer in the individual as a 'chemical engineer', an association which has been much criticised, but which has won through, thanks largely to Hinchley. He was mainly instrumental in the formation of the Chemical Engineering Group of the Society of Chemical Industry and was its first chairman, and also in the formation of the Institution of Chemical Engineers, from the inception of which he was honorary secretary. Hinchley first lectured at the Battersea Polytechnic and later at the Imperial College of Science and Technology, where he was appointed as the first professor of chemical engineering.

On his return to South Kensington, Hinchley at once threw himself into the social life of the College, and was particularly interested in the new Students' Union, with its many amenities. He also took a very active part in the affairs of the Old Students' Association.

Hinchley became a freemason whilst in Siam and took a great interest in masonry on his return. He was largely instrumental in the formation of the Imperial-College Lodge, of which he was a past-master, and took an active part in the formation of the Radium Lodge.

As a teacher of chemical engineering, Hinchley had exceptional qualifications by reason of his very practical engineering experience, combined with an extensive knowledge of chemistry and mathematics. Not only had he the requisite qualifications, but he also had the gift of getting the best out of his students. As Prof. H. E. Armstrong wrote in an appreciation in the *Times*, "he treated the subject with a common sense, a breadth of outlook, and in a practical way which made his pupils of altogether special value in industry".

All those who were privileged to know Hinchley intimately will always remember him as one whose greatest pleasure was to be doing something for others. It was the key-note of his life. Give him some project to organise which would be helpful to others and he never spared himself. His many friends were deeply distressed by the several weeks of suffering which he patiently endured before the end in the Freemasons' Hospital on August 13.

J. S. S. B.

Group-Capt. Martin Flack, C.B.E.

To Martin Flack, whose death at the age of forty-nine years occurred on Aug. 16, we are indebted for the clear setting out during the War of those principles which made high flying possible by the use of oxygen breathing apparatus, and for the tests which differentiated suitable from unsuitable candidates for flying. Moreover, he did excellent work in recommending the physical training required to make and keep those chosen for the air service in fit condition. In addition, at the time when cerebro-spinal fever caused great anxiety, he did first-class work in elucidating the means, by ventilation, spacing out beds, etc., of keeping down infection and for carrying out serum treatment.

Flack raised himself by his native genius and sterling character from the elementary school to the University of Oxford, and kept himself by scholarships up to the taking of his medical degrees. Then, beginning research with Sir Arthur Keith, he discovered anatomically the sinu-auricular node, and was first to prove by experiments on the living heart that this is the pace-maker of the heart—a most notable discovery. Next, working with me as demonstrator of physiology at the London Hospital Medical School, he proved himself to be a splendid teacher, and was enthusiastic in showing to his class experiments which the student usually has no opportunity of seeing, such as those fundamental ones by which Harvey proved the circulation of the blood.

Flack and I together carried out researches on the influence of breathing excess of carbon dioxide and deficiency of oxygen, and on the increased power to do work which the breathing of oxygen gave. We showed that runners, boxers, and swimmers were improved in performance by breathing oxygen.

This work enabled Flack, when the need suddenly arose, to design the means for overcoming the failure of war-pilots to fly at high altitudes. Oxygen breathing apparatus was supplied and perfected so that flying became possible at extreme heights. Flack tested himself in a chamber at a pressure equal to a height of well over 40,000 feet—a very courageous performance. He also contrived the tests for pilots who had crashed, which showed whether their nervous system had become stable or was still unfit for flying. One of these tests was the ability to hold the breath long and the effect of this on the blood pressure, another the power to raise a column of mercury 40 mm. high and hold it by the breath as long as possible. He was able to classify pilots as good or bad, without knowing their records for crashing, and his classification agreed with the records. By the tests which Flack introduced, the efficiency of the air service was very greatly increased, and for this Great Britain owes him a great debt of gratitude.

Flack was troubled by a rheumatic heart, but, in spite of this, was a most cheery, humorous, and energetic man, and no one could be a better colleague than he. His far too early death will be lamented by many friends, and by the Air Service in particular. LEONARD HILL.

MR. DAVID DAVIES.

BY the death, on Aug 15, of David Davies, of Gilfach Goch, Wales has lost one of her most industrious students, and the science of palæobotany an interesting personality.

Born near Merthyr Tydfil, sixty-one years ago, Davies began his working life as a 'door boy' in a local colliery, and as soon as he was old enough became a collier. He had a passion for knowledge, especially that relating to the rocks among which he worked, and took advantage of the evening class facilities then available in the Rhondda Valley, with the result that, after passing through the various grades of colliery official, he became, while still a comparatively young man, agent to the Britannic group of collieries of the Cambrian Combine.

The interest in fossil plants that, in his boyhood days, gained for him the nickname "Dafydd Ffossil", was maintained as he grew to manhood, and, encouraged by well-known palæobotanists, he began to collect systematically from each of the separate horizons at which fossil plants occurred in the eastern part of Glamorgan. His object was to record not merely the kinds of plants that were present, but also the associations of plants and the relative abundance of each species, genus, and class of plants, and thus to lay the foundations of an ecological study of the successive 'coal-forests' that occupied the site of the South Wales coalfield.

The results of Davies's work have been published in the *Quarterly Journal of the Geological Society*, the *Transactions of the Royal Society*, and other journals, and at the time of his death, which occurred suddenly while on holiday in Norway, he was nearing the completion of a series of parallel investigations in the more westerly regions of the coalfield. During the course of such intensive collecting, he got together a very large series of coal-measure fossils, the majority of which he presented to the National Museum of Wales for the use of future students: the remainder passed into the hands of the late Dr. Kidston, and are now in the collections of the Geological Survey.

It is a matter for regret that Davies did not live to complete the work upon which he had been engaged for nearly forty years, but his manuscripts have been so carefully arranged that the essential parts of his conclusions can still be published; and the 'David Davies' collection in the National Museum of Wales, probably the largest collection from any one coalfield in the world, is a permanent memorial to his industry and devotion to science. Some years ago his work was recognised by the University of Wales and the degree of M.Sc. conferred upon Davies, and he has served for a long period upon the Council and upon the Court of Governors of the National Museum of Wales.

David Davies did not allow his interest in science to interfere with the discharge of his official duties, and he had the satisfaction of seeing a colliery district that was threatening to become derelict when he assumed charge, in 1911, enter upon a new phase of activity, resulting in the growth of Gilfach Goch from a village of some two thousand inhabitants to a community five times as large.

F. J. N.

DR. W. E. DOWNEY.

BY the death of W. E. Downey, as a result of an accident on Aug. 19 while climbing the Jungfrau, the Research Laboratories of the G.E.C. lose a brilliant worker of outstanding promise; the staff of the Laboratories lose a colleague of unusually charming personality.

Downey entered the Wembley Laboratories five years ago, and his first task was the extremely difficult one of investigating the manufacture of carbon black, with a view to putting it on a more rational basis. To this he brought a combination of scientific ability and technical insight which enabled him to apply scientific principles, so far as that can be done, to what is inevitably a very empirical process. Later, he had an opportunity of applying the same qualities to other problems, and showed at once that real talent for industrial research which depends on an ability to inspire other and less experienced workers and also to collaborate with colleagues engaged in other branches of work.

Downey, who was only thirty-one years of age, was educated at Huddersfield College and the Imperial College of Science and Technology. At the latter he had a distinguished career, culminating in the award of a Beit fellowship. During this period he published some papers on chemiluminescent oxidations; his death, coming when it did, robbed him of an opportunity of producing further work of a more fundamental kind which he would undoubtedly have originated.

Mr. J. Adamson, honorary secretary of the Institute of Marine Engineers since its foundation in 1889, on August 20, aged eighty-one years.

Dr. G. Bryce, president of the Royal Society of Canada in 1909 and one of the founders of the University of Manitoba, where in 1891 he was appointed head of the Department of Science and lecturer in biology and geology, aged eighty-seven years.

Mr. C. R. Hewitt, librarian of the Wellcome Historical Library and formerly assistant librarian of the Royal Society of Medicine, on Aug. 15, aged sixty-one years.

Lieut.-Col. J. R. Lord, C.B.E., medical superintendent of the Horton (County of London) Mental Hospital, Epsom, who was past president of the Royal Medico-Psychological Association and editor of the *Journal of Mental Science*, on Aug. 10, aged fifty-seven years.

Sir Thomas Stanton, C.B.E., F.R.S., formerly superintendent of the Engineering Department of the National Physical Laboratory, on Aug. 30, aged sixty-five years.

Prof. Richard Wettstein, professor of botany and director of the botanical gardens in the University of Vienna, known for his work in systematic botany, aged sixty-eight years.

News and Views.

For several centuries quinine has held its place as a specific in the treatment of malaria, but although it controls the disease it does not have a permanent curative action. Within the last few years, a quinoline derivative called 'plasmoquine' has been introduced to therapeutics as a substitute for quinine: investigation of its action suggests, however, that its value is rather complementary to the latter. Quinine attacks the asexual stages of the malarial organisms, except the sporozoites, but has little action on the sexual stage: plasmoquinine attacks the gametocytes. In the prevention of malaria, attention has been directed chiefly to the prevention of breeding by the mosquitoes in which the sexual stages of the developmental cycle of the malarial organisms take place, and to the prophylactic administration of small doses of quinine. The prevalence of the disease in the countries where it is endemic bears witness to the difficulty of eradicating it, although thorough destruction of all breeding-places is effective. A simpler method, available where the latter is impracticable, would therefore be of very great value.

Col. S. P. James, W. D. Nicol, and P. G. Shute describe some recent experiments on the prevention of malarial infection in human beings by the ingestion of plasmoquine, in a recent issue of the *Lancet* (vol. 2, p. 341; 1931). Ten volunteers were infected by allowing half a dozen mosquitoes (*Anopheles maculipennis*), infected with the parasite of benign tertian malaria, to bite the forearm; 0·02 gm. plasmoquine was taken three times daily after food for six days, the first two doses being taken before infection. The controls were patients who were to undergo a course of malariotherapy. The result was that the controls developed their first febrile paroxysms about a fortnight after infection, whilst none of the volunteers showed at any time any sign of the disease for the next four weeks. Plasmoquine therefore prevents mosquito-borne infection in healthy individuals when given in prophylactic doses, presumably by completely destroying the sporozoites; quinine does not have this property. It appears probable that a valuable preventive agent is now available: the results of its trial in a population among which malaria is endemic will be awaited with interest.

It has become platitudinous to talk of the educational possibilities of broadcasting. Everyone knows that the possibilities are there; but how many realise the machinery which the British Broadcasting Corporation has assembled in order that those possibilities may be realised? That machinery, sensitive to new impulses, and subject always to any alterations which will bring better results, ought to be better known. Briefly, two councils are responsible for what are vaguely known as 'talks': the Central Council for Broadcast Adult Education and the Central Council for School Broadcasting. For our present purpose we refer only to the former, but each council is composed of every kind of educational interest, and is divided into committees to which special tasks are assigned. For example, the Programmes and Publications Sub-Committee meets very frequently and deals with the important, difficult, and delicate task of planning talks and securing speakers who are not only expert in their subjects but who can speak in language of common currency.

A new pamphlet, which may be obtained from the B.B.C., shows how all this work is being developed. It presents, under the title of "The Changing World", the plan of talks from September 1931 to March 1932. We would emphasise the word *plan*. 'Talks' have never been confined to mere haphazard observations on topical subjects, and the present programme shows a series planned in advance for a special purpose. They involve greater continuity between courses on given subjects, and unity of theme and treatment.

The general titles are significant: the modern dilemma, industry and trade, literature and art, science, the modern state, education and leisure. All the speakers will be attempting to answer certain questions: What have been the forces of change which have affected the present century? What has been the influence on social thought and circumstances? *What is the significance to the future of these changes, and what responsibility rests with us to remodel our ways of life?* We italicise the last question deliberately; for, if a series of talks can help us to give a scientific answer to them, the process of broadcasting will have shown its supreme educational value, in the fullest sense of the phrase.

RESOLUTIONS passed at the second International Discussion Conference, held at Geneva on July 1–4 by the International Management Institute and attended by delegates from nineteen countries, afford some reply to certain criticisms of rationalisation, particularly those which suggest it is responsible for over-production, unemployment, the mechanisation of work, increased economic instability, and the imposition of handicaps on weaker businesses and countries. The exceptional depression in world business is attributed less to economic factors than to political and social disorder, especially unsatisfactory international relations. While technical rationalisation results in the production of larger quantities of goods at lower prices, remedy is not to be found in the retardation or restriction of this process but in the extension of the principles of rationalisation to the technique, organisation, and administration of industry, first on a national and then on an international basis, and in the more efficient organisation of distribution. Subject to adequate publicity to safeguard the interests of consumers, the considered establishment of voluntary agreements to eliminate over-production and irrational competition is recommended, and a scientific study of distribution problems, based on international information. The Conference considered that among the many causes of unemployment, rationalisation was economically justifiable, being productive and carrying its own remedy in improvements in production and economy of human effort. The importance of minimising the displacement, assisting the displaced workers during the transition period, and of co-operation between employers' and workers' organisations was emphasised.

THE elimination of exhausting and objectionable tasks, the improved hygienic conditions, and improvement in prospects of promotion, wages, and hours of work are among compensations which rationalisation can offer for the alleged increased mechanisation of work, and the Conference recommended further efforts to encourage the full utilisation and development of the capacity of the individuals. Mistaken judgment in rationalisation has contributed at times to economic instability, and the Conference urges the importance of the development of professional institutions on wider industrial lines, so as to provide all the basic facts essential to direction and reorganisation, and the practical extension of rationalisation principles to whole nations as well as to industry. The professional organisation thus visualised will assist in the insurance of the weaker members of national or international groups against excessive risk. The importance of a close study of the social consequences of rationalisation measures is reiterated, rationalisation being both a tool and a method, and consequently capable of abuse as well as rightful use. A vigorous development of management research group movements is indicated, and closer co-operation between industry and education.

A PROJECT of some interest to scientific workers is the proposal for the formation of an international bibliography of translations, which has been favoured by various international writers', publishers', and librarians' organisations, as well as by the Institute of Intellectual Co-operation. A sub-committee of the Committee on Intellectual Co-operation of the League of Nations, reporting in July on the project, considered that a publication of this type would render valuable service in art, literature, and science, facilitate the rational collection of information for writers, publishers, translators, etc., and prove a starting point for other endeavours to co-ordinate and systematise translation. The plenary committee was requested to take action with the view of securing the early publication of an international bibliography. Co-ordination of scientific bibliography is still a problem of fundamental importance, and the committee of scientific advisers in its July meeting considered the ways in which the obstacles to this and other problems of scientific co-ordination could be more effectively overcome. Scientific co-ordination has both a technical and a moral aspect, in so far as it not only improves the conditions of scientific work but promotes intellectual *rapprochement* and international understanding. Probably the most effective contributions in this field will be made by efficient national organisations and by international associations the chief task of which is the organisation of scientific work. The Committee on Intellectual Co-operation has, however, assisted in the creation of an atmosphere favourable to such developments.

A LARGE and interesting power station which utilises peat for fuel is operating at a distance of 75 miles from Moscow. It is called the Shatura power station, and is situated near three small lakes lying close together, and adjoins an immense peat bog. The present operations cover about fifty square miles. There are three large boiler-houses fitted with chain grate stokers specially adapted for burning peat. The turf is supplied in two forms, sods and dust, the dust dropping on the top of the sods in the furnace. The latest boiler put in is made to burn turf dust only; it has a number of oil burners to heat up the furnace before commencing, but has no chain grate. The present way of collecting the turf is by means of powerful hydraulic hose jets which play on the turf and wash it down into an excavated pit as a wet sludge. It is pumped out of this on to the fields, where it is left to dry. Then a slicer on a caterpillar tractor runs over the field, cutting the turf into sods and turning it over. A year's turf has to be collected and dried in four or five months. It is stated in an article by F. C. Wigham in the *Electrical Times* of Aug. 13 that other work must be found in the winter for the 5000 men employed on the turf field. The turf work is a separate business from the electric works and sells its product to the latter at a profit. All industries in Russia must now earn 6 per cent on the capital employed. In the annual report, it is stated that 920,000 tons of turf were consumed last year, the cost of the turf in the bunkers being a little more than 11 roubles per ton, the par value of the rouble being 2*s*. 1*d*. and its purchasing value being about half as much. The power is transmitted to Moscow at 115,000 volts, and the cost per unit last year was 2·20 kopeks, a kopek being equal to ¼*d*. In every five days, half the head staff are away on holiday on one day and the other half on another day.

IN connexion with the Weir report on railway electrification, it is of interest to notice that the electrification of the G.I.P. railway between Bombay, Poona, and Igatpuri has revolutionised passenger and goods traffic and has been of immediate benefit to Bombay and its neighbourhood. It seems probable that considerable main line electrification will be undertaken in North and South India in the near future. The electrified section of the railway extends for 272 track miles. The total amount of the original estimate was about four million pounds, and Messrs. Merz and McLellan, of Westminster, were the consulting engineers. The power supply for the main line system is obtained from a steam power station, and coal of a lower grade than that utilised by the steam locomotive is used for the boilers. The transmission system consists of two high-pressure transmission lines extending 272 miles and supported on lattice type steel towers, of which there are about 2000, their average height being 70 feet. There are 840 miles of steel-core aluminium conductors used in the transmission. The distance between consecutive traction substations on the main line is twelve miles. The pressure of transmission is 95 kilovolts, and this is transformed into 560 volts at the open-air substations and then converted into 1500 volts direct current by rotary machines connected in series. Only five of the substations have attendants, the remaining substations being controlled from the former by electrical methods. The goods locomotives for the line were made by Messrs. Metropolitan Vickers Electric Co., and each weighs 120 tons, being the largest hitherto built in England. Smooth running has been obtained with speeds up to 80 miles per hour, and the scheduled time from Bombay to Poona has been reduced by 30 per cent. The whole scheme has been carried through in three years with practically no interruption of the normal traffic.

THE British Drug Houses, Ltd., London, N.1, have recently issued various pamphlets describing certain of their products. The catalogue of fine chemicals includes both organic and inorganic compounds, analytical reagents, indicators and standard stains. All the commoner substances are stocked in standard packages of 25 gm., 100 gm., 250 gm., and 500 gm. A leaflet describes an outfit for the simple estimation of the blood area in 0·1 c.c. of blood according to the method of Osman and Close (*Brit. Med. Jour.*, Vol. 1, p. 1064; 1931). The urea is converted to ammonia by adding urease to the blood, and the process completed by precipitating the proteins with trichloroacetic acid, filtering and estimating the nitrogen in the filtrate colorimetrically against a series of standards. For the injection treatment of varicose veins, ampoules of sodium morrhuate (5-10 per cent solution) and of quinine and urethane solution are issued as sclerosing agents. When properly carried out, this treatment results in permanent cure and is much simpler than operative removal. It is well known that the liquid extract of ergot of the British Pharmacopœia contains little or no ergotoxine: moreover, most solutions of the latter deteriorate on keeping. The British Drug Houses are issuing a liquid extract guaranteed to contain, by physiological test, 0·03 per cent ergotoxine, and also, an improved preparation, 'Ergodex', of the same strength, which is miscible, contains the whole alkaloidal content of ergot and exerts the full therapeutic effect of the entire drug. It suffers no loss in activity after storage for 12 months when kept in well-closed containers protected from bright light.

IN recent years our knowledge of the deep living pelagic fauna of the oceans has been greatly advanced through collections made by oceanographical research vessels. It is safe to say, however, that the larger part of the examination of the animals themselves has been undertaken on the preserved material either in museums or in other institutions. Such observations as can be made on the delicate organisms and on the living animals themselves have had to be noted on board ship, where vibration and other movements of the vessel do not make for ideal conditions. To be able to examine living collections on the day they are caught in the peace of a shore laboratory is therefore an ideal to be sought after. This possibility has recently been proved by the Bermuda Oceanographic Expedition of the New York Zoological Society under the leadership of William Beebe, who gives a short account in *Zoologica*, vol. 13, Nos. 1 and 2. The laboratory is established on Nonsuch Island, and with the aid of a tug, the *Gladisfen*, collections can be made in 1000 fathoms of water a little more than five miles from the shore; living material is brought to the laboratory in cooled water. It is hoped that in this way much interesting information otherwise unobtainable will become available.

IN the keeping of aquaria the opinion is current that the successful maintenance of fish and plants can be accomplished only if sunlight falls upon the tank at some part of the day. But the revision of this opinion is suggested by an article in the *Aquarium Review* for July, where the author describes his two years' experience of a community tank without sunlight. The tank in question measures 54 in. by 12 in. by 12 in., holds roughly about 30 gallons of water, and is heated to about 74° F. by a simple arrangement of two fish-tail gas jets playing upon a distributing layer of sheet tin beneath the slate bottom. The room in the window of which the tank is placed faces due north and is situated on the fourth floor of a five-storey building in a London street. The success of the arrangement is shown by the fact that about forty tropical fishes, selected for their bright colouring and peaceable habits, live there in amity, and that by the cutting-off of a portion at the end of the tank by a partition of opaque glass many broods of viviparous fishes have been reared. The study of the article is commended to naturalists who have been deterred by apparently unpromising conditions from installing tropical aquaria.

IN the *Aquarist* for July-August, W. J. Pitt tells of a dwarf chamæleon (*Chamæleo pumilus*) having had two litters without a second impregnation. The reptile was bought in London on April 9 of last year, when it appeared to be pregnant, and—the species being viviparous—duly brought forth a dozen young, all perfect and (except three) living, on April 17. No male was kept with it, but nevertheless on Oct. 23 ten more young were born, but this time dead and, with the exception of two, one of which was perfect and the other nearly so, in an early stage of development. This, as the observer remarks, makes untenable the suggestion that the journey from South Africa had caused the first litter to be prematurely born; it may be added that a litter of twenty-two would be a very unlikely number—about double the normal expectation. It is mentioned that an occurrence like the above is apparently unrecorded for reptiles, though well-known in some viviparous fish, such as the swordtails (*Xiphophorus*), now familiar to aquarists.

THE Annual Report of the Joint Board of Research for Mental Diseases, formed by the City and University of Birmingham, for the year ending March 14, gives an outline of the work of the Laboratory. A general attack on the problems of mental disease is being made from the bacteriological, histological, and chemical points of view. Negative as well as positive results are recorded. Mention is made that a murder-suicide case was examined for nasal sinus disease. Presumably as this is a laboratory report, it represents the more physiological approach; parallel with this there should be a psychological study. Even granted that it could be shown that a suicidal-murderer had some physiological defect, this does not prove that this defect was related as cause and effect to his behaviour.

IN an article by Dr. Ellice McDonald on "Cancer Research and the Scientific Method" (*Science*, July 17, 1931, p. 55), the principal biochemical deviations from the normal in the cancer patient are detailed. These comprise increased glycolytic activity and diminished lactic acid formation of tumour tissues, increased alkalinity of the blood plasma, and diminished calcium and increased potassium content of cancer cells. It is considered, therefore, that any cure for cancer must be capable of altering these conditions and bringing them back to normal. At present these appear to be the only criteria that can be formulated for a cancer cure.

AN exhibition of modern optical instruments has been arranged at the Science Museum, South Kensington, and will remain on view until the end of October. Among the two hundred exhibits are apparatus for spectrophotometry in the ultra-violet, an aerial camera which takes 100 photographs with one filling, a projection microscope magnifying up to 5000 times, rangefinders, theodolites, etc.

ON the evening of Aug. 10, one of the greatest earthquakes of the year occurred in western China (NATURE, Aug. 22, p. 299). Its epicentre has been determined by the U.S. Coast and Geodetic Survey, from a large number of records, as situated in lat. 42° N., long. 90° E. (Science Service, Washington, D.C., Aug. 11). The origin was thus in the Sinkiang province of China, on the west edge of the Gobi desert, an area so sparsely settled and so far from lines of communication that direct news of the earthquake can scarcely reach us for many weeks or months, if ever.

THE Institution of Heating and Ventilating Engineers is appealing to the industry for £2000 in order to construct an experimental room enclosed within a larger structure, so that the outer surfaces of the walls of the room may be exposed to controlled conditions and the efficiencies of different methods of heating the room determined. Promises may be sent to the Institution at 12 Russell Square, W.C.1, and are subject to the decision of the Department of Scientific and Industrial Research to proceed with the scheme.

WE have recently received from the British Museum (Natural History) part 2, fascicle 4, of a monographic work on the Diptera of Patagonia and South Chile, in course of publication. The present contribution deals with the Simuliidæ, by Dr. F. W. Edwards, and the Caratopogonidæ, by Drs. A. Ingram and J. W. S. Macfie. It is well up to the standard of its predecessors, and, when completed, the whole work will form an important addition to our knowledge of the fauna of the region concerned.

THE Imperial Bureau of Plant Genetics for Herbage Plants, which is located at the Agricultural Buildings, Alexandra Road, Aberystwyth, has issued the first number of its *Bulletin*. The numbers are to appear quarterly at 1*s*. 6*d*. per issue, 4*s*. for the present year, and 5*s*. annually thereafter. The first number contains abstracts of current papers on herbage, classified according to the decimal system, and indexed. *Bulletin* No. 3, issued at 3*s*., contains a detailed account, by Prof. R. G. Stapledon, Mr. T. J. Jenkin, and Mr. R. D. Williams, of the methods employed in herbage breeding at the Welsh Plant Breeding Station, Aberystwyth. This is illustrated by three plates, and the methods are explained particularly in connexion with various grasses, including cocksfoot grass, and such leguminous crops as the clovers and lucerne. These methods are of much value in connexion with the production and improvement of pasture grasses and fodder crops.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Corpuscular Explanation of Cosmic Rays.

WITH reference to the attempts that are being made to determine whether the cosmic radiations are corpuscular or undulatory in character, such as those described by Bruno Rossi,[1] there is one point which I have vainly tried to understand. Why is it assumed that such rays would or could have the high penetrating power of cosmic rays? As I tried without success to point out at the recent discussion at the Royal Society, there is no experimental evidence of corpuscular rays being able to traverse more than 4 mm. of aluminium. It is, of course, known that a few of the β-rays of radium and thorium have energies, as measured by their magnetic deviability, up to some millions of volts. But what experimental evidence is there that these have greater penetrating power than rays of lower energy? Is it not rather to be expected that it would be less, or do the ordinary conceptions of relativity not apply to the theory of relativity? If we try to get the necessary penetrating power by the increase of mass of the particle due to its speed, is not the mass of every other particle with which it collides similarly increased?

FREDERICK SODDY.

Oxford, Aug. 22, 1931.

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[1] NATURE, 128, 300, Aug. 22, 1931.

Measurements on the Absorption of the Penetrating Corpuscular Rays coming from Inclined Directions.

IN a recent discussion on the cosmic rays,[1] Prof. Geiger has pointed out that it would be of interest to make comparative measurements on the absorption of the penetrating corpuscular rays coming from different inclinations to the vertical.

Such an experiment was performed by me shortly before I read this paper, by measuring the diminution in the number of coincidences when a screen of lead 9 cm. thick was introduced between two Geiger-Müller's tube-counters (5 cm. in diameter and 15 cm. long) placed with their axes horizontally, at a distance of 17 cm.

By inclining more and more to the vertical line the plane containing the axes of the two tube-counters, thus increasing the thickness of the atmosphere in the direction of those rays which can determine the coincidences, I expected to find a progressive hardening of the corpuscular radiation, similar to the one which had been stated, by filtering the radiation through a lead screen.[2]

The experimental result did not confirm this expectation. Indeed, with the two counters placed vertically the one above the other, I measured an absorption of 23·2 ± 1·6 per cent; whilst when the plane of their axes was put at an angle of 60° to the vertical line, the absorption was found to be 32·5 ± 3·5 per cent.

It appears, therefore, that the slant rays are softer and not harder than the vertical ones.

This result may be accounted for by assuming that the corpuscular rays generate in the atmosphere a softer secondary corpuscular radiation, and that the relative amount of the latter is in an inclined direction larger than in the vertical one.

BRUNO ROSSI.

Physical Institute of the
University of Florence,
Arcetri, Italy, Aug. 10.

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[1] NATURE, May 23, p 785; *Proc. Roy. Soc.*, July 2.

[2] B. Rossi, *Zeit. fur Phys.*, 68, 64; 1931; and *Rend. Lincei*, 13, 600; 1931.

Isotopic Displacement in Hyperfine Structure.

THE analysis of the hyperfine structure of several lines in thallium[1] indicates the existence of two distinct sets of energy levels; one for Tl 203 and the other for Tl 205. Each isotope has a nuclear spin $i=\frac{1}{2}$. For the line $6s\ 7s\ {}^3S_1 \longrightarrow 6s\ 7p\ {}^1P_1$ in Tl II, the doublet width is approximately the same size for the two isotopes, which signifies that the magnetic moments must also be approximately equal. The distance between the centres of gravity of the two doublets, however, is greater for Tl 205. Jackson,[2] studying rubidium, concludes that the lines are displaced toward the ultra-violet for the heavier isotope.

From existing theories of hyperfine structure, one is led to conclude that such a bodily displacement would occur even when both isotopes have zero magnetic moment. Experimental evidence as to this would be valuable.

It appears, then, plausible to assume that the electric field produced by the nucleus is not the same for the two isotopes. Whether the thallium nucleus, with a spin $i=\frac{1}{2}$, can have either a permanent dipole moment or a permanent higher moment is doubtful, if one may make an analogy with the case for the external electronic system.[3] Accordingly, the discussion will be confined to central fields, the difference between the two being in the radial dependence of the potential energy.

In order to determine the order of magnitude of the perturbation on a Schrodinger electron by deviations from the Coulomb law near the nucleus, it is probably sufficient to assume a potential energy curve as follows: $V=V_0$ for $r<r_m$, and $V=-\frac{Ze^2}{r}$ for $r>r_m$, where r_m indicates the radial extent of the nucleus. Since calculation showed that relativistic effects would not influence the result appreciably, the following treatment will not take them into account.

Sommerfeld ("Erganzungsband", p. 75) gives the radial function as $R=\frac{1}{N_r}\rho^l e^{-\rho/2} L_{n+l}^{2l+1}$, where $\rho=\frac{2Zr}{n}$ and $\frac{1}{N_r^2}=\frac{4(n-l-1)!}{n[(n+l)!]^3}$.

Atomic units are employed.

In the range from 0 to r_m, $\rho<<1$ and $e^{-\rho/2}\cong 1$. Consequently the only part of the Laguerre polynomial which makes an appreciable contribution is the constant term.

If w_1 and w_2 are the displacements of a $7s$ energy level, and of a $7p$ energy level respectively, then

$$w_1=\frac{1}{N_r^2}\int_0^{r_m}\left(\frac{Z}{r}+V_0\right)r^2dr[L_7^1(\rho)]^2\cong 2Zr_m^2+\frac{4}{3}V_0r_m^3,$$

$$w_2=\frac{1}{N_r^2}\int_0^{r_m}\left(\frac{Z}{r}+V_0\right)r^2dr[L_8^3(\rho)]^2\cong \frac{1}{3}K^2Zr_m^4+\frac{4}{15}K^2V_0r_m^5$$

where $K=\frac{2Z}{n}$.

The displacement w_1 is much greater than w_2, since electrons with $l>0$ do not approach as close to the nucleus as do the S electrons. Accordingly, in Tl II, the $6s\ 7s\ {}^3S_1$ level should be displaced much more than is the $6s\ 7p\ {}^1P_1$.

Neglecting w_2 then, and letting r_1 and r_2 be the nuclear radii of the two different isotopes, the difference in displacements is $\Delta w = 2Z(r_1^2 - r_2^2)$, if $V_0 = 0$. Experimentally, $\Delta w = 0{\cdot}2$ cm.$^{-1} = 10^{-6}$ atomic units. If we take $r_1 = 10^{-12}$ cm. and $r_2 = 9 \times 10^{-13}$ cm., then we obtain an effect of this order of magnitude. In any event, V_0 could be varied also, so that there seems to be no difficulty in accounting for the order of magnitude of the isotopic displacement on the hypothesis that the deviations from Coulomb's law near the nucleus are responsible.

My thanks are due Dr. Dirac for helpful discussion.

JAMES H. BARTLETT, JR.

Cavendish Laboratory,
Cambridge,
July 21.

[1] Schüler and Keyston, *Zeit. f. Phys.*, **70**, 1; 1931.
[2] NATURE, **128**, 34; 1931.
[3] See Unsöld, *Ann. d. Phys.*, **82**, 378; 1927.

Hyperfine Structure of Thallium II.

THE hyperfine structure of Tl II has been investigated by McLennan [1] and co-workers and partially by Schüler and Keyston.[2] Certain discrepancies in the results of the former authors can be attributed mainly to the low resolving power of the instrument employed (3 metre grating). The absence of characteristic fine structures in the magnetic analyses of the same authors is probably of the same origin.

With the large grating and the Weiss magnet at the Physical Institute at Tübingen, we have investigated the magnetic transitions of the hyperfine energy levels of singly-ionised thallium employing field-strengths of 15,000–43,350 gauss, in a manner similar to that employed by one of us [3] for the principal arc lines of thallium. A typical example of such transitions is the line λ 3092. In this case, the magnetic field disturbs only the ${}^1P_1$ levels (classified as $6s6p\,{}^1P_1 - 6s7s\,{}^1S_0$). The photometer curves, reproduced in Figs. 1 and 2 (magnification 30), made from fifth order plates, show quite clearly the effect of changing fields on the separations. In the perpendicular polarisation, the separation AB increases while CD decreases with increasing field; the sum of the two distances, however, remains practically constant. If the Paschen-Back effect were complete, the separations would be equal. The separation EF in the parallel components decreases with increasing field strength and is not resolvable at 43,350 gauss.

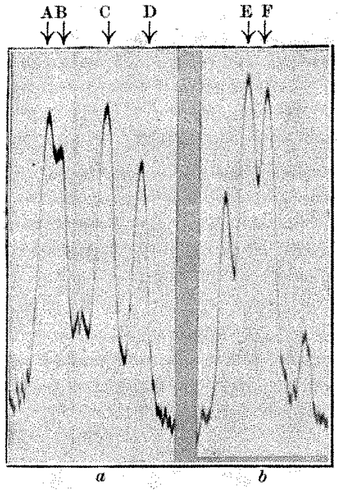

FIG. 1.—*a*, Perpendicular polarisation; *b*, parallel polarisation. H = 14,700 gauss.

The above analysis gives us a value of 0·092 ± 0·002A., or 0·96 ± 0·02 cm.$^{-1}$ for the hyperfine structure of the doublet λ 3092 in a zero field, and shows that the levels of $6s6p\,{}^1P_1$ are inverted.

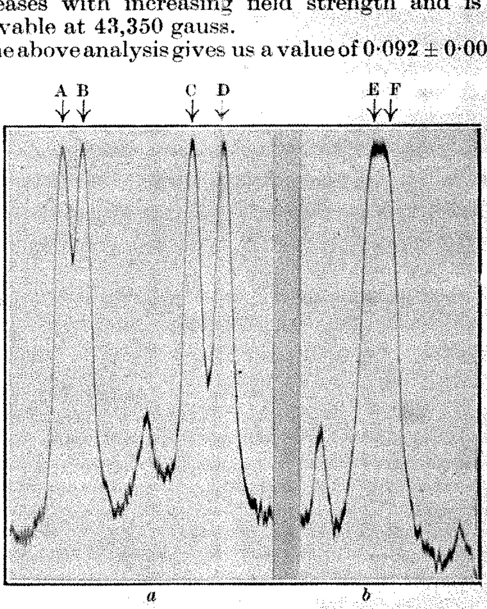

FIG. 2.—*a*, Perpendicular polarisation; *b*, parallel polarisation. $H = 32{,}500$ gauss.

A complete study of the Zeeman analyses of this and other lines of thallium II will be reported elsewhere.

J. B. GREEN
(Guggenheim Fellow).
JOHN WULFF
(National Research Fellow).

Physical Institute,
University of Tübingen,
July 14.

[1] McLennan, McLay, and Crawford, *Proc. Roy. Soc.*, A **125**, 570; 1929. McLennan and Durnford, *Proc. Roy. Soc.*, A **129**, 48; 1930. McLennan and Crawford, *Proc. Roy. Soc.*, A **132**, July 1931.
[2] Schüler and Keyston, *Zeit. f. Phys.*, **70**, 1; 1931.
[3] Back and Wulff, *Zeit. f. Phys.*, **66**, 31; 1930. Wulff, *Zeit. f. Phys.*, **69**, 70; 1931.

WE have recently published two communications [1] concerning an isotope displacement effect in the hyperfine structure of thallium II. On the other hand, in a recent paper on this subject,[2] J. C. McLennan and M. F. Crawford state that they have discovered no trace of an isotope effect. In order to avoid misunderstanding, we wish to point out that this apparent contradiction is entirely due to the fact that the resolving power of the grating used by McLennan and Crawford is insufficient to separate the lines due to the two isotopes. The smallest separation resolved by McLennan is $\Delta\nu = 0{\cdot}370$ cm.$^{-1}$; the largest isotope displacement is $\Delta\nu = 0{\cdot}280$ cm.$^{-1}$. With a Fabry-Perot étalon we were able to resolve separations of $\Delta\nu = 0{\cdot}040$ cm.$^{-1}$, that is, a tenth of the resolution obtained by McLennan.

When this fact is taken into consideration, the results are in complete agreement. McLennan's revised term analysis shows that the term which he previously denoted as $6s7p\ {}^1P_1$ is really a $1_1{}^0$ term of the complex group $5d^96s^26p$; this correction must therefore be made in the notation of the lines 5490 and 4765 which we investigated. This change is of importance, since it shows that the two large isotope displacements arise from terms of this complex group, whilst the ordinary singlet and triplet terms exhibit smaller displacements.

H. SCHULER.
J. E. KEYSTON.

Astrophysikalisches Observatorium,
Einstein Institut, Potsdam,
July 20.

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[1] H. Schüler and J. E. Keyston, *Naturwiss.*, **19**, 320; 1931. *Zeit. f. Phys.*, **70**, 1; 1931.

[2] J. C. McLennan and M. F. Crawford, *Proc. Roy. Soc.*, A **132**, 10; 1931.

Evidence for the Spin of the Photon from Light-Scattering.

IN a recent communication (NATURE, **128**, 114, July 18, 1931) Sir C. V. Raman and S. Bhagavantam remark that the reversal of the sign of circularly polarised light in scattering, as observed by Hanle[1] and by Bär,[2] is to be expected from the quantum theoretical law of conservation for angular momentum. As the quantitative theory of the effect was developed some time ago,[3] it may be of interest to note here the principal results, emphasising the fact that the effect can be understood as well on a purely classical basis.

The properties of every Raman transition (whatever the composition of the incident light may be) are determined by an ellipsoid fixed in the molecule, which gives the deformation of the polarisability-ellipsoid, caused by the nuclear motion corresponding to the transition.[4] From this it follows immediately that the state of polarisation of the scattered radiation for circularly polarised incident light is already completely determined by the depolarisation ρ for linearly polarised incident light, defined in the usual way. More especially, if I_r and I_u are the intensities of the reversed and the unreversed part of the scattered light in the *forward* direction, the following relation holds, both in classical and in quantum theory:

$$\frac{I_r}{I_u}=\frac{2\rho}{1-\rho}. \quad . \quad . \quad . \quad . \quad (1)$$

This is analogous to the well-known relation for natural incident light

$$\rho_n=\frac{2\rho}{1+\rho} \quad . \quad . \quad . \quad . \quad (2)$$

which, besides, also remains valid for circularly polarised incident light, when observed in directions *transverse* to the primary ray.

From (1) it follows that we get reversal of the sign of circular polarisation always if $\rho > \frac{1}{3}$. This is always the case for rotational or rotational-vibrational transitions $\left(\rho=\frac{3}{4},\ \frac{I_r}{I_u}=6\right)$; it can be the case, too—contrary to the statement of Raman and Bhagavantam—for purely vibrational transitions, as ρ can vary here from 0 to $\frac{3}{4}$ (loc. cit.[4]); reversal cannot take place for the undisplaced (Rayleigh-) line, its depolarisation ρ remaining necessarily less than $\frac{1}{3}$.

From the point of view of the conservation law it is important to note that in general a molecule can change its angular momentum without changing its spin energy. The scattered light quantum in this case will have the same frequency, but the sign of circular polarisation is changed. In the quantum theory, these changes are described by jumps in the magnetic quantum number m. The selection rules in scattering are for circularly polarised incident radiation: $\Delta m=0$, 1, 2, corresponding respectively to unchanged circular, linear, and reversed circular polarisation. From this consideration it is easily understood that purely vibrational lines can also show the reversal.

It may be remarked that in the usual observations and also in those of Hanle and Bär, owing to the insufficient dispersion available, the purely vibrational line (Q-branch) and the vibration-rotation branches are measured together. Under these conditions, it has been shown[4] that $\rho > \frac{1}{3}$ (1) for all degenerate vibrations, (2) for vibrations connected with a simultaneous increase of some and decrease of other components of the polarisability-tensor (loc. cit.[3, 4]). For the same cases reversal of the circular polarisation has to take place. This is in good agreement with all the observations on CCl_4, $CHCl_3$, C_6H_6, etc.

Recently also the distribution of intensity over the different branches of a line has been calculated by Dr. Teller and myself.[5] As in the theory of classical scattering, the scattering can be divided into a part dependent only upon the sum of the three principal values of the ellipsoid, this part alone contributing to the Q-branch, and the anisotropy scattering. For the latter, for example, the relation of the intensity of the Q-branch to that of the sum of all rotational branches, is found to be 1 : 2 for symmetrical top molecules, while it is 1 : 3 for the rotator (diatomic or linear triatomic molecules).

G. PLACZEK.

Institute for Theoretical Physics,
University, Leipzig, July 31.

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[1] W. Hanle, *Naturwiss.*, **19**, 375; 1931. *Phys. Zeitsch.*, **32**, 556; 1931.

[2] R. Bär, *Naturwiss.*, **19**, 463; 1931. *Helv. Phys. Acta.*, **4**, 131; 1931.

[3] G. Placzek, *Leipziger Vorträge*, 1931.

[4] G. Placzek, *Zeit. f. Phys.*, **70**, 84; 1931.

[5] G. Placzek and E. Teller, to appear in *Zeit. f. Phys.*

Group Rotation in Solid Ammonium and Calcium Nitrates.

THE phenomenon of molecular rotation in the solid state first recognised by L. Pauling[1] is, in accord with his prediction, proving of wide occurrence. In many compounds the excitation of rotation about various axes is accompanied by *gradual* changes in such properties as heat capacity, specific volume, and crystal structure. It is probable, however, that certain *polymorphic* transitions, such as, for example, the one in hydrogen chloride at 93·36° K, are also accompanied by changes in the rotation of the molecules. The three *gradual* transitions in solid hydrogen bromide[2] were interpreted by Pauling (loc. cit.) as accompanying stepwise excitation of rotation of an HBr molecule about three axes. On account of the low scattering power of hydrogen, it would be difficult to verify these interpretations by determinations of crystal structures. We have, however, found changes of the above types in ammonium nitrate.

Ammonium nitrate at atmospheric pressure is known to exist in at least five crystalling modifications.[3] The salt shows a small abnormal change in the specific volume starting at about −50° C. X-ray powder diffraction photographs of the solid at −33° C. and at −78° C. are closely similar, as would be expected if rotations of the *ammonium* groups alone are excited between these temperatures.

Most of the transitions in ammonium nitrate show decided hysteresis. Near −16° C., with ascending temperature, the low temperature modification changes to the usual orthorhombic form,[4] which in turn changes to a monoclinic form near 32° C. The structures of these three modifications are complex and are not yet completely elucidated. It is quite probable, however, that the oxygen atoms are in fixed positions in all. Upon further heating, the monoclinic modification inverts rapidly, near 84°, to a tetragonal form. Upon cooling, this tetragonal phase often persists to approximately 50° C. It inverts reversibly near this temperature to the metastable orthorhombic form;[5] on further cooling, in the region of the metastable transition, the stable monoclinic phase is often produced.[6]

We have observed the transition from the tetragonal to the stable monoclinic form in the presence of a small amount of solvent. Cooling at the rate of about 0·5° per minute, the transition was initiated at 76°, and the temperature then rose to 81° C., due to liberation of the heat of transition. Powder photographs of the tetragonal modification at 105° C. indicate that the unit of structure with $a = 5{\cdot}77$ A., $c = 5{\cdot}00$ A., contains two molecules of ammonium nitrate (NH_4NO_3). The observed intensities of interference maxima are best to be explained by a structure with the nitrogen atoms of NH_4^+ groups at 000, $\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}$, and the nitrogen atoms of NO_3^- groups at $\frac{1}{2}\,0\,\frac{1}{2}$, $0\,\frac{1}{2}\,\frac{1}{2}$, the nitrate groups rotating in (100) and (010) respectively about axes normal to their planes. The separations of the rotating NH_4^+ and NO_3^- groups in the plane of the NO_3^- groups are 3·80 A.

The tetragonal modification inverts near 125° C. to a cubic phase which persists to the melting-point at 169·5° C. This is the most rapid of ammonium nitrate inversions, but even in this case there is an appreciable hysteresis loop between heating and cooling curves. In one experiment, upon heating, the inversion in the dry salt was initiated at 127·15° and ended at 130°; upon cooling, the inversion was initiated at 123·52°, the temperature of the sample rising to 124·35°, and ended at 123°. Powder photographs of this cubic modification at 135° C. and 155° C. indicate that the unit of structure contains one molecule of ammonium nitrate with $a = 4{\cdot}40$ A. (155° C.). Since the lattice is a cubic one, it follows that the oxygen atoms cannot be in fixed positions. The intensities of reflection are best to be explained by a structure with nitrogen atoms at 000 and $\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}$ and with the centres of the oxygen atoms statistically distributed on a sphere of 1·25 A. radius around one of these points. The separation of the rotating NH_4^+ and NO_3^- groups is 3·79 A. On the basis of such a structure, it is possible to account for the formation of a limited series of solid solutions between ammonium chloride (NH_4Cl) and cubic ammonium nitrate.[7]

It is thus probable that in solid ammonium nitrate above 125°, all the rotational degrees of freedom of both the ammonium and of the nitrate ion are fully excited. Of the three transitions in the solid that are accompanied by changes in molecular rotations, one is *gradual*; another, although of the polymorphic type and previously not considered unusual, is remarkable for the extent and kind of its hysteresis; while the third is a typical rapid *polymorphic* transition.

The results of this work and of our previous study of the *gradual* transition in sodium nitrate[8] indicate that rotation of the nitrate group is often to be found in crystalline nitrates. Published X-ray diffraction data obtained from calcium, barium, strontium, and lead nitrates[9] and nickel nitrate hexammoniate[10] are extremely unsatisfactory. The crystal structures suggested for these various compounds are probably quite incorrect. The symmetry of barium nitrate determined from piezo-electric and unambiguous optical measurements is different from that of the structure described. The structure of nickel nitrate hexammoniate is known to be incompatible with the symmetry indicated by Laue photographs.

It is probable that the nitrate group has spherical symmetry at room temperatures in all of the compounds mentioned immediately above. The structures are probably similar to that of fluorite, the fluorine ions being replaced by rotating nitrate ions, and the calcium ions by the metallic ions or the $Ni(NH_3)_6^{++}$ group, which is not rotating at room temperatures. In calcium nitrate, on the basis of such a structure, the Ca^{++} to NO_3^- distances are about 3·30 A., in close agreement with the calculated value.

The expected transitions in these compounds are now being studied.

F. C. KRACEK.
S. B. HENDRICKS.
E. POSNJAK.

Geophysical Laboratory,
Carnegie Institution of Washington.
Bureau of Chemistry and Soils,
Department of Agriculture, Washington, D.C.

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[1] *Phys. Rev.*, **36**, 430; 1930.
[2] Giauque and Wiebe, *Jour. Am. Chem. Soc.*, **51**, 1441; 1929.
[3] Lehmann, *Zeit. f. Kryst.*, 1, 106; 1877: Wallerant, *Bull. Soc. Franc. Min.*, **28**, 311; 1905.
[4] Grossner, *Zeit. f. Kryst.*, **38**, 144; 1904.
[5] Bowen, *J. Phys. Chem.*, **30**, 721; 1926.
[6] Behn, *Proc. Roy. Soc.*, **80**, 449; 1908.
[7] N. L. Bowen, *J. Phys. Chem.*, **30**, 726; 1926.
[8] Kracek, Posnjak, and Hendricks, *Jour. Am. Chem. Soc.*, in press.
[9] Vegard, *Zeit. f. Phys.*, **9**, 395; 1922.
[10] Wyckoff, *Jour. Am. Chem. Soc.*, **44**, 1260; 1922.

Apparent Dissociation Constants of Carbon Dioxide in Sea-water of Different Salt Contents.

IN addition to neutral salts, sea-water contains a small quantity of 'excess base' in the form of bicarbonate and of carbonate, together with free carbonic acid. The ratio of HCO_3' to CO_3'', free CO_2, and consequently hydrogen ion concentration, varies with time and place, dependent upon the intensity of assimilation by plants, of respiration by animals and plants, exchange with the carbon dioxide of the atmosphere, production of calcium carbonate in the skeletons of coccolithophores and animals, and its solution from calcareous sediments. Further, the interrelation between carbon dioxide tension, hydrogen ion concentration, and excess base in saline physiological fluids has been the subject of much research, concerning which there is a considerable and growing literature.

With the object of extending recent researches by one of us (K. B.) concerning the first and second apparent dissociation constants K_1' and K_2' of carbonic acid in sea-water of varying salinity, and of developing suitable analytical methods of estimating 'excess base' (*Alkalinität*) and pH on board research vessels, collaboration was arranged by the International Council for the Exploration of the Sea. With a knowledge of these two constants and the above two variables, one can calculate the carbon dioxide tension, the total carbon dioxide, and the proportion of bicarbonate to carbonate.

Values for K_1' were obtained by shaking sea-water of varying salinity into equilibrium with sufficient carbon dioxide to bring its pH between 5 and 6, as measured by means of a quinhydrone electrode, the free carbon dioxide being obtained from the carbon dioxide tension as measured gasometrically. The variation of K_1' with content of neutral salts was found to follow closely a formula of cubic root type as employed by Bjerrum,

$$pK_1' = 6{\cdot}518 - 0{\cdot}588\sqrt[3]{C}, \qquad t = 18°,$$

where pK_1' is the negative logarithm of K_1' and C is the concentration in terms of normality of all the cations. Since the composition of the salts in ocean-water is almost constant, the cations are in direct proportion to the salinity, from which they were calculated.

The value of K_2' was measured at a pH of about 9, when the free carbon dioxide may be neglected, $HCO_3' + CO_3''$ equals the bound carbon dioxide as found by gas analysis and $HCO_3' + 2\ CO_3''$ equals the carbon dioxide in combination with 'excess base' as found by titration.

The temperature coefficient of K_1, for which the values found by previous workers do not agree closely, remains to be investigated. The results will in due course be published in the *Rapports et Procès-verbaux* of the International Council for the Exploration of the Sea.

KURT BUCH.
Helsingfors.
H. WATTENBERG.
Munich.
H. W. HARVEY.
Plymouth.

Hydrolytic Adsorption of Activated Charcoal.

THERE is a difference of opinion regarding the behaviour of charcoal as a gas electrode in explaining its hydrolytic adsorption (Frumkin, Schilow). It has been suggested alternatively that acidic or basic oxides formed during activation are responsible for such adsorption, and that charcoal is a negative adsorbent possessing a negative charge in water (Schilow). On the gas electrode theory, charcoal should be positively charged and adsorb acids. Negatively charged oxygen charcoal which adsorbs alkali is known. Both positively and negatively charged charcoals are possible. A relationship between the electric charge, as measured electrokinetically, and the hydrolytic adsorption of either acid or alkali has been pointed out, and it was suggested [1] that 'acid' adsorbing activated sugar charcoal would be positively charged. Negatively charged charcoal with hydrogen or weakly basic cations in the mobile sheet of the double layer should adsorb alkali and liberate acid from a neutral chloride solution. This relationship between the sign of the charge and hydrolytic adsorption has been confirmed with charcoal.

In view of the fact that it is recognised (Frumkin) that the gas electrode theory does not apply to the observation of one of us, the results obtained recently (Roychoudhury) are of interest as showing (*a*) that activated charcoals have generally a negative charge but become positive on sustained washing; (*b*) a relationship between the sign of the electric charge and acid or alkali adsorption; (*c*) the primary adsorption of $H^{\cdot}$, OH', Cl', and SO_4'' ions; (*d*) an anomalous effect of the mass of the adsorbent on the adsorption of acids; (*e*) that alkaline extracts can be obtained even from activated sugar charcoal; (*f*) that both cations and anions are possibly formed during activation, their nature and amount depending on the treatment.

Moreover, the facts observed previously (Frumkin, Schilow), that the adsorption of acid is not determined by the activity of hydrogen ions, that both hydrogen and oxygen charcoals adsorb benzoic acid equally, that hydrogen charcoal adsorbs acids, and the part played by the ash constituents, also suggest a limit to the applicability of the gas electrode theory in this instance.

J. N. MUKHERJEE.
S. P. ROYCHOUDHURY.

Department of Chemistry,
University College of Science and Technology,
Calcutta, July 8.

[1] *J. Indian Chem. Soc.*, **2**, 219; 1925.

Orientated Deposits of Copper on Bismuth.

WHEN copper is deposited electrolytically from copper sulphate solution on a cleavage surface (0001) of bismuth with extremely low current density, the minute copper crystals show distinct orientations under the microscope (Fig. 1).

The triangular shaped crystals, nearly equilateral, are of light bluish colour and their sides are parallel to the cleavages $(0\bar{2}21)$ on the surface (0001) of bismuth. The parallelogrammatic shaped crystals, dark in colour, have their longer axes parallel to any of the three directions.

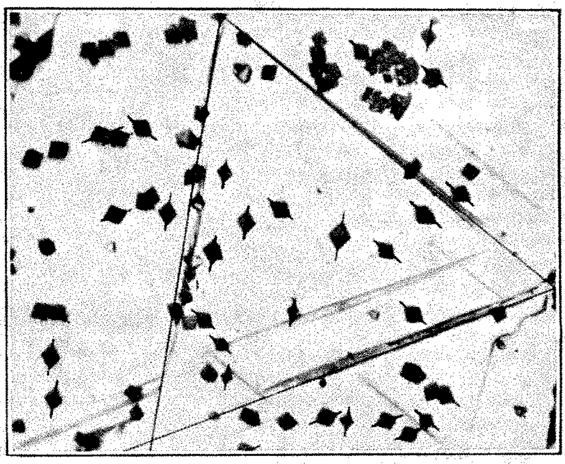


FIG. 1.—Crystals of copper deposited on bismuth. Lines have been drawn marking the long axes of the copper crystals and outlining the bismuth crystal.

The reason for this may be explained by the hypothesis of 'epitaxie' of L. Royer.[1] The details of this investigation will be published in the near future, in the *Memoirs of the Faculty of Engineering*, Hokkaido Imperial University, Japan.

YOSIMITI HORI.

Faculty of Engineering,
Hokkaido Imperial University,
Sapporo, Japan,
July 11.

[1] L. Royer, *Bull. soc. franç. minéral.*, **51**, 7; 1928: *Compt. rend.*, **182**, 326; 1926: **191**, 1346; 1930, etc.

Rotation of 'Dust Devils'.

THE direction of rotation of 'dust devils' has been noted in Lower Egypt and Iraq during the past four years, and the reports received in this office indicate that in about 50 per cent of cases the direction of rotation is clockwise, and in the other 50 per cent anticlockwise. This seems a surprising result, because if a 'dust devil' is due to the raising of dust and sand by the vigorous upward movement of air over a limited area, the rising column should assume an anti-clockwise rotation. I had an opportunity recently of watching the formation of numerous small whirls over a hot sandy space. The whirls did not attain a height of more than 2 ft., and the objects raised were leaves and feathers (not sand); the eye of the observer, being at a height of about 4 ft. 6 in., was well above the rotating column. Thirty disturbances were observed in about twenty minutes, and in no case was the rotation other than anti-clockwise (that is, cyclonic).

It occurred to me then that perhaps a discrepancy was being introduced in observers' reports, because the level of the eye in relation to the part of the column where rotation was observed is important. A clockwise rotation looked at from below is anti-clockwise looked at from above, and an observer may be likely to look up in many cases when the 'devil' is not well defined at the ground.

An analysis of reports in which the sense of rotation is given with the observer looking down on the whirl, shows that 27 out of a total of 29 are reported as anti-clockwise (or cyclonic). Most of these observations came from one station, and observations are required from other stations before the apparently anomalous behaviour of 'dust devils' can be explained.

J. DURWARD.

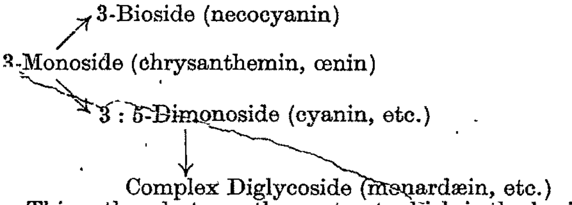
Meteorological Office, Heliopolis,
July 23.

Constitution of Anthocyanins.

As the result of synthetical work in Great Britain, combined with analytical observations by Karrer and his collaborators in Zurich, the position of the sugar groups in the main anthocyanins of the pelargonidin, cyanidin, and malvidin series can be fixed with a tolerably close approach to certainty.

We suggest that pelargonin, peonin, cyanin, and malvin are not biosides at all, but are di-monosides with separate glucose residues attached to positions 3 and 5 in the anthocyanidin nucleus. Mecocyanin, prunicyanin, keracyanin, and others of similar type, are, however, biosides; the biose group being in position 3. The arguments are a little too involved to put forward here in detail, but we wish to point out that the new idea of the constitution has an important consequence.

The anthocyanins are now considered to be related as follows:


3-Bioside (necocyanin)
3-Monoside (chrysanthemin, œnin)
3 : 5-Dimonoside (cyanin, etc.)
Complex Diglycoside (monardæin, etc.)

This rather destroys the contrast which is the basis of Miss Scott Moncrieff's interesting letter in NATURE of June 27, because the two types of anthocyanin are to be regarded as brethren rather than as cousins. Nevertheless, Miss Scott Moncrieff's rule holds in the majority of cases.

We have recently examined a large number of related varieties of garden flowers, and find that the two sugar types occasionally occur in varieties of a single species; thus both types of pelargonidin diglycoside *and* both types of cyanidin diglycoside are found in different sweet-peas.

G. M. ROBINSON.
R. ROBINSON.

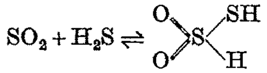
Dyson Perrins Laboratory,
Oxford, Aug. 18.

Reaction between Hydrogen Sulphide and Sulphur Dioxide.

IT is known that there is no reaction between hydrogen sulphide and sulphur dioxide in the dry state, and that mercury, benzene, or carbon tetrachloride have no effect on a mixture of the dry gases.

In the course of an investigation on the reaction between hydrogen sulphide and sulphur dioxide in non-aqueous solutions, we have found that the two gases when dissolved in benzene or carbon tetrachloride do react in the presence of mercury even when suitable precautions are taken to exclude moisture and oxygen from the reaction vessel. But a solution of hydrogen sulphide or of sulphur dioxide in either of the organic solvents has no action on the metal.

We have reason to believe that thiosulphonic acid is the primary product of the reaction between the gases:



$$SO_2 + H_2S \rightleftharpoons O_2S(SH)H$$

and that at the interface between the organic solvent and mercury the thiosulphonic acid is decomposed, producing sulphoxylic acid and the metallic sulphide. Displacement of the equilibrium in the above equation is caused by the formation of the sulphide, which lowers the interfacial tension between mercury and the organic liquid.

Further work is in progress.

BASRUR SANJIVA RAO.
M. R. ASWATHNARAYANA RAO.

Central College (Mysore University),
Bangalore, S. India,
July 16.

A Method of Studying Surface Films.

IF a substance, for example, ergosterol, is spread in a mono-molecular layer on the surface of water contained in the tray of a Langmuir-Adam apparatus for the measurement of surface films, it is possible to make the following observations.

Where a continuous mono-molecular film is formed, one is able to see that waves, produced at the surface by a tuning-fork, show a very strong diminution of their amplitude. The experiment is very easily performed: waves are produced by an electrically-driven tuning-fork, which is in contact with the surface of the water in the tray by a dipple: the wave-length of these waves can be about 0·4 centimetre. A beam of parallel rays is thrown vertically on the surface, where it is reflected. The reflected light is concentrated by a lens (5 dioptr.) in a single point on a scale. As soon as waves disturb the surface, the point is distorted into a straight line. Now, the influence of the spreading substances is to diminish the amplitude of the waves, and this is determined by a shortening of the line of reflected light.

We have studied different substances, and have observed that not every spreading substance shows the phenomenon in the same very striking way. Nevertheless, we believe that this method of studying surface films has some advantages. It is possible to make measurements at zero pressure, and the method gives results that are very well reproducible.

Proteins also show the phenomenon.

We hope that exact quantitative measurements of the effect will enable new capillarity constants to be determined.

E. GORTER.
W. A. SEEDER.

Leyden.

Insectivorous Snakes.

IN the letter of Messrs. Miller and Pagden in NATURE of May 9 it is stated that "records of insects having been devoured by snakes do not appear to be abundant". During some work on the parasites of snakes at Thandaung fifteen *Simotes violaceus* were dissected. In all cases the stomach and intestine were full of insect remains, sometimes very tightly packed and completely filling the lumen, chiefly those of a small brown grasshopper. In only one case were any vertebrate structures found: a small newt and a viper's tooth. Remains of insects were also found in *Natrix piscator*, *N. chrysargus*, and *Trimeresurus gramineus*.

F. J. MEGGITT.

Biological Department,
University of Rangoon.

Research Items.

Social Organisation in Manoa.—Miss Margaret Mead, while engaged during 1925–26 in a study of the adolescent girl in Samoa, was brought into exceptionally intimate touch with every household group in three villages on the north-west coast of the island of Tau, Luma, Siufaga, and Faleasao. Her observation of Samoan theory and practice in social organisation, which differ considerably *inter se*, are published as *Bull.* 76 of the Bernice P. Bishop Museum. The Samoan social organisation is an amalgamation and recombination of several distinct principles: hereditary rank, the functions and privileges of relationship groups, and the recognition of the organised village community with rights and privileges of its own. The dominant note in Samoan society is that all a Samoan's interest, all his emotion, is centred in his relationship with his fellows within an elaborate social pattern. Individual work and play, religious activity, art and personal relationship have never been admitted and receive scant attention from the society. All attempts at a development of personality along other than social lines are neglected and wither away. The taboo against a woman touching the bonito canoe is a survival, for such a taboo on women against the canoe as is found in the Marquesas and New Zealand has no place in Samoan culture, because neither men nor women in Samoa have any importance in themselves until translated into a social scheme. Thus the entry into a kava ceremony by a woman who had no right to be there might completely invalidate a whole communal undertaking, but not on account of her essential female potency, which here is negligible. With this emphasis on things done within the social pattern goes the complementary feeling that things done alone are suspect, if not downright wrong. The expectant mother, the young chief, and the bride-to-be must never be alone. This militated against the development of individual communion with the supernatural and against the formation of secretly cherished magical formulæ.

Indian Terra-cottas.—In the *Indian Antiquary* for August, Mr. K. de B. Codrington discusses the difficulties of dating Indian terra-cottas. Very few have been placed stratigraphically. There are four main groups of material for dating. (1) Two figurines, a rabbit, or cow, and a bridled horse, were found on the level of the brick floor two feet above the plinth of the southern of the two Râmpurvâ pillars. (2) *a*, Group of four figurines from Nîlgiri graves, mostly from pot-covers, in the British and Madras Museums: these are roughly modelled figures of men, women, and animals, hand-moulded with sticked-in details; *b*, a group excavated at the Bhir mound, among them a toy horse ascribed to the 'pre-Mauryan' period; *c*, fragmentary terra-cottas found in the monastery mound at Shâh-jî-kî-Dherî, a Græco-Buddhist site with Gupta surface finds. (3) Numerous terra-cotta figures excavated at Basârh, attributed to Kushan, Sunga, and Mauryan age, on slender evidence. A second group from this site is of importance. The figurines are of coarse workmanship, the eyes being represented by circles. They are from the same level as a seal ascribed palæographically to the fourth century. (4) Gupta fifth and sixth century terra-cottas. Dr. Coomaraswamy has recently compared figurines with the terra-cottas of the 'Indo-Sumerian' culture of Harappa and Mohenjo-Daro of 4000–3000 B.C.; but nothing from the two sites affords exact parallels. They are primitive only in the sense that they are very crude. Five of these figures have recently been acquired by the Indian Museum, South Kensington. Though technically they partake of the tradition of both Basârh and Shâh-jî-kî-Dherî, they belong rather to the finer Basârh. The technique and the details of the hairdressing and jewellery all point to the late second-first century B.C. as the date of origin.

Mammals of an Island Group (Pityusa).—The island group of Pityusa, of which the chief island is Ibiza (or in the "Times Atlas", "Iviza", grouped with the Balearic Islands), lies between the Balearics and the mainland of Spain. The mammal fauna, described by Dr. Otto Koller (*Sitzunsber. Akad. Wien*, Abt. 1, Bd. 140, p. 57; 1931), includes only ten species, but like most island faunas, presents features of great interest. There are endemic forms such as *Genetta* and *Erinaceus* and, perhaps, also *Crocidura*, all derived from the original fauna of the southern Spanish mainland; and it is evident that the basic fauna is common to the Balearic Islands and Pityusa. The separation from the mainland must have taken place in Pliocene times, but only later were the two island groups themselves separated. Thereafter, two new linkages appear to have taken place: a land-bridge between Pityusa and southern Spain permitted the immigration of *Martes foina mediterranea* and *Crocidura russula pulchra*, which are absent from the Balearics; while a union between the latter and the Corsica-Sardinia region gave them, instead, *Martes martes latinorum* and *Mustela nivalis boccamela*.

Disease-Resisting Turnips.—Trials with turnips at Craibstone, Scotland, described by W. M. Findlay (*Scottish Journal of Agriculture* (vol. 14), on land which is badly infected with finger-and-toe disease, have brought to light a disease-resisting variety. Although the history of this turnip, recorded under a variety of names, can be traced back for nearly one hundred years, its valuable properties do not seem to have been fully recognised. The Bruce, as it is proposed to call it, is a purple-top yellow turnip, of the dark-coloured bottom and flesh type, with certain additional characteristics such as purple colour in the ribs and veins of the leaf. The percentage of the dry matter in the Bruce, a property usually taken as an indication of quality, was found to be higher than that in a number of other types of turnip, and it also proved of equal feeding value to Green-Top Yellow (Challenger) in a milk production trial. As regards cropping on healthy soil, the Bruce headed the list of five varieties if the yield was reckoned on a dry matter basis; and when grown on land infected with finger-and-toe disease, it was the only strain that produced a good crop. Complete immunity is not claimed for the Bruce. Infection, however, appears to be confined to the roots, the bulbs themselves being rarely injured. The seed is small but germinates well, and is recommended in preference to larger seed of an inferior strain. Sowing on infected ground is advised if the crop is to be grown for seed, in order to maintain, and increase if possible, its disease-resisting properties.

Kansas Permian Insects.—A series of papers on Kansas Permian insects by Dr. R. J. Tillyard has been published during the last few years in the *American Journal of Science*. The present contribution (Part 13) deals with the new order Protelytroptera and appears in vol. 21 (March 1931) of the periodical mentioned. The fossils in question include seventeen specimens, of which four are more or less complete, and from a study of their characters Dr. Tillyard concludes that they are neither true Coleoptera nor ancestral to that order. After taking various possibilities into account, he comes to the decision that these fossils represent the ancestral group from which the existing order Dermaptera, or earwigs, has been derived. At the same time he suggests that the fossil remains that form the order Protocoleoptera may have been a remnant, which found refuge in Australia, of this new order. The solution of the affinities of the Protelytroptera is bound up with the venation and the method of folding of the hind wings, which appear to approach the earwig type more closely than any other. The elytra, or fore wings, on the other hand, are very much less shortened and of the nature of normal convex, hard wing covers. Not very much evidence is to be obtained from other parts of the body, but there appears to be no features directly contrary to the hypothesis that the order is ancestral to the Dermaptera. The new order is divided by Dr. Tillyard into no less than five families, including seven genera and eleven species.

Phenomena of the Upper Atmosphere.—Prof. S. Chapman's Bakerian Lecture, which is published in the August issue of the *Proceedings of the Royal Society*, summarises a number of efforts which have been made to attack mathematically the problems connected with dissociation and allied phenomena in the upper air. Although many of the numerical values of atomic constants which it is necessary to introduce are known only approximately, very considerable progress has been made, largely by Prof. Chapman himself, in the interpretation of existing observational data. Prof. Chapman has shown, for example, that the quite large amount of energy which is emitted in the form of general green auroral radiation during the course of a night is probably stored up as energy of dissociation—perhaps including ionisation—during the daytime; recombination is a process the rate of which is largely controlled by density, whilst the emission of light from the metastable atoms of oxygen which give the green line takes place, so far as is known, within a second or less of the formation of the atom, independently of the presence of other atoms or molecules, and hence these metastable atoms must have relatively long-lived ‘ parents ’. It follows from similar considerations that the emission of the green line probably occurs between heights of 100 km. and 200 km. Prof. Chapman discusses the origin of the ionisation in the main 100 km. layer which is responsible for the majority of ordinary atmospheric wireless phenomena, and shows that there is much support for the view that it is caused by a stream of neutral particles from the sun; he also suggests that the positive ions present in this layer are mainly molecular nitrogen, whilst those in Appleton's upper ionised layer are atomic oxygen. The position of the upper layer and the maximum density of electrons in it can be predicted very satisfactorily from the hypothesis that its ionisation is due to ultra-violet radiation.

Origin of γ-Rays.—In a paper in the August number of the *Proceedings of the Royal Society*, Lord Rutherford and Dr. C. D. Ellis discuss the nature of the nuclear changes which lead to the emission of γ-rays. Their starting point is the now well-established fact that many α-particle emitters give not a single α-particle but a group. The implication is that the α-particles in the nucleus can exist in states of different energy, and it is a reasonable hypothesis that transitions of the α-particles between these states occur in which γ-rays are emitted or the available energy is transferred directly to an extranuclear electron in the atom. There is strong evidence that energy differences in the α-particle groups for a given element are connected numerically with the energy of its γ-rays, but since the energy of α-particles can be found only rather less accurately than the energies of γ-rays, the numerical data used in this paper are drawn from measurements made upon the latter. The particular model of the nucleus of which use is made is one in which different numbers of α-particles are excited to the same quantum state, apparently the exact opposite of what occurs with the extranuclear electronic systems, where such an arrangement is eliminated by the Pauli exclusion principle. From this it is shown that it would be expected that the energies set free in transitions should be given to a first approximation by an expression of the form $E=pE_1-qE_2$, p and q being integers, E_1 a difference in energy of two states (in the ordinary sense), and E_2 a smaller energy of interaction. This prediction is finally tested by making a diagram with the energies of the γ-rays shown as ordinates against integers as abscissæ, the points being placed so as to lie on diagonal lines. In the diagram given for radium C′, six diagonals are required for some forty γ-rays, and the fit is, on the whole, excellent. The same is true for a smaller number of rays from radium B. In addition to this detailed numerical work, the paper contains a discussion of a number of other points—in particular, the probability for various types of transitions of the α-particles.

The Photoelectric Effect.—The first July number of the *Physical Review* contains a paper by R. H. Fowler, analysing some recent careful experimental work on the effect of temperature on the photoelectric current from clean metals in monochromatic light. The experiments show that there is no sharply defined maximum wave-length for emission of photoelectrons, but that the photoelectric sensitivity falls off gradually at low frequencies, especially at the higher temperatures, so that the sensitivity curve can be followed to a frequency determined primarily by the delicacy of the current measuring device used. Mr. Fowler shows that these results are to be expected from Sommerfeld's theory of metals, and can be completely accounted for by the change in the velocity distribution of the electrons inside the metal with temperature. From the theory a graphical method has been developed for finding the work required to extract an electron from the surface, which makes use of the general form of a whole family of sensitivity curves, and is more certain than previous methods for finding the work function from similar data. At the same time, Mr. Fowler shows there is a necessary uncertainty of about one per cent in the results, so long as an ambiguity in the theory of photoelectric emission remains unresolved. The work-functions for silver, gold, and tantalum are 4·74 volts, 4·90 volts, and 4·12 volts respectively.

Organic Acids in Plants.—Nelson and Mottern, in the August number of the *Journal of the American Chemical Society*, describe investigations of the organic acids in barley, maize, oat, and rye plants. These all contain aconitic acid, which is also present in wheat, sugar cane, and sorghum. Oxalic, malic, and citric acids are also present. Barley contains malonic and tricarballylic acids, whilst maize contains no malonic acid but tricarbalyllic acid. The percentages of oxalic acid in the fresh plants varied from 0·019 (barley) to 0·048 (rye).

Organic Gold Compounds.—The use of the Grignard reagent in the preparation of organic gold compounds has been shown to be limited to the ethyl radical and less electronegative radicals. In the August number of the *Journal of the American Chemical Society*, Kharasch and Isbell describe the action of anhydrous gold chloride on aromatic compounds, which is found to lead to the introduction of gold into the aromatic nucleus and the formation of a compound, $RAuX_2$. Direct 'auration' is thought to be as general a reaction as nitration, halogenation, or mercuration, except that it is much more rapid and the products are much less stable. Nitrobenzene, however, dissolves gold chloride without undergoing reaction. Phenyl, tolyl, and diphenyl auric dichlorides, methyl salicylate auric dichloride, and *o*-nitroanisole auric dichloride are described. The second paper deals with the gold imide compounds. The gold imide complexes are very stable, and do not give tests for gold with stannous chloride or oxalic acid. They are represented by the general formula $H^+[Au(imide)_4]^-$, and are called imido-auric acids on account of the similarity of their structure to that of chlorauric acid. They are obtained by direct combination of auric hydroxide and the imide. Succinimido-auric acid is a stronger acid than carbonic acid.

Insulation of Overhead Transmission Cables.—At the international conference of high-voltage electrical engineers which met in Paris recently, H. O. Austin read a useful paper on the insulation of overhead lines for high pressures, an account of which is given in the *Electrician* for Aug. 7. He stated that increasing the number of insulators does not necessarily diminish the number of breakdowns on a transmission line. It may, in fact, increase the number of transient currents due to switching operations or to lightning. Many operating records show that troubles arising from sudden 'flashovers' of the current over strings of insulators, due to the line either being directly struck or having high voltages induced in it by lightning flashes, are greatly increased by great height. He mentioned that the 220-kilovolt line of the Hydro-Electric Commission of Ontario, which uses short spans and has the earth and conductor wires at relatively low heights above the ground, has been working very satisfactorily. Owing to the appearance of corona discharges when the three-phase lines are close together, it is usual to put them several feet apart. This increases the reactance of the line and the cost of its erection. He suggests that the conductors should be coated with a suitable insulating paint or covering so as to prevent the formation of the corona and permit close spacing. This seems to us an excellent suggestion. If the thermal conductivity of the paint were high, its use would appreciably increase the carrying capacity of the line. In addition, it would go a long way towards preventing interference with radio communication, which is serious when brush discharges take place. The presence of dew in the early mornings on lightly loaded lines favours these discharges and sometimes causes the line to flashover. A slight temperature increase of the lines, obtained, for example, by allowing a large current to flow for brief periods, would prevent the formation of dew.

Astronomical Topics.

The Mass of Neptune's Satellite, Triton.—We learn from a *Daily Science News Bulletin* dated July 30, issued by Science Service, Washington D.C., that an attempt has been made to obtain this mass with the 60-inch reflector at Mount Wilson by Dr. S. B. Nicholson, Dr. A. van Maanen, and Mr. H. C. Willis. A series of photographs of Neptune were taken when near its stationary point, so that the same comparison stars could be employed for several nights. The method, of course, involves the determination of the small shift of Neptune due to its motion round the common centre of gravity of itself and Triton. The problem is evidently rather too difficult for solution at present, as the values obtained for the mass range from 0·01 to 0·04 of that of the earth. The first value is a little less than that of our moon, the second is about equal to that of Mercury and to the largest satellites of Jupiter and Saturn. It might have been anticipated *a priori* that the mass of Triton probably lies between these limits. It is conjectured in the above *Bulletin* that the mass of Pluto may be about the same as that of Triton; but there seems to be good reason for thinking that Pluto's mass is considerably greater than the above values.

Lunar Circles.—In a note appearing in the issue of *Scientiarum Nuncius Radiophonicus* for June 25, under the heading "Johannes Boccardi—De efformatione circorum lunarium", the ballistic theory of the origin of lunar circles is discussed. This theory regards the circles as the results of deformations of the moon's surface caused by shocks produced by enormous celestial projectiles. It does not seem possible that such projectiles could have been small satellites of the earth captured by the moon, so that they could only have been gigantic meteorites. This view the author decides to be improbable for various reasons. First, although the earth has a surface area thirteen times as great as that of the moon, there is no evidence that it has ever been struck by projectiles of the dimensions necessary to form the lunar circles. The only terrestrial formations analogous in any way to these circles occur in Arizona and are on a vastly smaller scale. Moreover, the fact that the lunar circles lie in chains indicates a common and approximately simultaneous origin. The most powerful telescopes fail to reveal any such circles on the planet Mars. In the light of these considerations, the author deems the ballistic theory of this phenomenon to be untenable.

Comet Notes.—Prof. G. van Biesbroeck contributes to *Astr. Jour.* No. 958 a discussion of the definitive orbit of the comet 1925 *j* = 1925 VII, which he himself discovered on Nov. 1, 1925, in the same telescopic field as 1925 *c* (Orkisz), which he was observing. 280 observations are used, extending over seven months. The following hyperbolic orbit was obtained:

$$\begin{array}{rl} T & 1925 \text{ Oct. } 2{\cdot}97348 \text{ U.T.} \\ \omega & \left.\begin{array}{rrr} 106^\circ & 24' & 12{\cdot}0'' \\ 334 & 33 & 43{\cdot}4 \\ 49 & 19 & 15{\cdot}9 \end{array}\right\} 1925{\cdot}0 \\ \Omega & \\ i & \\ \log q & 0{\cdot}1948557 \\ e & 1{\cdot}0004276 \end{array}$$

The excess of *e* over unity is eighteen times its mean error, so it is well established. He then applied perturbations by Jupiter and Saturn for the seven preceding years (on the lines adopted by Prof. E. Stromgren), and found that on Feb. 19, 1918, the orbit was elliptical with *e* 0·999820 and period 811,000 years. This is referred to the centre of gravity of sun, Jupiter, Saturn. It is shown that the orbit previously to 1918 was permanently elliptical. This result agrees with that for all other comets that have been similarly tested.

It would be interesting in these cases to trace the comet's course in the future, as well as in the past. The departure of a comet from the solar system would be nearly as interesting as the introduction of a comet from outside the system.

Echinoderm Larvæ.

PROF. MORTENSEN'S "Studies of the Larval Forms of Echinoderms", reviewed in NATURE for Dec. 8, 1921, is well known. He has now issued two sets of additional notes,* one resulting from a visit to Amboina and the Kei Islands in 1922 and a journey to Java, Mauritius, Cape Town, and St. Helena in 1929–30, the other describing observations made at the Swedish Zoological Station of Kristineberg in 1918. These notes are directed to making known the form of the various larvæ, with the view, first of correlating the larvæ with the adults of their species, and secondly of seeing what light their comparison may throw on the relationships of species, genera, and families. The memoir includes a summary of similar observations published since 1921 and is noteworthy for the beautiful illustrations, many in natural colours, by the author himself.

Difficulties inseparable from travel and especially an unfortunate accident with fouled water make the notes less complete than was hoped, but many points of interest are recorded. For example, the form previously described as *Echinopluteus transversus* is now unexpectedly found to belong to *Diadema* and possibly allied genera. The inference from its muscular system that this larva must swim by moving its long post-oral arms is now confirmed by observation; the movements are quick, rhythmical, and interrupted, recalling the jerky motion of puppets. Certain observations on cultures of these larvæ showed how dependent the rate of development is on physical conditions. Retardation increases the possibility of transport by currents, and is a factor in the geographical distribution of adults.

Turning to brittle-stars, one notes that two species of *Ophiactis* prove to have the same type of larva, so that in this class also the larval form may have a bearing on classification. On the other hand, a star-fish, *Archaster typicus*, differs from the somewhat similar *Astropecten* in the possession by its larval form of a Brachiolaria stage. The question arises whether the Brachiolaria or Bipinnaria stage is the more primitive, and Prof. Mortensen again gives reasons for regarding the simpler Bipinnaria as the forerunner of the Brachiolaria. This may be, and yet the conclusion that the brachiolarian sucker is not homologous with the pelmatozoan stalk may not follow, for, as Prof. MacBride insists, the fixed stage may have been dropped by *Astropecten* and similar forms as unsuited to their muddy or sandy habitat. It is to be noted that the two or possible three species in which Prof. Mortensen detects a brachiolarian stage live on or near hard coral-reef.

The larvæ of allied forms often manifest other differences, which, while seeming to be fortuitous variations, may depend on some physical factor. Thus in many ophiurid larvæ the front 'arm' on the right is longer than that on the left, and in one species it also loses its band of cilia. More curious is a difference in the development of the hydrocoel ring (the rudiment of the water-vascular system): in *Amphiura filiformis* the hydrocoel in forming this ring grows upwards and bends round above the œsophagus; in *Ophiura albida* it bends below the œsophagus to achieve the same ultimate result.

This selection may conclude with a couple of notes on adult sea-stars. In two species of *Archaster* "a kind of copulation takes place, the male lying on the back of the female"; his rays alternating with hers. A small fish, *Fierasfer*, has long been known to take shelter within various Cœlentera and Echinoderma, but Prof. Mortensen has found it within the actual body-cavity of two species of the cushion-shaped sea-star *Culcita*. Since the body-cavity of an echinoderm has no direct opening to the exterior, the occurrence offers as great a puzzle as how the apples got into the dumplings. Prof. Mortensen suggests that the fish enters the sea-star's mouth and bites a hole in the stomach wall through which it enters the body-cavity; it probably feeds on the genital organs, and, when it wants to breed, bites its passage out again.

Prof. Mortensen has brought back much from his travels and has shown how much more there is to be learned in these tropical regions if only better aquarium facilities could be provided.

F. A. BATHER.

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* Det Kgl. Danske Videnskabernes Selskabs Skrifter: Naturvidenskabelig og mathematisk Afdeling. 9 Række, IV, 1: Contributions to the Study of the Development and Larval Forms of Echinoderms, I-II. By Th. Mortensen. Pp. 39+7 plates. (København: Andr. Fred. Høst and Søn, 1931.)

The Artificial Coniferous Plantation and its Place in Forestry.

THE afforestation programmes being undertaken in New Zealand by private companies and the State Forest Department have been the subject of comment in NATURE (Feb. 14 and April 18, 1931). That further consideration of these programmes would appear to be not without its importance is brought about by the opinions expressed by the Director of the State Department on the subject of artificial coniferous plantations versus indigenous forest, a question which at the present day has almost a world-wide importance. Mr. E. Phillips Turner, Director of Forestry in New Zealand, in answer to frequent demands on the subject, has prepared a brochure (*Circ.* No. 31, N.Z. State F.S., 1931) entitled "Trees used in State Afforestation in New Zealand". The Circular should be consulted for the valuable information given under each of the chief species (mainly conifers) made use of. These may be noted as *Pinus ponderosa*, *P. laricio*, *P. radiata*, Douglas fir, larch (*Larix europœa* and *leptolepis*), *Sequoia sempervirens*, *Cupressus Lawsoniana*, *Thuya plicata*, *Pinus strobus*, *P. muricata*; and a few others of lesser importance. Eucalypts were originally grown on a considerable scale in the early years of the work of the State Forest Department; they are, however, so subject to attacks of various insects that they are not now being planted. Poplars are being experimented with and are thought to have a considerable future.

The great temptation to concentrate on the artificial conifer plantation is due to the extraordinary rapidity of the growth of some of the exotics in New Zealand. That every country is adopting a correct policy in endeavouring to provide, in so far as possible, for its own requirements in coniferous softwoods is conceded. But the time would appear to have arrived when a halt should be called in a policy which seeks to substitute the artificial coniferous plantation (planted, it may be admitted, on areas of poorer soil) for the valuable indigenous hardwood forests of the country, the ultimate disappearance of which under the axe of the exploiter or by fire is being accepted as inevitable.

The Director of Forestry states that experiments are being made to test the practicability of re-establishing the native softwoods in cut-over State forests, when the land is not suitable for farming. Experiments are being made with Kauri, the New Zealand valuable timber tree, "to test the practicability of working a Kauri forest on a sustained yield plan" and the possibility of re-establishing Kauri on tea-tree scrub lands which formerly carried Kauri forest. As regards indigenous hardwoods, the various species of southern beech (*Nothofagus*) are said to be quick growing. Beech forests are therefore to be managed for the production of future hardwood requirements.

The concluding paragraphs of the brochure sum up the opinions held by the State Forest Department. It is pointed out that, after the naturally-grown forests of native trees have been cut over, there will be an end of the splendid wide and clean boards now being obtained, and that thence boards of natural timber will be mostly narrow and more or less knotty, such as the red and white Baltic deals exported to Great Britain (the writer must be confusing the British-grown material with that of the Baltic, which usually is free from knots). Secondly, it is anticipated that fabricated boards, etc., made from disintegrated wood will largely replace natural timber, and knotty timber can be used for the former without any serious difficulty. Thirdly, and in spite of the recognition by the Forest Department that they must eventually disappear, it is said that it will be apparent to all "that the remaining splendid stands of indigenous timber, which Nature has provided us, should be used with the greatest care and economy".

Attention has been directed (NATURE, Feb. 14) to the private companies which have been formed in New Zealand to promote afforestation work. Many of these companies have been federated into an Association which represents a combined capital of £5,000,000. The objective of these companies is the ultimate afforestation of a million acres of exotics. It is recognised that this work to be done expeditiously is a purely business proposition, quite outside the capacity of a State Department, which could not be granted the funds from the public purse to carry it on with such rapidity.

As a result of the War, several of the European countries are making arrangements to increase their areas of coniferous softwoods. In France, for example, there are extensive stretches of very poor heather, etc., clad lands in the Plateau Central, for the afforestation of which an extensive propaganda is being carried on. Whilst the Government Forest Department is undertaking a certain amount of work, the aim is that the greater part of the afforestation work shall ultimately be done (with grants when necessary from the State) by the private proprietor and the village communities owning the land. But this recognition does not involve the sacrifice of her magnificent hardwood forests, chiefly of oak and beech, which have been under an increasingly fine management since the days when Colbert (1660) first ordered an investigation into the methods in force in the State forests.

With such examples before her, it would appear to be an irremediable disaster for New Zealand to sacrifice those of her fine indigenous forests still left, without an effort to save them, and the markets dependent upon them, for future generations.

The Mellon Institute.

ON the occasion of the award of its medal to Messrs. A. W. Mellon and R. B. Mellon, the founders of the Mellon Institute of Industrial Research, Pittsburgh, U.S.A., the American Institute of Chemists has devoted an issue of its bulletin to an account of the inception and progress of the Institute. According to the *Chemist* for April, its foundation in 1913 was a direct result of the success of the inauguration of the industrial fellowship system in the University of Pittsburgh. Twenty years after the adoption by Dr. R. K. Duncan of this method of combining education with industrial profit there are in operation sixty-four such fellowships, the work being conducted by 109 fellows and 31 assistants. The extent to which the value of the Institute as a servant to industry has been realised may be gauged by the fact that for ten years after its establishment, in accommodation believed to provide for future growth, the waiting list was almost as long as the list of companies whose problems were already being investigated.

A new home, some three hundred feet square and eight stories high, and designed in the Ionic style, will be a notable monument to the economic success of industrial research and the esteem in which the organisation is held in a progressive industrial country.

The industrial research carried out by the Institute is organised on a contract basis. The problem is set by, and the results become the property of, the donor of the fellowship; the worker is found and engaged by the Institute and provided with the broadest facilities for a minimum period of one year. Only one investigation is carried out on a particular subject at any one time. The prosecution of fundamental scientific investigations is not neglected, funds being available for application to this essential precursor of industrial development. All questions of publication, patent protection, or advertisement are determined by consultation with the donor, whilst all forms of co-operation which do not violate the necessary limits of confidential operation are encouraged.

The Institute stimulates the holders of fellowships to put forth their best efforts by affording both freedom and sustained support. Besides creating new industries and strengthening old ones it has thus produced a body of trained and practised investigators, who have played no small part in advancing the industrial position of the United States of America.

On its educational side, the Mellon Institute is worthy of special attention. The education which is afforded is not merely scientific, but also social; it is concerned with the personal and official duties of research staffs, with commercial procedure, with professional ethics, and with industrial psychology. The worker is trained to convey and interpret the results of his scientific work to the non-scientific business man in such a way that the latter can estimate its commercial value and appreciate its possibilities. The effort is being made to raise the professional status of the research worker by encouraging the proper type of man to engage in scientific professional work, and by improving his economic position. Equally important is the effect on the outlook of those entrusted with the direction of affairs, both in individual industries and in national and international trade.

The increasingly dominant position of science cannot be overlooked, and it becomes essential in the modern world that those who are given responsibility should also be equipped with knowledge. America is justly proud of the Mellon Institute; it is an institution which deserves the careful study of progressive nations.

Rock-Paintings in North-West Australia.

THE paintings in rock-shelters and caves of north-west Australia, which differ in type from those of other parts of the continent, were first seen and described by Sir George Grey in 1839. These paintings and others from adjacent sites have now been examined by Mr. A. P. Elkin, who has discussed their meaning with the Ungarinyin tribe of Walcot Inlet. The results are published in *Oceania*, vol. 1, No. 3.

In one of the caves, it has been customary to deposit the bones of the dead after they have been exposed in platform-burial and 'cried over'. This is a great honour, only conferred on fully initiated men who die before they are old enough to be considered 'close up' dead. The bones are painted with red ochre "to keep them clean". Each horde has its own picture gallery. The paintings are in black, white, red, and yellow. One case of the use of blue is recorded. The most remarkable painting is that of a man placed horizontally and thirteen feet from crown of the head to sole of the foot. Smaller figures near-by, two of them female, are his 'children'. He has eyes and nose but no mouth, a peculiarity of all the human figures, the natives saying that "it cannot be done". The face is partly surrounded by a horseshoe-shaped head-dress representing the band of red ochre which the natives paint on the forehead and the face. Projecting from this are red lines with black tips representing the hair. Small round rings near the feet are a ground fruit, *nalgo*.

The paintings as a whole may be divided into representations of the human figure, especially the head; various objects, such as the sun, water-lilies, *nalgo* fruits, snakes, crocodiles, kangaroos, and the like; and, lastly, stencilled hands. Some of the paintings are obviously of a considerable age and are partly obliterated. The natives say they do not make these pictures; but they retouch them. The heads without mouths are retouched as a rain charm, usually just before the wet season, but the charm is effective even in the dry season. Rain is the totem of the horde. If the headman dreams that he has retouched the figures, it is equally efficacious. Connected with their significance as the power that brings rain is the association with the 'rainbow-serpent', which is sometimes regarded as the totem of the head figures, a snake being shown with them. The retouching of the female figures causes an increase in babies, which the rainbow spirit makes and brings to the water-holes in the rain. Retouching the animal and vegetable figures leads to an increase of the species depicted.

Radioactivity and Earth Movements.

THE Geological Society of Glasgow has published (*Trans.*, vol. 18, pp. 559-606) a lecture by Prof. A. Holmes, given in 1928, which he has expanded into a valuable memoir on the cause and distribution of the major movements in the earth's crust.

The fundamental fact in geological history is the alternation of periods of powerful earth movements and active vulcanism with long intervals of repose. Prof. Joly explained this alternation as due to the accumulation of radioactive heat and its escape at periods of diastrophism. That theory has been generally rejected owing to its lack of agreement with the main facts of geological history. Prof. Holmes upheld it in a modified form; but he has now abandoned it. He retains the action of radioactive heating, and rejects J. W. Evans's suggestion that the heat thus generated has been used in physical changes in the minerals around the disintegrating radioactive material.

Prof. Holmes attributes the main earth movements and crustal disturbances to convection currents in the fluid substratum. He establishes the existence of this fluid layer in his preliminary discussion, which includes a critical summary of recent literature on the major structure of the earth's crust, and of the evidence given by near earthquakes. Amongst other instructive conclusions are that "we may regard the Pacific crust as being like that of the continents" (p. 570). Prof. Holmes regards the primary convection currents in the fluid substratum as analogous in direction to those in the atmosphere, and corresponding in directions to those of the trade winds and monsoons. The persistent trend in one direction would therefore occasion continental drift, at a rate which Prof. Holmes estimates at three miles in 100,000 years. The formation of the Atlantic basin by such drift would take 100 million years.

The paper shows many striking agreements between the main mountain lines, the ocean basins, the distribution and origin of rift valleys, and oceanic transgressions and those that would result from such deep-seated currents. Isostasy is accepted for minor modifications of the main structures.

Acceleration of Fermentation by Algæ and Sea-water.

THE results of investigations carried out during the past few years show that alcoholic fermentation is accelerated (1) by the various vitamins to different extents, and (2) by cholesterol and ergosterol, which are supposed to contain, in greater or less proportion, the provitamin of growth. In view of the fact that, apart from the organic materials dissolved or suspended in sea-water, marine algæ constitute, either directly or indirectly, the sole food of marine animals, it seemed of interest to ascertain what effects these algæ would exert on the course of fermentation.

In the *Atti della Reale Accademia Nazionale dei Lincei* for Jan. 18, Dr. Pirrone, of Messina, describes experiments which demonstrate that *Ulva lactuca* (*L.*) *Lejol*, either in the fresh state or when dried, accelerates the fermentation of glucose very considerably. This effect is due to the presence in the alga of one or more organic substances, probably existing as sols, which are soluble in water, alcohol, or ether at the ordinary temperature.

Experiments made by De Fazi in 1927 yielded results which indicated that the velocity of the alcoholic fermentation of glucose solutions prepared with distilled water, previously sterilised and subjected to the radiations from a quartz mercury vapour lamp, was appreciably greater than that of a similar solution made with sterilised water which had not been exposed to such radiations.

Further experimental data communicated by Sanzo and Pirrone to the Accademia dei Lincei on Jan. 18 now show that freshly collected sea-water, if added to glucose solutions in proportions not exceeding 20 per cent, causes a marked increase in the velocity with which such solutions are fermented by yeast. If the sea-water is kept for about twenty-four hours after collection before being added to the glucose solution, this accelerating influence diminishes slightly in degree to a value which does not change with further storage of the water. The maximum effect is observed when the glucose solution contains about 13 per cent of sea-water, and increase of the percentage above 20 is accompanied by progressive diminution in the velocity of fermentation.

University and Educational Intelligence.

CAMBRIDGE.—Dr. A. Harker, St. John's College, has resigned his readership in petrology as on Sept. 30, and, in view of the recent replacement of the professorship of mineralogy by a professorship of mineralogy and petrology, the General Board does not intend to recommend to the University the continuation of the readership.

Dr. F. R. Winton, Clare College, has been appointed University lecturer in physiology for three years, and Dr. E. G. Holmes, Christ's College, has been appointed University lecturer in pharmacology for three years. Dr. T. W. Wormell, St. John's College, has been reappointed observer in meteorological physics for five years.

THE Council of the Institution of Naval Architects has awarded the Elgar Scholarship in Naval Architecture (1931)—£130 per annum for three years at Armstrong College, Newcastle-on-Tyne—to Mr. H. Lackenby, of Messrs. R. and W. Hawthorn Leslie and Co., Hebburn-on-Tyne, and the Earl of Durham Prize to Mr. J. A. Price, of H.M. Dockyard, Sheerness.

THE University of Cambridge has issued a pamphlet containing summaries, extending, on an average, to a page and a half, of 72 dissertations approved during 1929–30 for the Ph.D., M.Sc., and M.Litt. degrees. More than half of the candidates had come to Cambridge after taking their first degrees in other universities—14 in English universities, 5 in Australian, 16 in universities in other parts of the British Empire, and 4 in the United States of America. Ten were women. The dissertations are classified under departmental headings as follows: mathematics 10, physics 9, chemistry 8, botany 8, biochemistry 6, other departments of science 16, other departments 12. The corresponding figures for the preceding year are: chemistry 9, agriculture 6, geology 6, biochemistry 6, mathematics 4, botany 4, other science departments 9, other departments 12. Of the three candidates in the department of English, two were from the United States of America and one was from Aberdeen. It would be unscientific to infer that English, like the proverbial prophet, is not without honour save in her own country, but this distribution of the Cambridge candidates for higher degrees in English seems significant.

AMERICAN educational progress in 1930 is briefly reviewed in the January issue of *School Life* by a member of the staff of the Federal Office of Education. The enthusiasm for educational research displayed by Federal and State authorities and voluntary organisations is astonishing. The Federal Government has just completed a survey begun in 1927 of land-grant colleges, is half-way through a survey of secondary education to be finished in 1932, and has begun a survey, for which Congress appropriated 200,000 dollars, of the professional education of teachers. Educational problems of every kind are being subjected throughout the country to scientific examination with scant regard for traditional prejudices and with confidence in America's ability to find the right solutions. "No longer do school boards send delegates abroad to bring back ideas for our democracy. Our rapid advance in the sciences basic to education and our supremacy in mechanical lines open for us the road to world leadership." There is likewise a remarkably widespread ambition on the part of teachers to improve their qualifications. Summer schools in 1930 were attended by 421,000 teachers, or about 45 per cent of the total number.

Birthdays and Research Centres.

Sept. 6, 1870.—Prof. F. G. DONNAN, C.B.E., F.R.S., professor of general chemistry in the University of London, the Sir William Ramsay Laboratories of Inorganic and Physical Chemistry, University College.

The chief subjects under investigation at present in the laboratory which I have the honour to direct are as follows: Colloid sols and gels, electrochemistry, photochemical actions, absorption of light in the visible and ultra-violet, X-ray analysis, surface phenomena and molecular films, catalysis, heterogeneous reaction kinetics, chemical and other effects of electrical discharges in gases (active molecules and atoms), infra-red absorption and molecular structure, magnetic susceptibilities of chemical systems, dielectric phenomena and dipole moments, properties of highly dried liquids, scattering of light in liquids. The possibility of investigating such a wide variety of phenomena is due to the generosity of Imperial Chemical Industries, Ltd.

Sept. 6, 1876.—Prof. J. J. R. MACLEOD, F.R.S., regius professor of physiology in the University of Aberdeen.

It is generally recognised that carbohydrate metabolism is partly under the control of the nervous system, and so-called diabetic centres have been described in various regions of the brain. Donhoffer and I are finding that a lesion involving the anterior region of the pons but of no other region of the brain causes a marked hyperglycæmia, and that this occurs whether or not glycogen is present in the liver. The muscle glycogen is rapidly used up as a result of the lesion. It fails to produce hyperglycæmia after removal of the adrenal glands. Its effects are annulled by insulin. A method has also been evolved for the measurement of the amount of insulin in blood, and it is hoped that it will be possible by its use to supply direct evidence as to whether the internal secretion of this hormone varies under various physiological and pathological conditions in the manner described by other investigators using indirect methods.

Sept. 6, 1892.—Prof. E. V. APPLETON, F.R.S., Wheatstone professor of physics, King's College, London.

For some years now I have been specially interested in various geophysical problems, the chief of which has been the determination of the electrical structure of the upper atmosphere, using wireless waves as the exploring probe. The method of experimental attack used has been to send vertically upwards wireless waves of different frequencies and make observations on them when they return after being reflected at high levels. Thanks largely to the energy and skill of a group of investigators working for the Radio Research Board of the Department of Scientific and Industrial Research, whose efforts I have been permitted to direct, a large mass of information relating to the heights reached by waves of different length has been accumulated. Since different concentrations of ionisation are required to turn back waves of different length, it is readily seen that the data mentioned yield information relating to the variation of ionisation content with height.

Up to the present a fairly complete study has been made of the diurnal and seasonal variation of the ionisation in the lower of the two ionised regions which have been found to exist, and attention is now being directed to similar observations for the upper region, which is found to be richer in ionisation. It is hoped to continue these measurements for at least one eleven-year sunspot cycle.

The results of such observations in England have directed my attention to the possibility of making similar observations at a place within the Arctic Circle, and in particular in the region of marked auroral activity; and next autumn it is hoped to send out a group of workers from England to investigate the upper-atmospheric ionisation at Tromsö in Norway. Such work will, I think, form a suitable item for the 1932–33 International Polar Year programme.

Sept. 7, 1877.—Sir John Cadman, G.C.M.G., past president of the Institution of Mining Engineers and of the Institution of Petroleum Technologists.

After occupying the chair of mining and petroleum engineering in the University of Birmingham, and controlling the petroleum executive during the War period, I became technical director and eventually chairman of the group of companies controlled by the Anglo-Persian Oil Company. In these capacities I have been able to apply my scientific and administrative experience to the complex organisation of a great industrial concern in which there existed a maximum opportunity for the application of science to industry.

I have given particular attention to the application of geophysics to geological work, of improved chemical and physical methods to the treatment of petroleum, to the elaboration of new oil products, and to the hydrogenation of coal and oils. The problem which is particularly engaging my attention at present relates to the balancing of the world's fuel supplies, having regard to their relative physical availability and the relevant economic factors.

Sept. 9, 1867.—Dr. Robert Mond, president of the Faraday Society and of the Egypt Exploration Society, honorary secretary of the Davy Faraday Research Laboratory, joint treasurer of the Palestine Exploration Fund and treasurer of the British School of Archæology at Jerusalem, and honorary trustee of the Royal Ontario Museum.

I am engaged in assisting astronomical, chemical, medical, agricultural, archæological, and prehistoric research in England, Egypt, Palestine, and Brittany, as well as keeping in touch with general scientific and technical progress.

Problems which are worthy of investigation are: (1) Preventive inoculation of cows against tuberculosis. (2) Production of clean, cool, raw milk of a quality fit for conversion to human food (specialised feeding of cows). (3) Methods of modification of such milk to suit individuals.

Subjects to which I have given attention and which require further elucidation are: (1) Study of rotary gas engines. (2) Alloys. (3) The time-lag between wholesale and retail prices.

Sept. 12, 1851.—Sir Arthur Schuster, F.R.S., formerly secretary (1912–19) and foreign secretary (1920–24) of the Royal Society; honorary professor of physics in the University of Manchester.

Old age and failing health prevent my taking any further active part in scientific investigation; but the reminiscences of a long life, which I am collecting, may direct attention to matters of scientific interest.

Societies and Academies.

Paris.

Academy of Sciences, July 6.—**R. Fosse, A. Brunel, and P. E. Thomas**: The application of the quantitative spectrophotometric analysis of allantoin to the blood of some mammals and to the seed of numerous plants. Figures are given for the allantoin found in the blood of some mammals and in a large variety of seeds. Two seeds are remarkable for the high proportion of allantoin they contain, *Phaseolus mungo* (0·18 per cent) and *Dolichos sinensis* (0·33 per cent).—**L. Cayeux**: The existence of organic residues and especially of verticiliate siphon Algæ in the limestone schist system of the Belgian Congo.—**S. Stoïlow**: The values of the analytical functions in the neighbourhood of the boundary of a domain of regularity.—**M. Fekete**: Suites of factors retaining the class of a Fourier's series and also of certain local individual properties of the corresponding function.—**Laurent and Augustin Seguin and André Labarthe**: An apparatus for the study of the phenomena of injection and of combustion in motors by the ultra-cinematograph. By means of a special arrangement of a neon tube and condensers, the apparatus described can take up to 100 photographs at the rate of 30,000 per second.—**Pan Tcheng Kao**: The velocity of propagation of aerial ultra-sound waves. A study of the velocity of propagation of ultra-sounds by Pierce's method.—**Ch. Dietsch**: A method of measuring high intensities of continuous current.—**Edouard Belin**: The secrecy of telegraphic and radiotelegraphic transmissions. The message is transmitted in its original form (telephotography or teleautography) and distorted by a special machine before transmission. At the receiving end is a similar machine worked the reverse way.—**G. Mahoux**: The influence of electromagnetic waves on the resistance and hardness of metals and alloys.—**Mme. M. Châtelet-Lavollay**: The comparative absorption spectra of complex salts of chromium and of trivalent cobalt.—**C. Marie and N. Thon**: The phenomena of expansion presented by certain electrolytic deposits of metals. The experimental method is based on the direct observation of the deformations undergone by a thin flexible cathode, one side of which is covered with an insulating material. Metallic deposits have a general tendency either to contract or dilate. The results vary with the conditions (nature of the solution, acidity, nature of the cathode, state of the surface, and so on) and have a practical interest from the point of view of the adherence of deposits and their defects.—**Mme. P. Curie and S. Rosenblum**: The magnetic spectra of the α-rays of the active deposit of actinon.—**A. Bates**: Temper and ageing of extra-mild steels.—**W. Broniewski and J. Król**: The cold hardening of iron.—**A. Michel-Lévy and H. Muraour**: The temperature of deflagration of colloidal (explosive) powders. In order to ensure identity of temperature of explosive and surroundings, the tests were made on shavings weighing from 1 mgm. to 2 mgm. For more than 150 explosives examined the deflagration temperature was round about 200° C. and not 170° as generally accepted.—**Grégoire**: The number of pairs of ions produced in air by an α-ray of polonium.—**Augustin Boutaric and Jean Bouchard**: The influence of light on the flocculation of colloidal solutions in a fluorescent medium. Rôle of coloured inhibitors and of the viscosity of the medium.—**Marcel Ballay**: Some properties of austentitic grey cast irons.—**M. and Mme. M. Lemarchands**: Concerning chemical inertia.—**J. J. Rutgers**: Modification of Pregl's method for determining nitrogen. The changes suggested are mainly directed towards reducing the time required for the determination.—**A. Sanfourche and A. Portevin**: The attack of various alloys by phosphoric acid solutions.—**P. Brenans** and **B. Rapilly**: Mercury salicylate.—**L. Debucquet** and **L. Velluz**: Organic compounds of tungsten and molybdenum containing sulphur. These metals form double sulphides with piperazine and piperidine: these are crystalline substances of definite composition.—**A. Mailhe** and **Creusot**: The transformation of benzene into methane. A quantitative study of the production of methane from a mixture of benzene and hydrogen in presence of reduced nickel as catalyst. Much higher yields of methane were obtained with benzene carefully freed from thiophene.—**Charles Dufraisse** and **Marius Badoche**: Researches on the dissociable organic oxides. Dihydroxy-dihydrorubrene, $C_{42}H_{28}(OH)_2$, a fourth product of oxidation reducible to rubrene.—**Yves Milon**: The evolution of the coast-line and the formation of tombolos in the Paimpol region (Côtes-du-Nord).—**François Ruellan**: The decomposition and disaggregation of the biotite granites in Japan and Corea and the resulting forms.—**Caulle** and **Idrac**: The phenomena of the whistling pits near Caux.—**M. Bridel** and **R. Lavieille**: The sweet principle of Kaá-hé-é (*Stevia Rebaudiana*). The products of diastase hydrolysis of stevioside; glucose and steviol.—**Pierre Chouard**: Specific correlations proved for some Portuguese Scilla (*Scilla monophyllos*, *S. Ramburei*, *S. odorata*).—**Emery**: Bacterial origin of the tumours of the elm. These tumours are proved to be of bacterial origin. They are caused by *Bacterium tumefaciens*. This organism has been isolated by the author from one of the tumours, and the process of invasion has been reproduced experimentally on another young elm.—**L. Lavauden**: A new *Propithecus* (*Propithecus Perrieri*) of Madagascar.—**E. Le Breton**, **F. Mocoroa**, and **E. Stulz**: The proteolytic ferments of the intestinal juice and of the pancreatic juice. It is concluded that only abnormal pancreatic juices contain ereptic ferments or kinase, or sometimes both. Independently of any kinase of pancreatic origin, the intestinal juice always contains ereptic ferments and enterokinase.—**Albert Leulier** and **Mme. Andrée Roche**: The mechanism of the antiglycosuric action of santonine. From the therapeutic point of view, santonine ought to be a useful adjunct to insulin in the treatment of certain forms of diabetes.—**Maurice Piettre** and **Boris Celan**: The formation of articular humours of fibrin apart from the fibrinogen of blood origin. The function of the white cells.—**Mme. J. Kostitzine**: The statistics of the infestation of hermit crabs by *Chlorogaster*.—**Néda Marinesco**: The electromotive force of filtration produced by the ascent of the sap in plants. It has been shown that it is possible to make the sap rise or fall more or less rapidly in plants by applying a potential difference to the stems. The results afford an explanation of the results obtained by acting with a high frequency field on some plant species.—**Jean Troisier** and **Roger Cattan**: Exanthematic fever in man, without visible symptoms, caused by *Rhipicephalus sanguineus*, its virulence for the ape and guinea-pig. A man inoculated with crushed *Rhipicephalus* showed no symptoms of the disease, but his blood was virulent to an ape (*Cercopithecus Patas*). A guinea-pig was also infected by the blood. The inoculated man, although showing neither fever nor eruption, gave a positive Weil-Felix reaction.—**Félix Bertyn**: The poisonous effect of the fogs of the Meuse valley is due to industrial emanations. The fatal effects of the fog in the Meuse valley during December 1930 have been variously attributed to the fog alone, or to this with some contamination with micro-organisms. The author puts forward evidence that neither of these hypotheses can account for the facts, and it is much more probable that the fumes from chimneys and from zinc works were responsible for the fatalities.

Leningrad.

Academy of Sciences, *Comptes Rendus*, 1931, No. 1.—**G. A. Nadson** and **G. Filippov**: The formation of new stable races of micro-organisms under the influence of X-rays. (2) Description of races of *Sporobolomyces*. New races obtained in cultures of *Sporobolomyces* under the influence of X-rays are described in detail. The races retain their morphological and physiological characteristics after hundreds of generations on different media, without exhibiting any tendency to revert to the original form. Some of the races differ from the original to such an extent that they might be considered as distinct species and even genera.—**N. F. Alexeenko**: Diatoms growing on stones on the Black Sea littoral near Sebastopol. The following species were found in large numbers: *Synegra gracilis* Kutz. var. *commutata* Grun., *Mastogloia interrupta* Hantzsch, *M. pontica* sp. n. and *Nitzschia reinhardi* sp. n. The two new species are described and figured, and comparative tables of species of *Mastogloia* and *Nitzschia* are given.—**A. Zachvatkin**: Periodic variations in the level and in the chemical composition of the water of Lake Gusinœ, Transbaikalia. Lake Gusinœ, like Lake Baikal, belongs to the system of post-Tertiary lakes. During the last two centuries the lake has sometimes been reduced to two small lakes, and then has again become very large in area. The chemical composition of the water has changed accordingly, the lake having been reported by some authors as a salt lake, while at present it contains fresh water. The fauna is very poor, which can be explained by the frequent changes in the salinity of the lake.—**A. Frank-Kamenetskii** and **V. Koncevich**: The chemical composition of the water of the hot springs in northern Transbaikalia. Twenty-seven groups of thermal springs have been investigated by the authors, who report on the chemical composition of the waters. Sodium sulphate is the main component of the water, while silicic acid and its salts are also common. The temperature of the water in different springs ranges from 32° to 80° C.—**D. Beliankin**: Anemusite (with reference to pacifites of Barth). The author, on the basis of analyses of anemusite and of pacifites, expresses the opinion that they are not basalts with anemusite, in the sense of Wright and Washington, but simply basalts with the excess of the aluminate, or aluminated basalts. The excessive aluminate is contained not only in plagioclase, but also in the pyroxene of the rock.

Washington, D.C.

National Academy of Sciences (*Proc.*, vol. 17, No. 5, May 15).—**A. L. Dryden, jr.**: Accuracy in percentage representation of heavy mineral frequencies. The present tendency is to count mineral grains in a section and express the result as a percentage. This can give higher accuracy than inspection of samples, but statistical methods indicate the importance of stating exactly how the result is obtained.—**Harvey Cushing**: (4) The method of action of pituitrin introduced into the ventricle. The characteristic effects of intraventricular injection of pituitrin are not observed when the hypothalamic nuclei are out of action.—(5) The counteractive effect of tribromethanol (avertin) on the stimulating response to pituitrin injected in the ventricle. The conclusions of the previous paper are supported by the fact that avertin, which is believed to act on centres in the diencephalon, counteracts the effect of pituitrin.—(6) Concerning a possible 'parasympathetic centre' in the diencephalon. Includes a review of the evidence of the foregoing five papers; it is suggested that the neuro-hypophysis bears a similar relation to the parasympathetic division that the adrenal medulla does to the sympathetic division of the autonomic nervous system.—**A. H. Sturtevant** and **Jack Schultz**: The inadequacy of the sub-gene hypothesis of the nature of the scute allelomorphs of *Drosophila* (see NATURE, Aug. 15, p. 273).—**L. V. Morgan**: Proof that bar changes to not-bar by unequal crossing-over.—**Chas. W. Metz** and **M. Louise Schmuck**: Differences between chromosome groups of soma and germ-line in *Sciara*. Deductions as to inheritance in *Sciara* based on chromosome counts in germ tissue require modification in view of the fact that the chromosome group for body tissue differs from that for germ tissue in both sexes.—**Myron Gordon**: The hereditary basis for melanosis in hybrids of Mexican killifishes.—**Mary Sears**: The responses of the deep-seated melanophores in the frog to adrenalin and pituitrin. The responses are similar but take place more slowly.—**Earle B. Perkins** and **Theodore Snook**: Control of pigment migration in the chromatophores of crustaceans. Pigment migration appears to be due to a substance produced by the eye-stalks and is of the nature of an interspecific hormone; the efficiency of the substance is increased by boiling the sea-water extract.—**Forrest Clements**: The correlation between tanning and unexposed skin colour as recorded by the colour top. Field studies on American Indians show high correlation between unexposed skin colour and degree of colour change by exposure; this correlation is negative for the black and red elements of the colour top and positive for the yellow and white. Thus, the darker the skin, that is, the greater the proportion of the black and red elements and the less the proportion of yellow and white, the less will be the amount of tanning on exposure. This suggests a possible exposure-index for ultra-violet light therapy.—**Henry B. Bull** and **Ross Aiken Gortner**: Studies on electrokinetic potentials (9). The electrical field of force at liquid-liquid interfaces. Salt solution is forced as a spray through a hole in one electrode and the charge carried to another electrode measured, the electrodes being immersed in oil. The curves obtained resemble closely the electrokinetic potential curves at cellulose-aqueous solution and glass-aqueous solution interfaces.—**Wilder D. Bancroft** and **G. H. Richter**: Reversible coagulation in living tissue (3). Evidence from the treatment of lunatics supporting the hypothesis that excessive dispersion or excessive coagulation of nerve colloids can cause insanity; these two forms of insanity obviously require different treatment.—**R. J. Seeger**: A critique of recent quantum theories.—**Paul S. Bauer**: Dissipative dynamical systems (1).—**B. O. Koopman**: Hamiltonian systems and transformations in Hilbert space.—**Marston Morse**: The order of vanishing of the determinant of a conjugate base.—**G. A. Miller**: Automorphisms of order 2 of an Abelian group.—**Tracy Yerkes Thomas**: On the unified field theory (6).

Official Publications Received.

BRITISH.

Journal of the British Wood Preserving Association. Vol. 1. Pp. viii+99. (London.) 7*s*. 6*d*.

Annual Report of the Council to the Members of the City and Guilds of London Institute to be presented at the Yearly Meeting in June 1931. Pp. lviii+85. (London.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1384 (Ae. 509—T. 3077): Tests of various Lateral Controls fitted to a Siskin Aircraft. By W. G. Jennings. Pp. 10+12 plates. 9*d* net. No. 1386 (M. 71—A. 77): The Influence of Titanium Tetrachloride on Cast Aluminium Alloys. By Dr. W. Rosenhain, J. D. Grogan and T. H. Schofield. Pp. 10+5 plates. 1*s*. net. No. 1387 (M. 72—A. 81): Gas Removal and Grain Refinement in Aluminium Alloys. By Dr. W. Rosenhain, J. D. Grogan and T. H. Schofield. Pp. 8+3 plates. 9*d* net. (London: H M. Stationery Office.)

The North of Scotland College of Agriculture. Calendar, Session 1931–1932. Pp. viii+118. (Aberdeen.)

Mean Hourly Values of the Magnetic Elements at Toolangi, 1928 and 1929. Observed and reduced under the direction of Dr. J. M. Baldwin. Pp. iv+7. (Melbourne: H. J. Green.)

FOREIGN.

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Danske Farvande i Vinteren 1930–1931 (The State of the Ice in the Danish Waters during the Winter 1930–1931). Pp. 12. (København: G. E. C Gad.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Supplement to Bulletin No. 91: The Soils of the Libyan Oases. By Dr. R. R. Le G. Worsley. 8 plates. (Cairo: Government Press.) 2 P.T.

Union Geodésique et Géophysique Internationale: Section de Magnetisme et Électricité terrestres Bulletin No. 8: Comptes rendus de l'assemblée de Stockholm, 15-23 août 1930. Publiés par les soins de Ch. Maurain Pp. x+479. (Paris: Les Presses universitaires de France.)

Journal of the College of Agriculture, Imperial University of Tokyo. Vol. 11, No. 2, March 28th. Pp. 75-240+plates 8-15. (Tokyo: Maruzen Co., Ltd.) 3.00 yen.

U.S. Department of Agriculture. Circular No. 167: Moss Peat, its Uses and Distribution in the United States. By A. P. Dachnowski-Stokes. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

Diary of Societies.

TUESDAY, SEPTEMBER 8.

INSTITUTE OF MARINE ENGINEERS, at 6.—President's Address.

LONDON NATURAL HISTORY SOCIETY (Botany Section) (at London School of Hygiene and Tropical Medicine), at 6.30.—A. W. Robbins: Some Preliminary Remarks on Brambles.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.

FRIDAY, SEPTEMBER 11.

INSTITUTE OF MARINE ENGINEERS (Official Visit to the Shipping, Engineering and Machinery Exhibition at Olympia). At 3.—A. C. Hardy: Marine Engineering as a Marketing Proposition. At 6.—A. R. T. Woods: The History of Marine Refrigeration.

CONGRESSES.

SEPTEMBER 1 TO 19.

INTERNATIONAL ILLUMINATION CONGRESS. (For Programme see NATURE, Aug. 29.)

SEPTEMBER 6 TO 12.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS (at Zurich).

Tuesday, Sept. 8.—Dr. W. Rosenhain: Chairman's Address. (Group A.)
  J. G. Pearce: The Structure and Mechanical Properties of Cast Iron.
  Prof. E. Piwowarsky: Der Grauguss und seine Prüfmethoden.
  Prof. A. Portevin: Caractérisation des propriétés mécaniques des pièces moulées en fonte grise.
  Prof. F. Pisek. Tests on Cast Iron—A Consideration of Test Results Obtained in Czechoslovakia.
  Dr. E. Dubi. Beitrag zu der Frage der Prufungsverfahren fur Gusseisen.
  Prof. J. Galibourg: Les métaux aux temperatures élevées.
  Dr. A. Pomp and Dr. W. Enders: Abkurzungsverfahren zur Bestimmung der Dauerstandfestigkeit des Stahles.
  R. G. Batson and H. J. Tapsell: Materials at High Temperatures.

Wednesday, Sept. 9.—Prof. P. Ludwik: Ermudung.
  Dr. H. J. Gough: The Present State of Knowledge of Fatigue of Metals.
  Dr. D. J. McAdam: Fatigue.
  Dr. P. Forcella: L'essai aux chocs répétés à flexion alternée sur les rails des chemins de fer italiens; essais de torsion altérnée de 360° sur fils de cables métalliques pour voies ferrées aériennes et funiculaires.
  Dr. E. Schulz and Dr. H. Buchholtz: Über die Entwicklung der Dauerprufung in Deutschland.

Thursday, Sept. 10.—Dr. M. Moser: Der Stand der Kerbschlagproben-Frage in Deutschland.
  Prof. R. Zoja: Essais au choc sur barreaux entaillés.
  Dr. M. Schmidt: Kerbschlagproben, Normenprobe.
  Dr. R. H. Greaves: Meaning of the Notched-Bar Impact Test for Investigation and for Acceptance Test Purposes.
  A. Steccanella: L'essai de résilience comme essai de reception.

Friday, Sept. 11.—F. F. Lucas: Advances in Microscopy.
  Prof. C. Benedicks and H. Lofquist: Progress of the Knowledge regarding Slag Inclusions in Iron and Steel.
  Dr. J. L Haughton: Progress of Metallography
  Prof. W. Guertler: Die neuere Entwicklung der Konstitutionsforschung der Legierungen.
  Prof. A. Westgren: X-Ray Investigations of the Constitution of Alloys.

Tuesday, Sept. 8.—Prof. M. Roš: Chairman's Address. (Group B.)
  Prof. R. Grengg: Anwendung mineralogischer und petrographischer Erkenntnisse auf die technische Materialprufung nichtmetallischer anorganischer Stoffe.
  Prof. P. Niggli: Anwendung mineralogischer-petrographischer Erkenntnisse auf die technische Materialprufung nichtmetallischer anorganischer Stoffe.
  Prof. G. Berg: Welche petrographischen Eigenschaften sind fur die technische Eignung der Gesteine von besonderer Wichtigkeit?

Prof. H. Burchartz: Die Verfahren zur Prufung von Strassenbau- und Gleisbettungsstoffen auf Widerstandsfahigkeit gegen statische und dynamische Beanspruchungen.

J. F. Cellerier: Etude des moyens de préservation des pierres naturelles.

Prof. J. O Roos af Hjelmsäter: Chemical Action of Aggressive Waters on Cement.

Prof. G. Wiegner: Chemische Einflusse auf Zement und Beton im Boden.

Prof. I. Vandone: L'unification mondiale des essais des mortiers et des bétons de ciment

Dr. G. Haegermann: Die Zementprufung.

Dr. L. Lili: Propriétés intimes du ciment portland et de leurs conséquences.

Prof. Q. Sestini and Prof. L Santarelli: Le fer dans la constitution des ciments et les ciments ferreux.

C. Vigliani: Comportement des ciments naturels et artificiels après de longs délais.

Dr. A. Perfetti and Dr. E. Palumbo: Influence des variations de température des ambiants de préparation et de conservation des éprouvettes de mortier normal sur leur résistance mécanique.

Dr. A. Perfetti: Influence de la quantité d'eau de gâchage sur la résistance des mortiers normaux de ciment aux essais mécaniques.

Prof. F. Klokner: Rapport entre la ténacite et la résistance des différentes sortes de ciment.

A. Maitre-Devallon: Détermination du dosage des mortiers et betons en ciment ou chaux hydraulique.

Wednesday, Sept. 9.—Prof. R. Grun: Zemente mit hydraulischen Zuschlagen.

Prof. F. Ferrari: Ciments et substances pouzzolaniques.

Dr. C. Vittori: Les ciments pouzzolaniques rationnels de Segni.

B. L. Katzigheras: Einige Ergebnisse von Untersuchungen mit Santorinerde.

Dr. E Rengade: Les ciments alumineux.

P. H. Bates: Suggested Investigations of High Alumina Cements.

Thursday, Sept. 10.—A. Pena Bœuf: Élasticité et résistance des bétons.

Prof. O. Graf: Über die wichtigsten Eigenschaften des Betons, uber ihre praktische Bedeutung und uber die Nutzbarmachung der Erkenntnisse.

Prof. L Santarella: Résistance et élasticité du béton.

Prof. W. A Slater: Designing Concrete for High Strength, Low Permeability, and Low Shrinkage.

Friday, Sept. 11.—Prof W. Gehler: Festigkeit, Elastizitat und Schwinden von Eisenbeton.

Prof. F E. Richart: Stresses and Strains in Reinforced Concrete Columns.

Dr. F. Emperger: Die Stauchungsfahigkeit des Betons.

Prof. J. A. Bakker: L'état des constructions en béton armé âgées de 20 ans et plus.

Tuesday, Sept. 8.—Prof. J. O. Roos: Chairman's Address. (Group C.)

Prof. H. Suida and W. Janisch: Asphalte und Bitumen. Eignung im Bau- und Strassenbauwesen.

P. Hubbard and C. S. Reeve: Methods of Tests or Bituminous Materials.

Dr. J. P. Pfeiffer.—Summary of Investigations made in Holland and her Colonies with Respect to the Description of the Identification of Woods, with a View to drawing up a Method applicable in Practice.

R. Schlyter: Researches into Durability and Strength Properties of Swedish Coniferous Timber.

Wednesday, Sept. 9.—C. J. Chaplain: The Development of Mechanical Testing of Timber in Great Britain with a Note on Preservative Treatments.

M. L. Monnin: Essai des bois.

Dr. A. Perfetti: Étude des caractéristiques mécaniques de quelques qualités de bois.

Prof. E. Casati: Essais comparés sur éprouvettes de dimensions différentes de quelques essences de bois.

Prof. K. Ryska. Einige Fragen aus dem Gebiete der technischen Prufungsmethoden fur Hölzer.

Prof. M. Roš and Dr. J. Brunner: Die Knickfestigkeit der Bauholzer.

Thursday, Sept. 10.—Dr M. van Rysselberge: Le vieillissement artificiel des huiles minérales spéciales.

Prof. F. Frank: Alterung organischer Stoffe, wie Kautschuk, Öle, Harze, Fasern usw.

Dr. G. Barr: Ageing of Organic Materials.

Dr H. Stager: Die Alterung organischer Werkstoffe.

Dr. C. H. Weiss and P. Woog: Unification de la désignation de la viscosité. Nécessité d'employer le coefficient de viscosité absolu statique ou le coefficient de viscosité absolu cinématique pour la mesure pratique de la viscosité.

Friday, Sept. 11.—Prof. K. Bunte: Probenahme von Kohlen, Koks und anderen Brennstoffen, sowie von Schlacken und Aschen.

Dr. E. S. Grumell and Dr. J. G. King: The Sampling of Coal and Coke.

W. A. Selvig: Sampling Coal.

Dr. F. S. Sinnatt: The Determination of the Fusion Point of Coal Ash.

Prof. K. Bunte: Methoden zur Bestimmung des Schmelzverfahrens der Asche.

Dr. R de Benedetti and Dr. G. Rossi: Détermination des matières volatiles dans les combustibles solides.

Prof. P. Schläpfer: Untersuchungsmethoden zur Bestimmung des Back- und Blahvermogens und des Treibdruckes von Steinkohlen.

Monday, Sept. 7.—Prof. W. v Moellendorff: Chairman's Address. (Group D.)

L R. Feret: La grosseur des grains des matières pulvérulentes.

Prof. A. H M. Andreasen: Theoretisches und experimentelles uber Korngrosse und Feinheit.

Prof. L. T. Work: Present Status of Particle Size Determination.

Dr. H. W. Gonell: Zur Frage der Bestimmung der Grosse loser Korner.

Tuesday, Sept. 8.—Prof. H. F. Moore: The Calibration of Testing Machines.

Prof. F. C. Lea: Accuracy of Measurement and Variability of Test.

W. Ermlich: Eichung und Genauigkeit von Prufmaschinen.

Thursday, Sept 10.—Prof. M. Roš and A. Eichinger: Begriffliche und prufmethodische Beziehung zwischen Elastizitat und Plastizitat, Zahigkeit und Sprödigkeit.

P. Regnauld: Relations entre l'élasticité et la plasticité, la ténacité et la fragilité. Moyens pratiques de les caractériser.

Prof. G. Sachs: Elastizitat und Plastizität, Zahigkeit und Sprodigkeit.

Prof. F. B. Seely: Ideal and Practical (Test) Relations between Elasticity and Plasticity, Tenacity and Brittleness.

Prof. A. Schob: Begriffliche und prufmethodische Beziehung zwischen Elastizitat, Plastizitat, Zahigkeit und Sprodigkeit.

September 7 to 10.

International Psycho-Analytical Association (at Interlaken).

September 7 to 10.

International Congress for Studies regarding Population (at Rome).

September 7 to 12.

International Congress of Orientalists (at Leyden).

September 9 to 12.

International Professional Association of Medical Practitioners (at Budapest).

September 13 to 18.

Institute of Metals (at Zurich).

Sunday, Sept. 13, at 7.30.—Ulick R. Evans: Thin Films on Metals in Relation to Corrosion Problems (Autumn Lecture).

Monday, Sept. 14 and *Tuesday, Sept.* 15.—Alkins and Cartwright: Experiments in Wire-Drawing. Part. I.—Behaviour of a Composite Rod.

Alkins: Experiments in Wire-Drawing. Part II.—Notes on the Relation between Reduction of Area by Cold-Drawing and Tensile Strength of H. C. Copper.

Blazey: Brittleness in Copper.

Brownsdon and van Someren: The Application of the Spectrograph to the Analysis of Non-Ferrous Metals and Alloys.

Cooke and Larke: The Physical Testing of Copper and Copper-Rich Alloys in the Form of Thin Strip.

Daniels: The Attack on Mild Steel in Hot-Galvanizing.

Dunn: The Oxidation of some Copper Alloys.

Francis and Thompson: The Drawing of Non-Ferrous Wires.

Hanson and Slater: Unsoundness in Aluminium Sand-Castings. Part I.—Pinholes: Their Causes and Prevention.

Hanson and Slater: Unsoundness in Aluminium Sand-Castings. Part. II.—The Effects of Using Metal Previously Subjected to Corrosive Conditions.

Haughton and Payne: Transformations in the Gold-Copper Alloys. With an Appendix on X-Ray Examination of Gold-Copper Alloys, by G. D. Preston.

Hume Rothery: The Marco-Etching of Aluminium-Silicon Alloys.

Jones, Pfeil, and Griffiths: Nickel-Copper Alloys of High Elastic Limit.

Jones: The Copper-Magnesium Alloys. Part IV.—The Equilibrium Diagram.

Kloninger, Keller, and Meuche: Applications of the Electric Furnace for Non-Ferrous Metals, with Special Reference to the Bright Annealing Process.

Kurnakow and Ageew: Physico-Chemical Study of the Gold-Copper Solid Solutions.

Murphy: Constitution of the Alloys of Silver and Mercury.

Newson and Wragg: Note on the Failure of a High-Strength Brass.

O'Neill: Note on the Diameter Measurement of Certain Brinell Indentations in Cold-Rolled Metal.

O'Neill and Cuthbertson: The Work-Hardening Capacity and Elongation Properties of Copper.

Smith: The Spectrographic Assay of some Alloys of Lead.

Smithells, Williams, and Grimwood: Melting Nickel-Chromium Alloys in Hydrogen.

Sutton and Le Brocq: The Protection of Magnesium Alloys against Corrosion.

Waterhouse and Willows: The Effects of Cold-Rolling and of Heat-Treatment of some Lead Alloys.

V. Zeerleder: Influence of Variations in Heat-Treatment and Ageing on Duralumin.

September 13 to 19.

International Medical Educational Congress (with special reference to Balneology) (at Carlsbad).

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SATURDAY, SEPTEMBER 12, 1931.

CONTENTS.

PAGE
Vanishing Life of Australia 425
Geophysical Prospecting 427
Treatise on Physical Chemistry. By Prof. Eric K. Rideal, F.R.S. 429
The Complete Evolutionist. By A. K. . . . 429
Short Reviews 430
The Origin of the Solar System. By Sir James Jeans, F.R.S. 432
George Graham, F.R.S., 1673–1751 435
Obituary:
  Dr. Richard Wettstein. By Dr. A. B. Rendle, F.R.S. 436
News and Views 437
Letters to the Editor:
  Quantum-Mechanical Models of a Nucleus.—R. H. Fowler, O.B.E., F.R.S. 453
  Polarisation of a Beam of Electrons by Scattering.—N. F. Mott 454
  The Spermatogenesis of Ticks.—Prof. Ernest Warren 454
  Diamagnetism of Liquid Mixtures.—Prof. Edm. van Aubel 455
  Measurements of the Height of a Large Drop of Mercury.—R. S. Burdon 456
  Polarity and Vapour Pressure.—Dr. A. R. Martin 456
  Atomic Hydrogen Occluded in Iron Nitride.—Shun-ichi Satoh 457
  Audibility of the Aurora Polaris.—H. U. Sverdrup 457
  The Harvard Museum Expedition to Australia.—Prof. J. Stanley Gardiner, F.R.S. 457
  Training of Colonial Probationers in Anthropology.—Col. T. C. Hodson 458
  The External Meatal Notch as a Primitive Character.—Prof. Frederic Wood Jones, F.R.S. 458
Research Items 459
Astronomical Topics 461
The Nature of Cohesion 462
Selection of Engineering Apprentices . . . 463
Priestley as a Pioneer 464
Some Phenomena of the Upper Atmosphere . . 464
Birthdays and Research Centres 465
Societies and Academies 466
Official Publications Received 468
Diary of Societies 468
Supplement.
  The Physiology of Internal Secretion. By Sir E. Sharpey-Schafer, F.R.S. 441

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Vanishing Life of Australia.

THE conditions which made for the evolution of the fauna of Australia along its unique path, the isolation of the continent associated with the early influx of primitive groups of animals, are now hastening that peculiar fauna towards its doom. Uniqueness has its own attractions, and there can be no replenishment of the disappearing forms from the outside world. There can be no doubt on the question of the disappearance of Australian birds and mammals. Sir James Barrett expresses the general opinion in Australia when he says: "The answer is unequivocal. Except in certain places where enlightened citizens have protected them, they are all disappearing. It is difficult for anyone to show a visitor in the State of Victoria the larger marsupials or the lyre bird. It is quite impossible to find the smaller marsupials except in a few favoured places and with great trouble. It is, indeed, feared that some varieties have been exterminated."

The same opinion is held in America. The title of our article is that of a paragraph in the Annual Report for 1921 of the American Museum of Natural History, which goes on to say: "We are approaching the close of the age of mammals all over the world, but in no continent has the devastation been more rapid than that of Australia, owing to three causes: deforestation, an enormous fur trade, and an increasing leather trade. In 1921 it became apparent that the American Museum must secure its representative collection now or never. Accordingly an expedition headed by Curator William K. Gregory was sent to Australia . . . to explain the chief purposes of the Museum, which are to secure an exhibition of the wonderful and unique life of Australia, past and present, as distinguished from a research collection, which belongs properly in the Australian museums and in the great British Museum of Natural History in London."

It is a rule in the decline of a fauna that when agriculture and commercial slaughter have reduced numbers to rarity, new forces step in to complete the destruction. The rare animal becomes desirable, scientifically and commercially, and collectors, animated by one enthusiasm or the other, rush to secure the last of the specimens. In the British Isles with their limited fauna this tendency has been particularly forced upon the notice of naturalists. A few years ago, the once common kite, in spite of strenuous protection, was reduced to some five breeding pairs on the borders of

Wales; the great skua and the St. Kilda wren were brought to the verge of extinction, the osprey was exterminated, all through the activities of collectors.

In Australia the same forces have taken a hand in the threatening final stages. Sir James Barrett, in the work from which we have already quoted ("Save Australia", 1925, p. 3), says: "Australia has lately been inundated with collecting expeditions, and what is still more serious, private commercial collectors are trying to obtain specimens before extermination takes place"; and Dr. J. A. Leach writes (p. 122): "The rumour having gone forth that the Australian mammals, the most primitive in the world, are doomed to early extinction, the museums of the world are making special efforts to obtain specimens of Australian animals before it is too late. Many scientific expeditions have visited Australia in recent years. These must be controlled. Worse still, prices for Australian birds have soared so high that the greed of private traders has been excited, and some big shipments have been sent from Australia for private gain. The mortality has been heavy, and the cruelty involved great, but the high prices obtained for the remainder have yielded a handsome profit."

We had these facts and opinions in mind when in a note (July 11, p. 63) we referred to a new collecting expedition to Australia from the Harvard Museum of Comparative Zoology. Prof. T. Barbour, director of that museum, and himself a distinguished naturalist, takes exception to our comment, which he thinks may be interpreted as expressing jealousy of American scientific activity. We need scarcely assure him that our only jealousy is for the safety of the rare animals of Australia, and we welcome his assurance that no attempt is to be made to secure 'long series', although that was scarcely apparent from the American notice of the expedition, which stated that the collection aimed at being one of the largest and best balanced in the world. The instructions given to the members of the expedition in connexion with their collecting, as stated by Prof. Barbour, are unexceptionable, and we are certain that Harvard will make good scientific use of the specimens collected. Indeed, it becomes clear, when we examine the staff of this expedition and of the Agassiz Museum, from which it emanates, that this is no collecting expedition but one with more serious and desirable scientific aims.

Museums of zoology a century ago were collections of animals similar to and about as informative as other indiscriminate collections. Then in Darwinian times an attempt was made to illustrate the main lines of evolution, and following this to obtain long series of animals to study the variation of the individual species, so as the better to understand this evolution. The mere student or sightseer was relatively little catered for, and the bewildering variety of animals in the museum cases depressed him. To-day the adequate display of properly labelled and well selected animals illustrative of the phyla and their subdivisions is recognised as of peculiar necessity to students, since they have to learn much of this side of zoology, and also of the possible lines of evolution, without the aid of teaching that has to be thrown more and more in the direction of experimentation and the study of the forms of life in relation to their surroundings. It is this last side, which we may term the natural history of animals, that is likely to be increasingly occupying the attention of museums, for it interests the public also. To prepare the requisite displays, even of common animals, requires that each curator must know intimately his forms of life in the field, together with the vegetation and other animals associated with them. We understand that this is so well recognised at the Agassiz Museum that its staff is dispersed into the field during the summer months; the local province here is North America, including the West Indies. Occasional expeditions travel farther afield, following out the practice of Louis Agassiz, but no longer restricting themselves to marine life. The present expedition is under W. M. Wheeler, the distinguished American entomologist, whose studies on social and other insects have materially guided the development of modern research on insect life.

So far as we can see, it appears doubtful whether both the terms 'scientific' and 'collecting' can be applied to any expedition. The collecting expedition requires action and often a personnel not altogether desirable, while it tends to think too much of the value, as instanced by rarity, of the specimens obtained. The scientific expedition is necessarily led by experienced naturalists, whose study is the actions of the various forms of life in their natural habitats, and whose collections are supplementary to the understanding of these. These men personally dislike to kill, and no expedition led by them will ever gauge its success by the 'bag'. Such expeditions should be encouraged, whatever may be their origins, since their sole aim is to add to the common stock of knowledge.

This, however, leaves the question of the preservation of the fauna, which usually means the birds and mammals, of Australia and other regions unconsidered. It is surely useless to obstruct even 'collecting' expeditions, while the local fur and feather merchants and the professional collectors are left to pursue their aims. We suggest that nothing except local legislation, honestly and firmly applied, can really be effective in any country. The birds, mammals, and other animals can be classified by their rarity and by their effects, beneficial or otherwise, in relation to man. The introduction of animals from other countries would be considered as affecting both the local indigenous fauna and man's agriculture. In addition, national parks might be established, as has been done in Africa and other countries, and there are surely large tracts of Australia and Tasmania which might be so declared without seriously affecting the local population. Sporting, collecting, and scientific expeditions would be either licensed or prohibited as might seem desirable. There would be no hardship in this, for science has nothing to fear when it is understood that the progress of the State is inseparably locked with its own.

Geophysical Prospecting.

The Principles and Practice of Geophysical Prospecting: being the Report of the Imperial Geophysical Experimental Survey. Edited by A. B. Broughton Edge and Prof. T. H. Laby. Pp. xiii + 372. (Cambridge: At the University Press, 1931.) 15*s.* net.

TO the Imperial Geophysical Experimental Survey, 1927–29, was entrusted the task of testing, under conditions and on problems available in Australia, the applicability of the principal methods—gravitational, magnetic, seismic, and electrical—which recent developments in apparatus for local geophysical investigations have placed at the disposal of the economic geologist. As explained by the Director in his introduction to this Report, special stress was placed on the electrical methods, in view of the paucity of reliable information regarding these methods which was available at the time when the Survey was initiated.

The volume, however, comprises a good deal more than a mere detailed account of the tests undertaken in Australia, valuable though these are. As the title hints, it is, in addition, a comprehensive review of the principles of applied geophysics, and as such immediately stands out as the best available English exposition of these principles. Moreover, in the wealth of detail and illustration used to describe the apparatus employed, and the invaluable accounts of the procedure used in the field and in interpreting the results, the book fulfils all the functions of a practical manual of the science. Finally, in the comprehensively illustrated reports of the actual surveys undertaken, with the careful analysis and conclusions added both individually and as a whole, the volume permits all interested in the economic application of geophysics to form conclusions regarding its value on problems differing widely in characteristics. Of very particular interest in this connexion is the frequency with which, so far as possible, several methods have been tested on the same problem, in order that a comprehensive estimate of costs and value might be made.

The work is ingeniously divided into two parts. The first part, occupying some two-thirds of the book, may be regarded as the report proper; the second part comprises a very detailed exposition of the theory of each method and the apparatus employed. Thus the first part is more suited to the mining engineer and geologist who wish to assess the value of the method and its characteristic scope, whilst the second part is more adapted to the critical analysis of the physicist. In each chapter of Part 1, a brief introduction to the method is imparted, but much greater detail of the physical principles involved will be found in Part 2.

In Chapter xi will be found the general conclusions as to the applicability of the methods in Australia, and hints and statistics to serve as a basis for judgment as to their value elsewhere, but certain conclusions are also drawn in the various chapters of Part 1. Each section of the volume, whether principles, apparatus, procedure, or actual surveys, aims at a high standard, and attains it within the necessary limitations of the book. It is doubtful whether the whole range of the principles and procedure of geophysical prospecting could be comprehensively surveyed in a single volume of reasonable dimensions. So much of both pure and applied physics is involved in each individual method that a good-sized book could readily be filled in each case, as indeed has been demonstrated by the German publication "Sammlung geophysikalischer Schriften".

In the present volume, the tendency has been to build the 'procedure' round the actual 'practice' in Australia, so that in certain respects the account is simplified. On the other hand, the particular problems selected for the trial of some of the methods, for example, the gravitational, whilst probably representing the best available in Australia, by no means covered the complete field of applicability of these methods. Consequently the procedure adopted in these instances was rather restricted, and the exposition in these methods may be regarded as somewhat elementary. Similarly, the descriptions of the instruments used, and the conclusions derived as to the scope of these particular methods, are limited by the relatively restricted work carried out in Australia.

The above criticism applies generally to the gravitational, magnetic, and seismic sections, but they are nevertheless excellent outlines of principles, procedure, and apparatus. In the case of the electrical methods, the exposition is in all respects more comprehensive and complete. The whole field of direct current, low and high frequency alternating current supplies, potential, resistivity, and phase measurements, conductive and inductive excitation of the earth—in fact, practically all the known varieties of method used—are surveyed conscientiously and efficiently. It is in this section that the chief value of the volume lies. The accounts of electrical apparatus are very detailed and contain descriptions hitherto unavailable. In addition, in the method known by the name 'Potential-Ratio', we find a distinct advance in procedure of great importance. Even here, however, certain recognised methods were not actually tested in Australia and are not dealt with. One such method is that associated with the name of Gella, of the Elbof Company. In this method the measurements of the electromagnetic field, due to a current field introduced by two electrodes sited very near each other, are made in the region beyond the electrode interval, and certain advantages are claimed for such a procedure. As the Elbof Company has been operating under a commercial contract in Australia, it is unfortunate that no opportunity arose for the Survey to test the claims of this particular method. Two other methods, one involving the use of very low frequencies—for example, about 50 to 100 cycles—and the other utilising the electromagnetic field in the neighbourhood of a single rectilinear cable—are of comparatively recent development and therefore were not available for test during the Australian survey work.

Whilst the above reflections may serve to indicate how the volume falls somewhat short of the ideal of a really comprehensive account of the principles and practice of geophysical surveying, we would hasten to affirm that it is exceptionally complete. The very numerous diagrams and photographs are of immense value to the student, and to the practising geophysicist.

Turning now to the accounts of the various surveys, unqualified approval may be expressed of the way in which these have been presented. The selection of the tests gave a wide variety of problems, including the location and definition of deposits of sulphide and other ores, brown coal, and graphite, and the determination of regions bearing saline water. The accounts of the surveys are copiously illustrated by admirably clear maps and sketches, and many folding plates are inserted. The descriptions of the procedure, analysis, and interpretation are models of what such accounts should be, and are in striking contrast to the vague, unintelligible travesties which we meet so frequently in the average description of electrical surveys undertaken by commercial concerns. We do not encounter here the usual hieroglyphic indication of a 'good conductor', which has no apparent connexion with the actual measurements, but contrives to present a specious concordance with the actual mineral deposits known to exist by borings. In this volume, the whole procedure of the trial is made perfectly clear and the method of interpretation rendered intelligible. There is no attempt to gloss over difficulties or to hide perplexities. Finally, so far as was known by the date of publication, the results of confirmatory drillings are given. Unfortunately, the close of the Survey coincided with the advent of intense depression in Australia, so that few of the valuable indications obtained by the Survey have as yet been prosecuted by drilling or mining. This will doubtless be remedied as future opportunity arises. Meanwhile, it is heartening to note that many successes are already confirmed, in some cases where valuable deposits were previously unsuspected.

We cordially recommend this volume to the attention of all interested in economic geology and mineral resources generally, and, above all, to students and exponents of geophysical prospecting. The remarkably low price of the work is a mystery; we hope it will not create in the mind of the would-be purchaser the erroneous impression that it has any relation to the value. Had this book been published in Germany or the United States it would be twice the price.

Treatise on Physical Chemistry.

A Treatise on Physical Chemistry: a Co-operative Effort by a Group of Physical Chemists. Edited by Prof. Hugh S. Taylor. Second edition. In 2 volumes. Vol. 1. Pp. xv + 852 + 48. Vol. 2. Pp. xii + 901-1766 + 48. (London: Macmillan and Co., Ltd., 1931.) 30*s.* net each vol.

THE welcome appearance of a second edition of this two-volume treatise on physical chemistry has clearly demonstrated both the practicability and the usefulness of Prof. Taylor's somewhat novel experiment of attempting to produce a text-book by the co-operative efforts of different individuals; a practice usually reserved for dictionaries and tomes of a more encyclopædic character. Whilst the first edition was a good treatise, this second edition is better. Apart from the inclusion of new matter and the adjustment of stress on importance of what may be termed personal factors in the various chapters, the volumes, on the whole, are much more evenly balanced. We note, for example, the growth of uniformity in the treatment of the theory of solutions and of reactions taking place therein, a more minute analysis of the problems of the kinetic theory of gases, and a very desirable extension of the treatment of colloidal systems. Dr. Dushman's chapter on the quantum theory and atomic structure is really a remarkable production both for clarity and scope.

In the introduction to the first edition, Prof. Taylor states that the first volume represents that portion of the subject which can with advantage be addressed to the first-year student; the second volume presumably to those who are spending the two subsequent years in the study of chemistry. The treatise has swollen unavoidably from 1359 to 1766 pages. To those who were brought up with Ostwald, Nernst, or Sir James Walker's books on physical chemistry as texts during their years at college, these new editions, whilst representing faithfully the growth and, as some of us like to believe, the growing importance of the subject, will be welcomed and give much pleasure; but at the same time it raises in a somewhat pertinent form the important question as to what courses in college chemistry should and what such courses can do. It would be surprising if any student on graduation in chemistry could be really *au fait* with the content of these volumes. At the same time, it is doubtful if even the clear appreciation of what are somewhat vaguely termed general principles will suffice to render a man a competent scientific worker when he leaves college. Some happy combination of general principles, the working out of examples, and development of a logical and critical faculty seem to be desirable in any college course. Such are not obtainable in treatises. For example, the first-year college student in reading the first volume would receive his first introduction to the ionic theory in the heat of hydration of gaseous ions and the Donnan distribution on the two sides of a semi-permeable membrane.

For the research student, however, the two new volumes are really excellent. It is natural that with the rapid growth of particular phases of the subject even in the new volumes certain statements require revision, for example, the sections devoted to consideration of heats of adsorption of gases on active metal surfaces. Whilst a certain amount of duplication of material is unavoidable, the proof readings must have been no light undertaking and the final text is remarkably free from typographical errors. We note a few, such as 'Seminoff' for 'Semenoff' p. 1012, 'rom' for 'from' p. 1092, and 'corresponcence' for 'correspondence' p. 1172. It is to be hoped that when the third edition is called for, Prof. Taylor will continue to adopt the policy of attempting to make the book a representation of the science as it is, and not delimit it for the purpose of providing first-year college students with material for study. I suspect that this material is already too indigestible for their consumption. The printing and binding of the volumes are excellent.

ERIC K. RIDEAL.

The Complete Evolutionist.

L'Ologénèse: nouvelle théorie de l'évolution et de la distribution géographique des êtres vivants. Par Prof. Daniel Rosa. Adapté de l'italien par l'auteur. (Bibliothèque de Philosophie contemporaine.) Pp. xii + 368. (Paris: Félix Alcan, 1931.) 35 francs.

SOME time ago there was reviewed in these pages (NATURE, May 11, 1929, p. 709) a book in which Dr. George Montandon of Paris sought to explain the origin of human races by applying a theory of evolution which had been first propounded by Prof. Daniel Rosa of Modena in 1909. Dr. Montandon's advocacy has stimulated an interest in this new theory, with the result that Prof. Rosa has translated his chief work ("Ologenesi: Nuova teoria dell' evoluzione e della distribuzione geografica dei viventi." 1918) into French. The book in its French dress is much more than a translation of the original; the author has taken the opportunity of amplifying his theory and of introducing new evidence.

Prof. Rosa claims that his theory of hologenesis gives a more complete and satisfying explanation of all the facts known to students of the evolution of living things than any other. By applying it, the naturalist is given, so he believes, an acceptable explanation of how the present flora and fauna have come into existence; the palæontologist obtains from it a clue to the distribution of species in space and time, and it solves all problems of embryology, heredity, anatomy, classification, and of adaptation. The theory of hologenesis succeeds in doing so much because of its blunderbuss charge. Its shot has been culled from Lamarck, Darwin, de Vries, Weismann, Naegeli, etc., whereto Prof. Rosa has added a potent factor of his own. His theory has much in common with that held by the late Dr. William Bateson, namely, that evolution is an unfolding of potentialities inherent in the germ plasm of the originals of living things.

To make his theory clear to his readers, Prof. Rosa uses as a simile the development of a chick from the egg. The sequence of developmental processes which give rise to the chick lie dormant in the fertilised egg, and, in the period of incubation, the potentialities unfold themselves to produce a chick. In like manner, he holds that in every species of living thing, just as in every fertilised egg, there is a load of potentialities or determinants, which, when unfolded or spent, the species reaches maturity. Having reached maturation, the germ plasm of the species undergoes a sudden change whereby the mother species suddenly gives rise to two daughter species, which differ from each other and also from the mother. The daughter species then set out to unfold their determinants, and if the environment is favourable —for environment and selection play their part in the theory of hologenesis—then maturation stages are again reached and a further dichotomy with the production of new species takes place. Given living matter laden with an infinite and suitable supply of determinants, the hologenist is armed for all the eventualities with which the living world is likely to present him.

The theory of evolution has now reached a strange stage in its progress—a stage of indifference. Biologists of all shades of opinion are convinced that living things have evolved from simpler and older forms, but for the meantime they have lost interest in how the transformation has been effected; they are careless of theories and hungry for new facts. This mood will militate against the theory of hologenesis receiving the attention it deserves, for Prof. Rosa has cast his net widely and brought up for consideration a great assortment of biological facts. He is right when he declares that no theory of evolution can be finally acceptable unless it explains by natural and observable processes the wonderful adaptations and contrivances which are to be found everywhere in the kingdom of life. He faces the problems of adaptation and seeks for an explanation by postulating that the 'determinants' must be functional in their constitution, that their unfolding must take place as a harmonious specialisation of labour. We may grant that much and yet be no nearer to an understanding of how this specialisation does take place.

Prof. Rosa's book will serve to remind its readers how far we are yet from an exact knowledge of the machinery which underlies evolution. It is the physiologist rather than the morphologist who is most likely to find the clues to the essential problem of evolution. A. K.

Short Reviews.

Foundations of Geometry and Induction. By Jean Nicod. Containing Geometry in the Sensible World, and The Logical Problem of Induction. Translated by Philip Paul Wiener. (International Library of Psychology, Philosophy and Scientific Method.) Pp. iv + 286. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1929.) 16*s*. net.

THOSE who knew the late Jean Nicod will be glad to have this translation of his two main works; yet the book itself will interest a much larger circle of readers, because of the very problems it discusses and because of the original and valuable contributions made by the author towards their solution. In discussing "Geometry in the Sensible World", Nicod starts from data of perception and tries to derive the various geometries that can be built on them, a method which is quite the inverse of Prof. Whitehead's 'extensive abstraction'. For the logical development of this very interesting method, the author shows us an animal which is endowed successively with more and more complex senses, and tries to build up gradually the geometrical world of his sensations. He obtains in this way some remarkable conclusions which strengthen the case against Kantian philosophy, and illustrate to the full the relations between symbolic logic and experience. Indeed, the line of approach suggested by Nicod is one which ought to become classical in the investigation of the problems concerning mathematics and the external world.

In the second part of this volume, "The Logical Problem of Induction" is analysed in itself and in relation to the doctrine of probability. Nicod tries to show why induction by simple enumeration is a fundamental mode of proof, and that all those who have thought they can do without it have done so only by the aid of sophisms; also, that it can increase the probability of a hypothesis, even when the new facts observed should do nothing but repeat without variation facts already known. The author endeavours, finally, to show that it is not actually demonstrated by any procedure whatsoever how inductive reasoning can raise the probability of a law to the point of indefinite proximity to a certainty. The penetrating analysis of these various theses would have no doubt led the author to a more positive construction, but his premature death has unfortunately terminated a career which would have been a credit to scientific philosophy. T. G.

School Certificate Magnetism and Electricity. By Dr. Harold Toms. (Pitman's School Certificate Series.) Pp. viii + 440. (London: Sir Isaac Pitman and Sons, Ltd., 1930.) 5*s*.

THE author justifies the appearance of this new text-book in a preface, where it is stated that the traditional division of the subject into magnetism and voltaic and static electricity has not been adhered to, and that an effort has been made to present the facts as one homogeneous and inter-related set of phenomena rather than as three vaguely connected subjects. Emphasis is laid on mechanics and units since experience has shown that " only those who realise that mechanics can be applied to electrical and magnetic phenomena ever acquire a thorough grasp of the subject". The object has been " to provide a solid groundwork for those who, at a later stage, intend taking an advanced course ".

The exposition is clear rather than detailed, and, in spite of the size of the book, is in some respects superficial. A chapter on magnetic theory is entirely devoted to Weber's theory, and gives the impression that magnetism is a simple matter, wholly understood, and presenting no difficulties. One feels that even an elementary book should direct some attention to the great strides made on the theoretical side in recent years. Alternating currents, the dynamo and accumulators, are very briefly dismissed; hysteresis and the nickel cell are not mentioned. N. M. BLIGH.

The Laboratory Mouse: its Origin, Heredity and Culture. By Dr. Clyde E. Keeler. Pp. viii + 81. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1931.)

IN this monograph, by the author of a series of papers on inherited abnormalities, especially of the retina, in the mouse, the early chapters deal with the systematic position and history of house and domesticated mice. There is much curious information: we learn, for example, that, according to the London Pharmacopœia of 1667, " A flead mouse dried and beaten to powder, and given at a time, helps such as have Diabetes "; that a special word for the dominant spotted variety of mouse appears in the earliest Chinese lexicon, written 1100 B.C.; and that " The clergy of the Middle Ages never ceased to comment upon the libidinous habits of mice. Indeed, mice were frequently raised by curious churchmen in order to observe their wicked actions ".

The origins of the different fancy breeds are traced out so far as possible. A chapter follows, cataloguing and tabulating the various gene-mutations that are known in mice, with full descriptions of their effects; this leads up to an account of heredity, normal and abnormal. A chapter on the technique of breeding and keeping mice, five pages of photographs of different varieties, and a bibliography of 184 titles conclude a very admirable little volume. G. P. W.

The Bacteriophage and its Clinical Applications. By Prof. F. d'Herelle. Translated by Prof. George H. Smith. Pp. viii + 254. (London: Baillière, Tindall and Cox, 1930.) 18*s*. net.

THIS book, based upon the Lane Lectures delivered by the author at Stanford University, California, in 1928, is addressed primarily to practitioners of medicine. The subject of bacteriophagy is a complicated one, and still in an imperfectly understood state. The history of its discovery, its nature, and its relationship to bacterial mutations, infectious diseases, and recovery and immunity, are outlined quite clearly and simply. It is not within the scope of a book of this sort to enter exhaustively into the conflicting theories of the nature of the bacteriophage, nor does it do so. The author's views as opposed to those of Bordet and his followers are given in some detail. About sixty-five pages are devoted to the clinical application of the bacteriophage. Records of its use in enteric infections, infections due to pyogenic cocci, streptococcus, and bubonic plague are included.

The book is interesting. But it is unjustifiable to conclude, as its author does, that in bacteriophage lies an explanation of all immunity to the exclusion of generally accepted theories. The clinical application is as yet far from being established.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 346. Abt. 9: *Methoden der Erforschung der Leistungen des tierischen Organismus,* Teil 7, Heft 1. *Methoden der Tierhaltung und Tierzuchtung.* Pp. 226. (Berlin und Wien: Urban und Schwarzenberg, 1931.) 13 gold marks.

THE present section of this work contains four articles on the following subjects: (1) the collection, study, and rearing of tardigrades, by Prof. Marcus, of Berlin; (2) and (3) the collection, rearing, and investigation of ticks and of fleas, by Prof. Pawlowsky, of Leningrad, two valuable articles, stressing, as might be expected, the pathological significance of the parasites; and (4) methods of investigating subterranean faunæ, by Prof. Chappui, of Klausenberg, an article including much useful general information about the ecology of caves and underground streams. G. P. W.

The Origin of the Solar System.*

By SIR JAMES JEANS, F.R.S.

THE observational astronomer generally feels only an indirect interest in the problem of how our earth and its companion planets came into being; his telescope can give him no direct information on the subject, since such planets as other suns may possess are too small and too distant to be observed. If every star in the sky were suddenly to give birth to planets we should in all probability remain unaware that anything was happening.

Yet the problem is of thrilling interest to science in its widest sense. The old nebular hypothesis of Laplace had pictured the stars as shrinking nebulæ which rotated faster and faster as they shrank, and in so doing threw off their equators rings of matter, each of which was destined in time to condense into a planet. This cosmogony implied that the shedding of planets was a normal event in the life of a star. It led to the concept, so commonly held in the nineteenth century, that every star in the sky was a sun distributing light and heat to a retinue of worlds circling round it. As solar light and heat are the most obvious essentials for terrestrial life, it was natural to take the next step and assume that every star we saw in our telescopes was busily at work radiating energy to maintain life on its surrounding planets. When once this step had been taken, no great violence to the probabilities seemed to be implied in taking the further step of assuming that each star had been created to this special end.

The more modern view supposes that the birth of planets is very far from being a normal event in the life of a star—it is an abnormal and exceedingly rare event. So rare is it that, even if the stars have already lived the longest lives that have ever been suggested for them—lives reaching back many millions of millions of years into the past—only a minute fraction of them can be surrounded by planets. If they are destined to live into the future for the longest period that has ever been suggested—a period measured in hundreds of millions of millions of years—even by the end of this inconceivable length of time only a minute fraction of their total number will be surrounded by planets. This view implies that most stars must live and die without giving birth to planets at all—and even of those that do, the majority must be so cold and shrunken before their planets are born that there can be little or no question of their sustaining life.

In brief, the older theory, with the help of a little kindly imagination, depicted a universe teeming with life. The more modern theory depicts a universe which proceeds steadfastly on its way, while here and there, in insignificant corners and at infrequent intervals, a strange accident results in life stumbling into being. It can scarcely be a matter of indifference to science—and still less to humanity—which picture is correct.

Let us first consider some evidence of a purely physical nature. The activity of radium appears at first glance to be permanent; yet we know that it is no more permanent than anything else in Nature. All radium gradually loses its potency; it deteriorates, so that after about 1600 years it will be only half as potent as it is to-day.

The reason for this loss of potency is now well understood. It is that the radium gradually changes into something which is not radium, and has not the properties of radium—the debris of radium, let us call it. After 1600 years, a mass of pure radium becomes changed into half radium and half debris of radium. The potency is reduced to half because the amount of radium is reduced to half.

It follows that if we are given a mixture of radium and its debris, we can tell how long the radium has been at work to produce this debris. For example, if the amount of debris is equal to the amount of radium, we know that the disintegration of the radium has been in progress for 1600 years; if three-quarters of the mass is debris the process has been in action for 3200 years, and so on.

The time needed for a mass of a radioactive substance to change into half substance and half debris is known as the 'half-period' of the substance: it varies enormously for different substances. It is 1600 years for ordinary radium; for one radioactive substance, radium C′, it is only about a millionth of a second, while at the other end of the scale are substances for which the half-period is measured in thousands of millions of years. For thorium it is about 16,500 million years; for uranium, 4500 million years.

Now in various rocks in the earth's crust geologists come upon imprisoned uranium accompanied by debris of uranium. In no case is the mass of debris ever as great as the surviving mass of the uranium. There is only one possible inference—the uranium has not been imprisoned for as long as 4500 million years. The proportion of debris found in all samples of rock tells much the same story—the uranium has been imprisoned for a time of the order of 1500 million years. The rocks in which thorium is imprisoned have much the same thing to say—the thorium has been imprisoned for a time of the order of 1500 million years. We conclude that something like 1500 million years must have elapsed since the crust of the earth solidified. We can now add something for the time before solidification and we shall obtain the total age of the earth. From a study of the relative abundance of ordinary uranium and its isotope actino-uranium, Rutherford has been able to show that this total age cannot have been more than about 3400 million years.

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* Address delivered at the Franklin Institute in Philadelphia on May 20, on the occasion of the presentation of the Franklin Medal to Sir James Jeans.

Shooting-stars or meteors confirm the story told by the earth's rocks. Occasionally one of these objects is too large to be completely vaporised by the resistance of the air, and what is left of it strikes the earth in the form of a large rock or stone known as a meteorite. Many of these bodies are found to contain imprisoned thorium or uranium, along with the debris of their disintegration. The amount of the latter makes it possible to estimate the length of time since the stone solidified. The time cannot be estimated with great accuracy, but no body that has been examined suggested a period of more than 2900 million years since solidification, and the majority appeared to be of about the same age as the earth. In a general way we may say that the length of time which has elapsed since the planets and other members of the solar system solidified cannot have been more than about 3000 million years.

This estimate depends solely on recent advances in physical science. The earlier cosmogonists had no means of forming such an estimate, and it would have been of little use to them if they had. It is important for us of to-day, because we can combine it with recent astronomical knowledge. We can tell how much the sun and stars have changed in 3000 million years. The sun is radiating its substance away at the rate of 360,000 million tons a day. This sounds like a very rapid rate of loss until we compare it with the huge total mass of the sun. We then find that radiation at this rate for 3000 million years scarcely affects the sun's mass at all. The mass of the sun, and indeed of all the stars, must have been very much the same 3000 million years ago as to-day. Furthermore, recent astronomical research has shown that the physical state of a star depends almost entirely on its mass —stars which have approximately the same mass as the sun are found to have also approximately the same physical constitution as the sun. Thus we must suppose that when the planets and meteors were born, the sun not only had the same mass, but also the same physical constitution and size as it has to-day.

This conclusion, based on evidence which can scarcely be challenged, provides a test which we may apply to the various theories of the origin of the solar system in turn. Let us first apply it to the most famous of all, the nebular hypothesis of Laplace. Laplace supposed that the sun started as a huge nebula, extending out as far as the orbit of the farthest known planet—to-day we must say as far as the orbit of Pluto ; as it shrank with cooling it left behind it rings of matter which afterwards condensed and formed the separate planets. When the earth was shed, this nebulous sun would have a diameter equal to the present diameter of the earth's orbit. We see at once that this hypothesis cannot survive the test I have just described ; and indeed there are many other tests, mainly of a dynamical kind, which it is equally unable to survive.

It would be an impossible task to test all the various theories of the earth's origin which might be propounded one by one. Let us notice that all such theories fall into two distinct classes, according as they suppose that the sun alone was concerned in the process of creating the planets, or that other bodies were concerned in addition to the sun.

If the sun alone was concerned it is difficult to discover by what mechanism the outermost planets could be projected to their present distances from the sun. We seem compelled to postulate some system of internal explosions as the origin of the planets, and this seems inconsistent with the present orderly arrangement of the planetary orbits. It also fails to explain why the systems of Jupiter and Saturn are so exactly like the main system of the sun in every respect except size. Indeed, this likeness is so marked that any theory which fails to explain it may safely be dismissed ; we may be sure that the same mechanism must have produced these smaller systems as had already produced the main system. This test seems fatal to any hypothesis of explosions. It is straining probabilities far too much to imagine that a succession of explosions could produce anything so orderly as the main system of planets ; it is straining them infinitely more to suppose that the same miracle could be repeated twice again to produce the similar systems of Jupiter and Saturn.

Thus there seems to be no alternative to supposing that at least one other body besides the sun was concerned in the birth of the planets. In 1750, Buffon imagined the planets to have been splashed out of the sun as the result of collision with a passing comet. In 1880, Bickerton propounded a somewhat similar theory, except that he replaced the comet by a star. This collision theory has recently been revived, with further modifications, by Jeffreys. Although his views call for further discussion and critical examination, it is difficult to see at present how they can possibly be reconciled with the similarity of the systems of Jupiter and Saturn to the main system. Grant for the sake of argument that a big splash formed the planets, then it seems quite beyond the bounds of probability that two smaller, but otherwise almost exactly similar, splashes should occur to create the systems of Jupiter and Saturn.

I believe I was the first, in 1901, to consider the possibility of the second body not colliding with the sun, but producing planets by tidal action. In 1904, Profs. Chamberlin and Moulton independently considered the same possibility, and developed it, along lines of their own, much further than I had done. They imagined that a series of solar eruptions, such as normally cause prominences, were so intensified by the tidal action of a neighbouring star that the ejected matter was projected clear of the sun's gravitational field, where it condensed into small solid bodies, which they designated as ' planetesimals '. These in turn underwent further aggregation and in due course formed the planets.

The scheme which they propounded seemed to me to be open to many objections. Not only did it fail to explain why the satellite systems of Saturn and Jupiter should resemble the main planetary system, but also it failed to explain why satellite systems should exist at all. Indeed, it is doubtful whether it can even explain the existence of the planets. Puffs of gas such as Profs. Chamberlin and Moulton imagined to condense into planetesimals would not condense into solid bodies at all. They could not do so inside the hot atmosphere of the sun, and as soon as they got clear of the sun's atmosphere they would merely scatter into space, like the leak of gas from a gas-burner. Calculation shows that any body of gas will do this unless it is of enormously greater mass than the supposed planetesimals. The mutual gravitational attractions of the molecules of a mass of gas of planetesimal dimensions would be too small by a factor of several millions to result in condensation in opposition to the ordinary gas pressure resulting from the kinetic energy of their motion.

Because the planetesimal theory seemed open to these and other fatal objections, I tried to trace out mathematically the course of events which would actually occur when a second star approached to within a specified distance of the sun and passed on its course without an actual collision taking place. Discarding all physical assumptions as to solar eruptions and the formation of planetesimals, I found that my own old conception of tidal action was able of itself, without any adventitious assumptions, to give a plausible account of the origin of the solar system. In this way I was led to propound a new theory of the origin of the solar system in 1916, which was very different from that of Chamberlin and Moulton.

The researches of Roche (1850) had already shown that every large mass such as the sun is surrounded by what may properly be described as a 'danger-zone'. No body of moderate size can revolve permanently inside this danger zone; it is rapidly broken up into minute pieces. Roche suggested that Saturn's moons and rings provide an example of this; the moons are all outside the danger-zone, but the rings are just inside, whence it is generally believed that the rings are the broken fragments of what was originally an ordinary moon of Saturn. There are good reasons for conjecturing that the system of asteroids which surrounds the sun forms a second illustration of the same effect.

Mathematical investigation of the tidal action between two stars showed that this concept of a danger-zone is equally applicable when two bodies merely approach one another temporarily and then pass on their respective courses. Two bodies which remain always at more than a certain distance from one another merely raise tides like those which the moon raises on the earth. As their distance lessens the height of tide increases; as it increases again the tides fall, until finally both bodies are left in their original undisturbed state But if the two bodies approach to within a certain critical distance of one another, the whole character of these tides changes. Instead of a small elevation travelling over the surface of the disturbed body, as ocean tides travel over the surface of the earth, we have a huge mountain of gaseous matter which continually increases in height as the bodies approach, and finally shoots out to form a long arm which may finally, if conditions are favourable, establish contact with the second body. The two bodies will then be joined by a filament of gas, much as the two ends of a dumb-bell are joined by the handle of the dumb-bell. Under other conditions contact may fail to be established, and a long filament of gas will be left projecting from the primary body in the direction of the secondary body. It can be shown that this filament must inevitably, as the result of the mutual gravitational attractions of its own molecules, condense into detached masses. We can even calculate how massive these condensations will be. No great accuracy is possible, but we find that such condensations would at least be of the same general order of magnitude as the actual planets.

Before condensation commenced, the filament would be shaped like a cigar or a torpedo; one of the two pointed ends is the peak of the tidal mountain, the other is the last thin dribble of matter which came off just as the gravitational pull of the receding star was failing. After condensation we should expect to find the largest condensations near the centre, where the matter was originally richest, with the size of condensations tailing off at either end.

This exactly represents the present arrangement of the planets. It explains why the central planet Jupiter is the largest, and why the sizes and the weights of the planets both show a general tendency to fall off as we recede from Jupiter in either direction. The discovery of Pluto, which is, I suppose, quite certainly less than Neptune both in size and weight, has recently provided welcome confirmation of this prediction of the theory. It is perhaps also significant that, on the whole, the densest planets are not the most massive planets, in which we might reasonably have expected to find the matter most tightly packed, but those which lie nearest to the sun, although these are of comparatively small weight. These came from the root of the tidal mountain, and it seems possible that the heavier elements were more abundant here than at the peak of the mountain. The puzzlingly low density of Saturn, only one-eighth of that of the earth, is at once explained if we suppose that Saturn was formed mainly out of the higher strata of the sun's atmosphere.

We can, however, elaborate the theory in much greater detail than this. The planets at present move in orbits which are almost circular, but this must inevitably result from their having ploughed their way, for thousands of millions of years, through the dust and debris of space. When the planets first condensed they would be describing quite erratic, and indeed almost random, orbits about the sun. Their orbits could scarcely be expected to show any regularity beyond that of all lying in the plane of motion of the passing star which had brought them into being. Those planets which passed near enough to the sun would enter its danger-zone and be broken up in turn, just as the sun had previously been broken up by entering the danger-zone of the other star; the plane of their motion would be that containing the orbit of the planet round the sun. In this way we get a conjectural explanation of the satellite systems of the planets, of their general resemblance to the main system, and of the fact that their orbital planes lie mainly in the plane of the solar system.

In time the planets would cool, then liquefy, and then solidify; the largest would remain gaseous for longest. Now a theoretical investigation of the question shows that planets which remained gaseous until after the birth of their satellites would be likely to give birth to a large number of small satellites, whereas planets which had already liquefied or solidified would be likely to give birth to a smaller number of large satellites—or possibly to no satellites at all. This at once explains a further regularity in the arrangement of the solar system. The planets which have the greatest number of satellites are the two big central planets, Jupiter and Saturn. These have nine satellites each, and all are very small in comparison with the planets round which they revolve. Like the main solar system, the satellite systems of Jupiter and Saturn show the characteristics to be expected in systems born out of a gaseous body. As we proceed away from these giant planets in either direction we come to planets whose satellites are fewer in number, but larger in size relative to the sizes of their primaries—the characteristics to be expected in systems born out of a liquid, or liquefying, body. This is at once explained if we suppose that the great size of Jupiter and Saturn caused them to remain gaseous for a long time, while the smaller planets such as Mercury and Venus liquefied or solidified almost at once. The cases of transition appear to be provided by our own earth in the one direction and by Neptune in the other; each of these planets possesses a single satellite which is abnormally large in comparison with the size of its primary.

We can perhaps find confirmation of this in the fact that Mars and Uranus, the two planets which come next to these as we pass inwards towards Jupiter, are both abnormally small; we might have expected Mars to be intermediate in size between the earth and Jupiter, and Uranus to be intermediate in size between Neptune and Saturn. Now if we suppose that these two planets were the smallest of all the planets which retained their gaseous condition for long, they would suffer more than the others from the continued dissipation of their atmospheric layers into space. On this view Mars and Uranus must be regarded as mere relics of far larger masses, and we see at once why they are abnormally small for their positions in the planetary sequence.

There are so many conjectural elements in this theory that it would be rash to claim, or even to hope, that it can in any way prove final. The highest claim I would make for it is that it accounts for many of the observed facts, and has not yet been found to suffer from insuperable objections—and this can be said of few, if any, other hypotheses as to the origin of the solar system.

If we accept it we must accept also the consequences I stated at the outset. Stars are very rare objects in space, and so are spaced very far apart, so far apart that it is very hard to imagine the sparseness of stars in space. If we take three particles of dust and place them in a large cathedral, this would be incomparably more crowded with dust than space is with stars. As a consequence stars approach one another very rarely, and it is an almost inconceivably rare event for two stars to come so close that planets are born. Planets, and so presumably life also, must be exceedingly rare in the universe.

We can regard this with satisfaction or the reverse, as we choose. Some will feel overwhelmed with a great loneliness; they will feel that it adds to the terror which overcame Pascal when he contemplated the immense voids of space. Others will view it with satisfaction, because it adds to the relative importance of human and terrestrial life. When we thought of each star as the centre of a system which teemed with life, human life appeared as a very small thing; it formed an inconceivably small fraction of the total life of the universe. The new view compels us to think of life on earth as forming a comparatively large fraction of all life of the universe.

George Graham, F.R.S., 1673–1751.

On Nov. 24, 1751, at night, a funeral procession left a shop bearing the sign of the Dial and One Crown, in Fleet Street, for Westminster Abbey. The hearse was preceded by three coaches containing the pall-bearers Dr. Knight, Mr. Watson, Mr. Canton, Mr. Short, Mr. Catlyn, and Mr. Bird, and was followed by nine other coaches. Thus was borne to his last resting-place George Graham, widely known both at home and abroad as the finest mechanician of his day. Arrived at the Abbey, the coffin was carried into the nave and was then laid beside that of Thomas Tompion, who had died in 1713, recognised as "the father of English watchmaking". The grave is not far from that of Newton. It is covered by a stone with an inscription, a part of which refers to Graham, "whose curious inventions do honor to ye British genius whose accurate performances are ye standard of mechanical skill". In the middle of the eighteenth century burials in the Abbey were more frequent than they are to-day, and it was a fortunate decision which led to the interment within its walls of these two famous masters of horology.

Graham, who was a Quaker both by upbringing and by conviction, was cast in much the same mould as that other Quaker and man of science of a later day, John Dalton. Born in Cumberland in 1673, at the age of fifteen he came on foot to London and there began an apprenticeship of seven years with Henry Aske, a clockmaker. His apprenticeship ended, he entered the employ of Tompion, afterwards marrying his niece and succeeding to his business at the Dial and Three Crowns, Fleet Street. In 1720 Graham moved across the street to the Dial and One Crown to a shop which was destined to become famous, and it was there he died, Nov. 20, 1751. The friend of Newton, Halley, Molyneux, Hadley, Bradley, and many others, Graham lived for the advancement of science and the benefit of mankind, and though his business brought him ample means, so little account did he take of wealth that on principle he refused to accept interest on loans and never invested in Government securities. To his more intimate contemporaries he was known as honest George Graham.

Of the life of such a man we cannot know too much, and both horologists and astronomers will read with interest the pamphlet issued by the *Vassar Journal of Undergraduate Studies*, giving Miss C. D. Hellman's sketch of George Graham, maker of horological and astronomical instruments. Miss Hellman has taken the trouble to consult most of the original works which give information of Graham's scientific inventions and observations and her account is the fullest we have hitherto seen. Graham's position among his fellows can be judged from the facts that in 1720, when he took up his residence at the Dial and One Crown, he was elected a fellow of the Royal Society, and that two years later he was made Master of the Clockmakers' Company. He had already invented the 'dead beat' form of the anchor escapement for clocks and watches, and in 1721 had brought out his mercurial pendulum, an improvement which became of great importance.

With these inventions to his credit, Graham then proceeded to add to his reputation by observations on the magnetic needle, during which he discovered the diurnal variation and measured the magnetic intensity. In 1725 he made his well-known 8 ft. quadrant for Greenwich Observatory and at the same time constructed sectors for both Molyneux and Bradley. Much of Bradley's work at Kew was done with his assistance. Other instruments he made were those supplied to the French Academicians who in 1736 visited Lapland to measure an arc of the meridian. At his house in Fleet Street he observed comets, solar and lunar eclipses, sometimes by himself, sometimes with a fellow-observer. He also served on a committee connected with Greenwich Observatory, and carried out work in connexion with the standards of measurements. On all these matters Miss Hellman gives an account, and her pamphlet contains extracts from Graham's paper published in the *Philosophical Transactions*. Without an equal in his own line, Graham lived to see the rise of Mudge, Harrison, Dollond, Bird, Short, and others, in whose hands scientific instrument making reached a pitch of excellence surpassing even that of Graham. Most of these, however, owed something to Graham, and Bradley once wrote: "If my own Endeavours have, in any respect, been effectual to the advancement of astronomy, it has principally been owing to the advice and assistance given me by our worthy member, Mr. George Graham, whose great skill and judgment in mechanics, joined with a complete and practical knowledge of the uses of astronomical instruments, enable him to contrive and execute them in the most perfect manner". "No greater tribute than this", says Miss Hellman, "could be paid to George Graham."

Obituary.

Dr. Richard Wettstein.

The death on Aug. 10, at the age of sixty-eight years, of Dr. Richard Wettstein, Ritter von Westersheim, Hofrat, professor of systematic botany and director of the Botanic Garden and Institute of the University of Vienna, removes a notable figure from the botanical world. His commanding presence, courteous demeanour, and powers of oratory give credence to the statement by the correspondent of the *Times* that on more than one occasion he was seriously considered as a possible president of the Republic.

Among botanists, Wettstein was known as a careful and painstaking investigator, a capable teacher, and an efficient organiser. He studied at Vienna under Anton Kerner von Marilaun, author of the well-known volumes on the natural history of plants, and, after a short period as a *privatdocent*, went in 1892 to Prague, where he followed Heinrich Willkomm as professor of botany in the German University. Seven years later he returned to Vienna to succeed Kerner, whose daughter he had married, as University professor and director of the Gardens. Shortly after his return, a commodious botanical institute was erected to replace the historic but meagre old buildings at the Gardens, and here Wettstein played the part of host to the delegates who met to formulate the Rules of Botanical Nomenclature at the International Botanical Congress in 1905, of which he and Prof. Julius Wiesner were joint presidents. More recently, as senior president of the International Horticultural Congress, in September 1927, Wettstein again welcomed botanists and horticulturists from all parts of the world at the University.

In 1889, while still *privatdocent* at Vienna, Wettstein succeeded Alexander Skofitz as editor of the *Oesterreiche Botanische Zeitung*, which he continued to edit, with some assistance in later years, until his death. The volumes of this journal contain numerous contributions from him relating to the Austrian flora, of which he was a careful student, to systematic botany, and to nomenclature. The journal took a leading part in preparation for the discussions on nomenclature at the Congress in 1905. In 1901, Wettstein led a botanical expedition to South Brazil under the auspices of the Austrian Academy of Sciences, the results of which he published in the *Denkschrift* of the Academy.

Wettstein's chief contributions to botanical knowledge lay in the application of principles of phylogeny and morphology to taxonomy. His monograph of *Euphrasia* (1896) was an intensive study of the species, and their origin and affinities, especially in relation to their geographical distribution. He also developed the idea of *Saisondimorphismus*—the evolution of early and late flowering forms of one stock—as a source of new species. A similar study of a group of European gentians appeared in the following year. He had previously (1891) contributed accounts of the families Solanaceæ and Scrophulariaceæ to the "Pflanzenfamilien", and a "Beitrag zu Flora Albaniens" was published in 1892 as a volume of the "Bibliotheca Botanica". He was a good draughtsman and his botanical contributions are illustrated largely by himself. To botanical students, Wettstein is familiar as the author of a widely used "Handbook of Systematic Botany" (1901–8); he attempted to derive the Angiospermous flowering plant from the Gymnosperms through the Gnetales, regarding *Casuarina* as the most primitive existing Angiosperm. The theory was an ingenious one, but has not been generally accepted.

Wettstein was honoured by his fellow-countrymen and also received many marks of recognition from European and overseas societies and institutions. He was elected foreign member of the Linnean Society of London in May 1914.

A. B. RENDLE.

WE regret to announce the following deaths:

Mr. M. M. Pattison Muir, senior fellow of Gonville and Caius College, and formerly prælector in chemistry in the University of Cambridge, on Sept. 1, aged eighty-two years.

Prof A. S. Pringle-Pattison, emeritus professor of logic and metaphysics in the University of Edinburgh, on Sept. 1.

Dr Droop Richmond, chief analyst to Boots Pure Drug Co., Nottingham, for sixteen years, on Aug. 26, aged sixty-four years.

Dr. Per Axel Rydberg, for the last thirty-two years curator of the New York Botanical Garden in the Bronx, on July 25, aged seventy-one years.

Dr. Louis W. Sambon, a pioneer worker in tropical medicine, on Aug. 31.

Col. the Hon. Milo G. Talbot, C.B., who was awarded a Royal Medal of the Royal Geographical Society in 1909, known for his surveys of the north-west frontier of India and Anglo-Egyptian Sudan, on Sept. 3, aged seventy-six years.

News and Views.

THE very personal appeal of the problems of the internal secretions is sufficient guarantee that the valuable résumé by the master in this subject which appears as a Supplement to this week's issue of NATURE will be widely read. Both author and subject came into being at about the same time and both have grown and developed side by side. During the eighty odd years of a fruitful scientific life, Sir E. Sharpey-Schafer has not only witnessed the change of view regarding the basis of animal behaviour but also he has played a prominent part in bringing about this broader basis. It is being realised more and more that racial and individual characteristics are not solely the expressions of an inherited nervous system but are also dependent, though to a lesser degree, on the development and efficiency of the organs of internal secretion. Many unwarrantable assertions appear from time to time regarding the part played by these special glands in the determination of personality, and until further information concerning their variations with age, climate, and habitat are available, such statements must continue to remain of a highly speculative nature. As in all subjects, during the constructive period, some confusion creeps into the nomenclature, but up to the present no better term has been introduced to connote an internal secretion than the word 'autacoid' proposed by Schafer to express the drug-like action of such a chemical regulator; it is more accurate though less euphonic than the term 'hormone' introduced by Starling, which was originally intended to suggest excitation only and would thus exclude depressing autacoids.

THE methods of studying these autacoid substances are based largely, first of all, on the loss or removal of the particular gland, with observation of the resulting deficiency disease set up, and secondly, with the cure of the disease by grafting or feeding with the gland from a healthy animal, or alternatively by injection of an extract of the gland, and lastly by administration of the active chemical principle when this is known. The method which has been most extensively used and has proved the most fertile in ascertaining important facts is the injection of extracts into animals and into man. This technique was not used much until Schafer, working in conjunction with Oliver, discovered that extracts made from the adrenal bodies give rise—when injected into the veins of an animal—to a very great increase in blood pressure. It is worthy of mention that all the fundamental facts were noted by Schafer in his early papers. In his work with Oliver he observed that one other gland extract besides that of the adrenal, namely, the pituitary, also contained a pressor principle, and an extract of this gland is now widely employed by obstetricians for the arrest of hæmorrhage after childbirth. The account of the interrelationships of the organs of internal secretion given by Schafer does not warrant the present-day wholesale dissemination of poly-glandular preparations coming from foreign drug manufacturers.

Progress in the elucidation of the mode of action and therapeutic action of a specific autacoid can be established only by careful dosage and observation of a physiologically standardised unit.

CONSIDERABLE interest has been aroused recently by the claim of Dr. Bendien, of Zeist, to have developed a method of diagnosis of cancer which is infallible even in the early stages of the disease. The method has been briefly described by Dr. A. A. Miller in a recent letter to the *Lancet* (Aug. 22, 1931; p. 427) and is given in more detail in a paper by F. C. Smith, E. R. Holiday, and J. Marrack (*ibid.*, Aug. 29, p. 507). It consists of two parts: in the first the serum is mixed with a series of mixtures containing varying proportions of sodium vanadate and acetic acid: normal human serum produces a precipitate in tube No. 6: if flocculation occurs below this, that is, in the more acid mixtures, carcinoma, tuberculosis, or some other disease is indicated. In the second part of the test, the precipitate obtained is heated to 56° C., filtered off, weighed, and dissolved in two per cent sodium bicarbonate solution. The ultra-violet absorption curve of this solution is then obtained by means of the spectrophotometer. Bendien claims that there is a curve typical of cancer and another of tuberculosis.

MARRACK and his co-workers (loc. cit.) in their investigation of the test, point out that the concentration of the precipitate in the bicarbonate solution is very variable owing to the fact that it is only dried by suction on the filter, so that it contains water up to 90 per cent of its total weight. No attention can be paid, therefore, to the actual height of the absorption curve obtained; only the shape and slope are significant. They obtained curves of the same general character as those of Bendien, but they found that the actual slope depended on a time factor. When the spectrophotometric examination is carried out as soon as the precipitate has been dissolved, both cancerous and non-cancerous cases show a typical 'tuberculosis' curve with absorption extending into the visible region of the spectrum, as indeed might be expected from the yellow colour of the solutions. On standing, however, the solutions fade slowly, and no longer absorb the longer wave-lengths: curves 'typical of carcinoma' are then obtained. The authors conclude that the method is of no value in the diagnosis of cancer. It is clear that further work is required before Bendien's claim can be accepted without question: it is possible that the different opinions expressed as to the value of the test may be due to differences in technique, but in any case, Marrack's work indicates that to be of value the details of the test must be very rigidly standardised.

INVESTIGATORS have long sought to discover the cause of the common cold. The condition is unquestionably contagious, and has therefore been considered to be a microbial infection. Many micro-organisms have at different times been assigned a causative rôle, and the evidence adduced in favour of one or another agent has frequently seemed to be impressive. Several well-recognised pathogenic micro-organisms, such as the pneumococcus, streptococcus, influenza bacillus, and *Micrococcus catarrhalis*, have been thought to play a part in the production of this catarrhal condition, the severer form of which was formerly often spoken of as an 'influenza cold', but none can be said to have established a position other than as a possible occasional cause. With the recognition of the existence of the ultra-microscopic or filtrable forms of disease-producing viruses, evidence accumulated that the causative agent of the common cold might belong to this class of infecting agents. This hypothesis receives confirmation by the studies of A. R. Dochez, K. C. Mills, and Y. Kneeland, jun. (*Lancet*, Sept. 5, p. 547), who found that the chimpanzee in addition to man is susceptible to an acute infection of the upper respiratory tract, resembling in every respect the similar infection in man.

MESSRS. Dochez, Mills, and Kneeland have filtered nasopharyngeal washings from individuals with acute colds through Seitz filters, which do not permit the passage of bacteria, and the filtrates were inoculated intranasally into chimpanzees, with the result that a typical acute attack of 'cold' developed. Human volunteers similarly inoculated also manifested the signs of the common cold, and such experimental colds both in apes and in man are contagious by contact to others, and may be passed in series from individual to individual. The virus in the filtrates preserved anaerobically in the ice-box maintained its activity for from four to thirteen days. A method of culture was also devised in a chick-embryo cystein broth medium. This was inoculated with the filtered nasal washings and the culture was carried on for twelve generations, when an inoculation with it induced a mild cold in one out of three human volunteers. The fifteenth culture, representing a dilution of approximately one to two quadrillion of the original material, also produced colds in two out of three inoculated volunteers. In addition to initiating symptoms of infection, the virus also appears to provoke increased activity of any potential pathogenic agents that may happen to be present in the respiratory tract, such as the pneumococcus and others.

ON July 7–20, representatives of the Geological Surveys of Southern Equatorial Africa met at Kigoma to discuss the compilation of a geological map of that part of the continent. The conference constituted the first meeting of the Sub-Commission of African Geological Surveys formed at the Fifteenth International Geological Congress, at Pretoria in 1929, and the countries represented at Kigoma were: French Equatorial Africa, Northern Rhodesia, Belgian Congo, Ruanda Urundi, Uganda, Tanganyika Territory, and Nyasaland. In these countries, provisional geological maps already exist, but great difficulty has hitherto been found in establishing the relation between the geological formations of any one country with those of neighbouring or more distant countries, and this difficulty has been greatest in the case of the ancient unfossiliferous formations. In the course of the recent discussions, however, assisted by a comparison of rock specimens and maps from the different countries, considerable progress has been made, and as a result of this the Sub-Commission has drafted a geological map of Southern Equatorial Africa, which it is proposed to publish at an early date. A great advance has been made in the mapping of the Katanga System, within which lie the great copper deposits of Northern Rhodesia and the Belgian Congo, and the tin-bearing formations of Uganda can be followed through Tanganyika and Ruanda Urundi to the Belgian Congo. Moreover, the Karroo System, bearing many coal deposits in this part of Africa, was discussed in some detail.

SINCE the only sound basis for the development of mineral resources is a thorough knowledge of the geological formations and of their relation to one another, the discussions at the conference and the conclusions arrived at, as summarised in the new geological map, should prove to be of considerable economical value, as well as of scientific interest. The conference recognised the following three important systems of pre-Karroo age: (*a*) The Basement Complex, comprising sedimentary and igneous groups showing wide variations in degree of metamorphism; this system is roughly comparable with the Swaziland System of South Africa. (*b*) The Muva-Ankole System, consisting principally of quartzite and shales, with acid volcanic rocks locally, and, more rarely, basic rocks. In some areas the shales are represented by phyllites or schists, and the quartzites show a similar range of metamorphism. The system can be traced from Northern Rhodesia to Uganda, and includes, for example, the Muva, Mafingi, Ukinga, and Karagwe-Ankolean groups. It is separated from the systems below and above by vast uncomformities, and it is considered as probably equivalent in part to the Witwatersrand and the Ventersdorp Systems. (*c*) The Katanga System, ranging from the Série des Mines to the Upper Kundelungu, and equivalent to the Transvaal-Nama and Waterberg Systems. At the base of the Lower Kundelungu is the great tillite of the Katanga, so that in this area at least one important glacial epoch of pre-Karroo age is recognised. It may be added that over a wide area in this part of Africa glacial deposits are believed to exist at the base of the Karroo, although their correlation with the Dwyka has not yet been established.

THE special displays of the flood-lighting of buildings in London which began on Sept. 1 and are being given in connexion with the International Illumination Congress have proved a great success and have attracted huge crowds of sightseers. The flood-lighting has brought out the beauty of many architectural features of the buildings which are seldom noticed. For example, the upper façade of Somerset House fronting the river is bathed in a clear rose-coloured light which makes a striking contrast with the dark terrace beneath. Buckingham Palace is perhaps the most brilliantly illuminated building, and makes a very attractive spectacle. The lamps required for it consume 200 electric units per hour. The principal area illuminated is from the Tower Bridge to Westminster. The clock tower of Parliament is flooded with light the colour of old ivory, and can be seen from great distances. The spire of St. Bride's Church, shown up in brilliant white light, also frequently catches the eye when driving through the City. The Institution of Electrical Engineers, on the Embankment, with its six bright pylons, is admired by many. We understand that this illumination is permanent. The illuminations include monuments and parks. From Northumberland Avenue the silhouette of Nelson on his column is a wonderful sight. The column itself is in darkness, and the statue, gently illuminated, stands out in detailed relief. Some well-known buildings in the neighbourhood of London have also been flood-lighted. The George Inn at Slough and the Dysart Arms at Petersham show up the merits of this system of lighting. In a few cases the display is a little garish, but the brighter the spectacle, the better pleased are the sightseers.

THE limitations produced by atmospherics on long-distance working between radio stations are very annoying to radio operators. The commercial operation of a long-wave receiving station may remain completely disorganised for long periods when intense atmospheric disturbances take place near the aerial. A flash of lightning acts as a long-wave spark transmitter, and as the voltage is in millions and the current in thousands of amperes, the effects produced may be very serious. Lightning flashes are not the only cause of atmospherics. The distribution of potential throughout the atmosphere is very irregular and it is probable that sudden equalisations of potential may occur without visual flash, causing all kinds of atmospherics. In *Television* for August, T. Bray points out that television is much less affected by atmospherics than radio communication. It might usefully be employed, therefore, in sending printed messages during heavy tropical atmospherics when ordinary radio cannot be used. Atmospherics manifest themselves as a rapid series of 'splashes' on the television screen, affecting it continuously and sometimes resembling flames passing over it. Bray shows by diagrams that even when aural and automatic reception of the morse code are impossible, the printed letters on the television screen are easily read. This special aspect of television may open out new commercial applications where it can be usefully employed.

NEWS from the *Nautilus*, the submarine in which Sir Hubert Wilkins is making his Arctic expedition, was received by radio by the *News Chronicle* from 350 miles from the north pole, where the ship was on Aug. 25. The actual position was then about lat. 84° N., long 10° E. Echo soundings had shown an irregular ocean floor varying between 1000 fathoms and 300 fathoms within a few miles. This was probably at the place where the *Nautilus* crossed a submarine ridge between northern Spitsbergen and Greenland. Farther east, at a position not stated, a depth of 1205 fathoms was recorded. At the time of the message the ship was in open water with much scattered pack-ice, but closer pack, involving the need to submerge, was expected to the northward. Progress was slow, and spray was freezing on the deck and conning tower. A message sent the previous day recorded a serious accident. The *Nautilus* was then 500 miles from the pole, when it was discovered that the diving rudder was lost. A diver discovered, however, that the ordinary steering gear was intact. The loss of the diving rudder made submergence difficult and restricted movements below the surface, but later in the week a message recorded progress. During last week no messages were received from the *Nautilus*, and a certain amount of anxiety was felt. The Norwegian Government decided to send a search expedition and two aeroplanes, under the command of Capt. Riiser-Larsen. A long dispatch from Sir Hubert Wilkins appears in the *News Chronicle* of Sept. 7, from which it appears that the *Nautilus* has been holed and emerged from the pack ice on Sept. 4 in about lat. 81° N., long. 11° E.; she was making her way slowly to Spitsbergen. It is stated that the scientific staff of the expedition are well satisfied with the results obtained.

A MEETING was recently held of the Sub-Committee on Symbols, Units, and Nomenclature used in Physics, appointed by the International Union of Physics. Sir Richard Glazebrook was appointed chairman of the Committee. Prof. Kennelly, as chairman of the Section of the Advisory Committee of the International Electro-Technical Commission dealing with electrical and magnetic magnitudes and units, wrote directing attention to the meeting of his Committee in London on Sept. 18, and inviting members of the Committee of the International Union of Physics to attend. This invitation has been accepted, and it has been arranged to hold a meeting of the Sub-Committee on Symbols, Units, and Nomenclature shortly afterwards to continue the discussion commenced at Brussels. Communications with regard to this meeting should be addressed to Dr. Ezer Griffiths, at the National Physical Laboratory, Teddington.

THE claim by Sir Colin Mackenzie, of Canberra, that the female aboriginal skull discovered in the Jervois Ranges is one of the most important of the prehistoric documents in the world to-day has been received with some scepticism in Australia. The skull is 173 mm. in length, the forehead breadth is 86 mm., and the volume between 956 c.c. and 980 c.c. It is contended that this cubic capacity is the smallest known in any complete human skull; hence that the skull belonged to an individual on the confines of the lowest humanoid stock. On the other hand, Prof. F. Wood Jones, of the University of Melbourne, is convinced, from the study of a cast, that the skull falls well within the limits of the normal modern Australian aboriginal female, and that Sir Colin Mackenzie's conclusions are unwarranted.

THE *Spectator* for Aug. 15 contains an article (p. 210) by D. Yorke on bird migrants at Rossitten, in which are some noteworthy observations on the relation of peregrines to their prey. The first one seen made five attempts to capture wood-pigeons from the migrating flocks, but always failed, even when it got into a flock and flew amongst them; ultimately it caught a greater spotted woodpecker and descended to eat it. Later, three peregrines were in sight at once, also attacking pigeons unsuccessfully; and again a woodpecker of the above species fell a victim. This would seem to indicate that the wood-pigeon, though greatly desired, is too much for many peregrines, and that the greater spotted woodpecker occupies to them the same relation as a warningly-coloured moth or butterfly does to insect-hunters—a sort of emergency quarry to be taken in default of anything better. It was proved a generation ago that the Danaid butterflies will be eaten by caged insectivorous birds in default of other live food, and the coloration of most woodpeckers would be classed as 'warning' if worn by an insect.

WE have received a letter from Mr. F. Gilbert Carruthers, 10 Addison Road, London, W.4, relative to the question whether earwigs use their forceps for purposes of offence or defence. He mentions that he inadvertently drank some soda water from a mug which contained one of these insects, and that the first intimation he received of the creature's presence was when he experienced a distinct nip on the lip. The nip, he adds, was more surprising than painful. In this connexion it may be mentioned that, when alarmed or disturbed, earwigs regularly open their forceps in a threatening manner. If a finger, or other object, be placed between the forceps, the latter will often close with a slight nip. The main function of these weapons is still obscure: on rare occasions earwigs have been recorded to use their callipers for seizing their prey, and also for fighting against one another.

SIR WILLIAM R. MORRIS has given £25,000 to the British Empire Cancer Campaign for the establishment of a research fellowship in radiology at the Mount Vernon Hospital, Northwood, Middlesex. This hospital was opened in 1929 as the Empire centre for the treatment of patients suffering from cancer, and for the investigation of the causes and cures.

THE twelve major topics announced for discussion at the third International Conference on Bituminous Coal to be held under the auspices of the Carnegie Institute of Technology, Pittsburgh, on Nov. 16–21 (see NATURE, Feb. 14), are as follows: cleaning and preparation; hydrogenation; by-products; fertilisers; low and high temperature carbonisation; gasification; combustion; railway and steamship fuel; smoke abatement, dust removal, and flue gas purification; origin, classification, and properties; competition between coal and other fuels; storage of coal. The following countries are among those to be represented: United States, Austria, Great Britain, Czechoslovakia, France, Germany, the Netherlands, Poland, U.S.S.R., Spain, and Switzerland.

J. A. A. KETELAAR has asked us to correct an error made by him in his letter in NATURE of Aug. 22, p. 303, entitled "Structure of the Trifluorides of Aluminium, Iron, Cobalt, Rhodium, and Palladium". The value of the z-parameter of the fluorine ions (2) is not $\frac{1}{8}$ but $\frac{5}{8}$, in accordance with the description of the structure at the end of the letter.

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The Physiology of Internal Secretion.

By Sir E. Sharpey-Schafer, F.R.S.*

PHYSIOLOGY must be looked upon as having begun with Harvey. As a science, therefore, it dates back merely three hundred years. It is only during the last one hundred and fifty that it has made real progress, and much of that progress has taken place during the last hundred.

During the period immediately succeeding Harvey's discovery of the circulation of the blood, the attention of physiologists was mainly devoted to the mechanical functions of the body. After Harvey, Stephen Hales was the first to study the mechanics of the circulation. Hales determined the amount of pressure which the blood exerts in the arteries; like a true student of Nature, he did not restrict himself to studying the flow of blood in animals but also investigated the conditions of the flow of sap in plants. In the meantime, it had been found by Malpighi, using the newly invented microscope, that the blood is not homogeneous but a suspension of coloured corpuscles in an otherwise colourless fluid. Nothing, however, was as yet known as to the real nature of blood or as to its functions. Nor was it until the foundations of chemistry had been established by Lavoisier that light was thrown upon the supreme importance of those functions. It has been reserved for the time in which we live to determine the constancy of composition of the circulating fluid and the necessity to health and even to life itself of maintaining that constancy within a very circumscribed limit.

The recognition of the regulation of bodily functions by the nervous system constituted the next step in advance in physiology. This recognition occurred about a hundred years ago. Since then it has been justly regarded as the dominating factor in the physiology of the Metazoa. The definite founding of this doctrine was due to Carl Ludwig in Germany and Claude Bernard in France. Side by side with these researches, others by various workers (Magendie, Bell, Flourens) were revealing the manner in which the central nervous system co-ordinates the functions of the various organs of the body. In our own times, the doctrine of the dominance of the nervous system and the manner in which all reflex and voluntary actions are regulated by it has been firmly established by the researches of Pavlov and Sherrington.

Thus the predominant feature of the development of physiology up to this time has been the evolution of knowledge of the regulation of bodily functions through the nervous system.

A 'new physiology', which does not supersede the old but assimilates and is incorporated with it, has sprung up within the last fifty years. The old physiology was based, as we have seen, on *nervous regulation*; the new physiology is based on *chemical regulation*. We have learned to recognise that the functions of organs are not governed solely by nerves but are largely influenced by chemical substances in the blood; the nerves and nerve-centres being themselves subject to chemical influences. On the other hand, chemical regulation may itself be influenced by the nervous system, so that the reaction is mutual.

Since the chemical substances which react with the tissues are normally produced elsewhere than in the tissues they act upon—many of them in special organs of internal secretion—their action is often spoken of as *humoral*, because they are conveyed in the blood or lymph (humours). But this term is too restrictive, for they may be actually produced in situ within the tissues upon which they act: in such a case, their action, although still chemical, would be incorrectly described as humoral.

Regulation by chemical substances appears to be a more simple process than regulation through nerves: it might therefore be supposed that chemical regulation would have been the first to be evolved. But this can scarcely be the case, for chemical regulation assumes the existence of a circulating fluid to convey the chemical materials for such regulation to the tissues on which they act, whereas nervous regulation is already developed in the lowest of the Metazoa, such as the medusæ, before the evolution of any circulatory system. The nervous system of these low forms of animal organisation, although much less complex, is already constituted of discontinuous units in no respect essentially different from the neurones of the higher animals, and serves to regulate their activities without, so far as we can tell, the aid of chemical or humoral stimuli.

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* From the John Mallet Purser Lecture delivered in Trinity College, Dublin, on June 26.

ORIGIN OF THE DOCTRINE OF INTERNAL SECRETION.

The history of the development of our knowledge regarding chemical as distinguished from nervous regulation, or, in other words, of the doctrine of internal secretion, is of considerable interest. The first indication that the regulation of function might be effected by chemical rather than nervous agencies was pointed out by Berthold in 1849. Berthold found that the implantation of testicular grafts into castrated cocks (capons) would restore the appearance of the birds to that of normal cocks, and concluded that the testicles must pass some substance into the blood which reacts on the organism in general. He was thus the first to introduce the idea of 'internal secretion'. But for many years his observation remained unnoticed. The idea was almost grasped by Claude Bernard, who in 1852, as the result of his work on glycogenesis, described the passage of sugar from the liver cells into the blood as an 'internal secretion', and recognised that every tissue in the body must be continually passing products of metabolism into the blood, either for nutrition or excretion, and must therefore be yielding similar 'internal secretions'. But this was a long way from the modern interpretation of the term, which implies material of a special nature capable of exerting a specific action. One cannot, therefore, claim Bernard as a founder of the new physiology.

The next distinct move in the establishment of the doctrine of internal secretion came from the clinicians. The Swiss surgeons, J. L. and A. Reverdin and Th. Kocher, described, in 1883, as the result of extirpation of the thyroid gland, a peculiar cachexia which was termed by Kocher 'cachexia strumipriva' and by the Reverdins 'operative myxœdema'. They compared it with the conditions which accompany atrophy of the gland in children or its degeneration in the adult. These conditions had already been described by Gull in 1874 and later by Ord in 1878, and the resulting affection had been termed 'myxœdema' from the peculiar œdematous condition which characterises the skin, which was supposed to be due to the presence of mucin.

That myxœdema is due to the absence of an internal secretion of the thyroid is shown by the fact that, if not too advanced, all the symptoms are removed by administration hypodermically (or even orally) of thyroid juice or extract of thyroid. The chief ingredient of the secretion is thyroxine, the chemical constitution of which has been exactly ascertained, thus enabling it to be produced synthetically. Thyroxine can be substituted for thyroid juice or gland extract and will remove the consequence of removal or atrophy of the gland.

Apart from the isolated observation of Berthold, the thyroid was thus the first of the endocrine organs to furnish definite evidence not only of the existence but also of the importance of an internal secretion. In the absence of its secretion, nutrition and growth are impaired and the functions of the brain, especially those of the cerebral cortex, can no longer be carried on normally; while administration of the gland substance or of its chief ingredient will restore the cretin to a normal condition both bodily and mentally. As Gley has remarked, we are faced with the remarkable fact that the highest functions of the brain cannot be carried out in the absence from the blood of a relatively simple chemical substance. And this substance is formed by a gland which is not connected either anatomically or developmentally with the central nervous system but is related primitively to the alimentary canal. Moreover, the internally secreting function of the thyroid is, so far as our present knowledge goes, independent of the nervous system. It can be carried on if the thyroid is entirely cut off from connexion with that system as by severance of all nerves passing to the gland or by transplanting it from the neck to some other position in the body.

The internal secretion of the thyroid was, as we have seen, discovered about fifty years ago from the results of surgical removal of the organ in man. These results were confirmed and amplified by experiments on animals, and form the actual beginning of our knowledge of the internal secretions, the existence of which had not previously been recognised. All the various internally secreting organs, now recognised as fulfilling functions of the highest importance, were until then regarded as mere rudimentary structures devoid of function : which may at some early period of evolution have had a meaning but had long ceased to exercise any influence in the animal economy.

In 1855, Thomas Addison described the disease which bears his name, and associated the symptoms of the affection with destruction of the suprarenal capsules. ' Addison's disease ' is characterised by extreme debility and is invariably fatal. The publication of Addison's memoir led to the performance of experiments by Brown-Séquard and others with the view of determining whether surgical extirpation of the capsules would produce effects in animals similar to those accompanying their destruction by disease in man. Although the pigmentation effects seen in Addison's disease were never observed in animals, these experiments showed that complete removal of both capsules was invariably fatal. Attempts made by implantation of capsules from other individuals to antagonise the effects of removal always proved abortive, and the cause of the fatal result of extirpation could not at the time be ascertained. Nearly forty years more elapsed before the suprarenal capsules were recognised as organs of internal secretion, owing to the discovery that a powerful, physiologically active material is produced in the medulla of the organ.

The discovery was made in 1893. On testing the effects of intravenous injection of extracts of a number of organs, including the chief ductless glands, it was found by Oliver and Schafer that while extracts of most organs produce a distinct fall of blood pressure, extracts of suprarenal and of pituitary cause an immediate and extraordinary rise. While this active substance of the pituitary has never been isolated in a pure state, so that its chemical constitution remains unknown, that of the suprarenal is obtainable in a crystalline form. It can also be prepared synthetically, and constitutes the now well-known drug ' adrenaline '. Adrenaline was the first of the active principles of the internal secretions to be isolated and synthesised and for long remained the only one, but it has now been joined by thyroxine.

Adrenaline and thyroxine may be taken as yielding examples of two entirely different kinds of action of the internal secretions. Adrenaline produces its effects immediately—upon heart, blood vessels, liver, salivary glands, intestine, pupil, spleen—but the effects soon pass off, owing to destruction of the adrenaline either in the tissues or within the vessels. Thyroxine, on the other hand, acts slowly and gradually, influencing the nutrition of the tissues, stimulating the multiplication of cells, and producing characteristic effects upon general metabolism. These results do not appear immediately and do not readily subside, but are continued long after the administration of the thyroxine has ceased ; they may even be cumulative, so that a dose which seems insufficient at first may, if continued, produce an exaggerated effect.

Adrenaline and thyroxine also furnish examples of a striking difference between the mode of secretion which occurs in different endocrine organs. Thus, adrenaline is passed from the cells of the suprarenal medulla, in which it is formed, directly into the blood ; whereas the internal secretion of the thyroid does not pass directly into the blood, but passes from the vesicles, in which it is secreted by their lining cells, into the lymph in the interstitial spaces of the connective tissue of the gland, and from these into efferent lymphatics, and eventually into the blood by the great lymphatic trunks.

On consideration of all the organs and parts of organs which are credited with the production of an internal secretion, it will be found that those which contain sinusoids, into the blood of which the secretion is passed directly by the cells of the organ, are—besides the suprarenal medulla—the liver, the islets of Langerhans of the pancreas, the pars anterior of the pituitary body (perhaps also the pars tuberalis), the parathyroids, and the placenta ; whilst the internally secreting organs which resemble the thyroid in possessing ordinary capillaries and pass their secretion into the lymph of the organ are the cortex of the suprarenal capsules, the pars intermedia and pars nervosa of the pituitary, and the gonads. Naturally, it does not follow that the efferent lymphatics are the only vessels which absorb the material of the internal secretion from the interstitial lymph of such organs ; it may also be absorbed in part from the lymph by the blood capillaries. The distinction is that in one case it is passed directly into the blood and produces its effects immediately, whereas in the other case its passage into the blood is slower and its effects are produced more gradually.

There can be no doubt that a real physiological distinction underlies this difference of the mode of secretion: and we may probably draw the inference that in the case of secretion directly into the blood, it is momentarily varying—increasing or diminishing—according to the immediate calls of the organism ; and that when reaching the blood through the lymph, its purpose is to cause such gradual changes as those affecting growth and nutrition.

Relations of Internal Secretions to Nervous System.

The internal secretion of some endocrine organs is independent of the nervous system, their activity or inactivity being directly influenced by constituents of the blood. Thus an increase of blood sugar will provoke an increased secretion of insulin from the islets of Langerhans. With other endocrine organs the case is different; their internal secretion is dependent on the nervous system. Of these, the medulla of the suprarenals furnishes an example. It can be shown that the adrenaline it forms is dependent for its secretion into the blood upon the integrity of the nerves passing to the organ. If the splanchnic is cut, the secretion of the corresponding suprarenal capsule is arrested; if now the peripheral end of the cut nerve is stimulated, the secretion is poured into the blood. Normally this influence is exerted through a nerve centre in the bulb, in the same way that the secretion of the salivary glands is poured out as the result of afferent stimuli affecting the reflex centre for salivation. This salivary centre can be influenced not only to increase but also to diminish or arrest the secretion, and, *ceteris paribus*, this is also true for the secretion of the suprarenal medulla, which can be influenced to secrete more or less adrenaline according to the nature of the stimulus reaching the bulb. This influence is the falling or rising of arterial pressure. Anything which tends to lower blood pressure produces an increase of the secretion, anything which tends to raise blood pressure produces a decrease of the secretion: and as a larger amount of adrenaline in the blood has the effect of raising arterial pressure and a diminished amount tends automatically to lower it, an average arterial pressure is thus maintained by a system of self-regulation exercised reflexly.

The chief afferent nerves for the reflex are those distributed to the carotid sinus—the bulbous extremity of the common carotid artery where it bifurcates into the internal and external carotids. This part of the vessel is richly supplied with nerves, as is also the small carotid gland which lies at the bifurcation. The researches of H. E. Hering and of J. F. and C. Heymans have demonstrated conclusively the fact that most of the vascular reflexes which are brought about by variations in arterial pressure are effected through the nerves of the carotid sinus and carotid gland. Whenever the sinus becomes more distended by an increase of arterial pressure, the vasomotor centre becomes inhibited and dilatation of the arteries of the body generally is produced. Similar effects produced through the agency of the depressor nerve have been longer recognised, the effect of its stimulation in lowering blood pressure by causing dilation of arteries through the vasomotor centre having been discovered by Cyon (working under Ludwig) so long ago as 1866.

As Tournade has shown, however, the raising and lowering of the blood pressure in the aorta and carotid sinus affects not only the vasomotor centre in the bulb but also an adrenaline-secreting centre, and this, by causing a variation in the amount of adrenaline poured into the blood, assists the regulating action of the vasomotor centre.

Detection of Adrenaline in Blood.

When first the presence of so powerful a stimulant of the vascular musculature was shown to be yielded by the suprarenal medulla, it was conjectured that the physiological purpose of the secretion must be to aid the nervous system in maintaining the tone of the arteries and in keeping up their blood pressure. But attempts to demonstrate that there is a normal or physiological secretion of adrenaline into the blood were made in vain by many experimenters. It was admitted that such a secretion could be produced by stimulation of the splanchnic nerves and by stimulation of the bulb either directly or through drugs; and also that an increase of secretion would be evoked by violent emotions and would show itself by producing the usual effects of adrenaline—the 'emotional secretion' of Cannon. But as it proved impossible, using even the most delicate physiological tests, to determine that adrenaline is present in the blood under resting conditions, the idea that it is being constantly secreted as a normal physiological act was given up. The question has, however, been answered in the affirmative by Tournade (working for the most part in collaboration with Chabrol) by the use of a new method of experimentation.

Two animals—generally dogs—are used for each experiment. Both are fully anæsthetised with chloralose. From one (*A*), both suprarenals are removed; from the other (*B*), preferably the larger, only one, usually the right. The whole of the blood coming from the remaining (or left) suprarenal of *B* is allowed to pass into *A* by making connexion between the suprarenal-lumbar vein of *B* and the external jugular vein of *A*. *A* therefore receives all the adrenaline secreted by *B*. *A* may be termed the 'receiver', *B* being the 'donor'.

The blood pressure of each animal is recorded from the femoral artery by mercury manometers. If anything is done to *B* which affects its secretion of adrenaline, the increase or diminution will show itself in the blood pressure of *A* ; *B*, of course, will remain unaffected, the whole of its suprarenal blood being passed into *A*. Hence, if the secretion of adrenaline by *B* is increased, the blood pressure in *A* will rise : if diminished, it will fall. Further, it is known that the intravenous injection of extract of suprarenal medulla, that is of adrenaline, produces in dogs not only a rise of blood pressure due to arterial constriction, but also what is known as a 'vagal pulse'—that is a slow and irregular action of the heart, caused by stimulation of the vagus centre in the bulb by the drug. This irregularity may therefore also be expected to occur in *A* if it is receiving an increased amount of adrenaline from *B*. Other tests of increased or diminished amount of adrenaline passing into *A* may be applied in addition, some of which are more delicate than the blood pressure test.

The following results have been obtained by Tournade by the above method :

1. If the venous connexion between the two dogs is interrupted by pinching, no change occurs in *B*, but in *A* the blood pressure falls, the intestinal movements increase in amplitude, the kidney and the spleen expand. On releasing the vessel, adrenaline effects are immediately again apparent, the blood pressure rises, a vagal pulse becomes apparent, the intestine is inhibited, the kidney and spleen shrink, and so on.

2. If the left splanchnic of *B*—in which, of course, the nerve supply of the remaining suprarenal is contained—is cut, the blood pressure falls in both dogs : in *B*, owing to paralysis of vasomotor nerves to the abdominal viscera; in *A*, in consequence of the failure of the suprarenal of *B* to secrete adrenaline. On now stimulating the peripheral cut end of the splanchnic of *B*, the blood pressure in that animal immediately rises, owing to contraction of its abdominal vessels ; and after a short delay, due to the time taken by the secreted adrenaline of *B* to pass through the venous anastomosis and to reach the circulation of *A*, the blood pressure rises also in this animal and displays the vagal character of the pulse ; besides which, all the other effects of addition of adrenaline to the circulating blood can be observed.

3. If the vasomotor centre in the bulb of *B* is directly stimulated by faradic shocks, there is an immediate rise in the blood pressure of *B* caused by general vascular contraction, and a delayed rise in the blood pressure of *A* due to increase of adrenaline : this is caused by stimulation of the adrenaline-secreting centre in the bulb of *B*. On the other hand, if the fourth ventricle of *B* is painted with dilute solution of cocaine, the activity of the adrenaline centre becomes depressed and less adrenaline is secreted by *B* and passed into *A*, the blood pressure of *A* falls, and the other effects of diminution of adrenaline in the blood of *A* can be observed.

4. If the blood pressure in *B* is lowered by any means, *B*'s adrenaline centre becomes reflexly stimulated, more adrenaline is passed into *A*, and all the effects of the increase become apparent in *A*. On the other hand, any agency which raises the blood pressure in *B*, such as stimulation of a sensory nerve, intravenous injection of a blood pressure-raising drug, re-injection of blood which has been withdrawn, is followed by a diminution of secretion of adrenaline by *B*, and all the effects which such diminution produces are observable in *A*.

5. Even comparatively slight changes in the blood pressure of *B* will cause quite appreciable differences in the amount of adrenaline secreted, so that such fluctuations in blood pressure as are shown by the Traube-Hering waves, or even by respiratory fluctuations when pronounced, are reproduced in *A* in the reverse sense ; every fall of blood pressure in *B* being followed by a rise in blood pressure in *A*, and vice versa.

The experiments of Tournade prove conclusively that this internal secretion is intimately dependent upon the nervous system.

EXCITATION AND INHIBITION.

Returning to the history of the new physiology, the next most striking fact regarding internal secretion, after the discoveries relating to the thyroid and suprarenal medulla, was the observation of Bayliss and Starling (1902) that an extract of duodenal mucous membrane contains a substance which when injected into the blood stimulates the secretion of pancreatic juice. To this substance they gave the name 'secretin', and supposed it to be formed when the acid chyme from the stomach comes into contact with the lining membrane of the duodenum. They spoke of it as a 'chemical messenger' absorbed by the blood from the intestine and carried to the pancreas in order to stimulate that gland to secretion ; and, somewhat later, assuming that all such chemical messengers possess a stimulating function, Starling suggested for them the general term ' hormone ' (stimulant).

Starling included in the term ' hormone ' such products of metabolism as carbonic acid and urea which pass into the blood from the tissues and act as chemical messengers stimulating the respiratory centre and the kidney respectively. More recent writers, in disregard of the original meaning of the term and the definition of it given by its author, have extended it to apply not only to substances which excite to activity but also to substances which have an exactly opposite effect—which, in fact, instead of exciting activity, depress it. We should, however, recognise in our nomenclature that the internally secreting organs yield materials which produce specific effects of two opposite kinds, namely, excitation and inhibition. These two kinds of effect are comparable with those obtained from stimulation of nerves, which we are in the habit of speaking of as ' excitatory ' and ' inhibitory ' and recognising as antagonistic. Antagonistic effects are also caused by drugs—some stimulating to activity, others restraining activity. Now, the active substances of the internal secretions act like drugs and several are used in medicine. Such are adrenaline, thyroxine, parathormone, insulin, as well as the active substances of liver and stomach, of the pituitary body, of the ovaries, placenta, and testes. As with nerves and as with drugs, some of these active substances are excitatory, others are inhibitory. They assist the excitatory and inhibitory nerves to maintain that constancy of physical and chemical condition which seems to be essential to life. They act as ' balancers ', throwing their weight first on one side, then on the other, so as to preserve a normal equilibrium.

The resemblance between the action of the internal secretions and that of drugs is very close : the active substances they contain are, in fact, drugs. This close resemblance should be incorporated in the nomenclature ; it is unfortunate that this was not originally done. Starling, who was a pioneer in their investigation and was particular to point out their drug-like character, was not aware that they may be either excitatory or inhibitory : he supposed that their action is always to produce excitation. It was for this reason that he invented the term ' hormone ', having selected that name because it expresses ' excitation ' (ὁρμάω, I excite). The example which led to the adoption of the name was ' secretin ', which excites the pancreas to secrete pancreatic juice ; as we have seen, Starling compared this action with that of carbon dioxide, which excites the respiratory centre to activity. He accordingly proposed the name ' hormone ' for all substances, whether organic or inorganic, carried by the blood for the purpose of exciting the cells of any organ to activity. At the time that he wrote (1906) our knowledge of the constituents of the internal secretions was comparatively limited, and it was supposed that they must all act like secretin and possess an excitatory action. The term ' hormone ' seemed, therefore, suitable.

Presently, however, when the knowledge of the action of internal secretions became extended, it was apparent that they not only stimulate to increased activity but that they also serve the antagonistic rôle of diminishing or restraining action. To express the latter the term ' hormone ' is inappropriate, since it involves an express contradiction in terms. I accordingly suggested in 1913 that such inhibitory substances might be distinguished as ' chalones ' (χαλάω, I restrain), as expressing both correctly and conveniently the opposite of ' hormones ' ; the term is gradually coming into use, although many authors, especially in the United States and Germany, still confuse chalones with hormones and use the latter term for both. Hormones have been longer known and are supposed to occur more frequently, but it is not improbable that as our knowledge extends it will be found that chalones are just as numerous, and not unlikely that for every hormone there is an antagonistic chalone : the ' law of balance ' of the living organism almost demands this. To denote all such specific principles of the internal secretions, whether excitatory (hormones) or inhibitory (chalones), I suggested the term ' autacoid ' (Greek αὐτός, self, ἄκος, a drug).

In nearly every instance an autacoid is either exclusively hormonic or exclusively chalonic. Adrenaline, which is hormonic in its action on the circulatory system but chalonic in its action on the muscular coat of the alimentary canal, appears to furnish an exception. Occasionally, however, it excites intestinal muscle instead of inhibiting it. All its excitatory activities are paralysed by ergotoxine, its effects being then purely chalonic.

Regulation of Gland-function by Nerves and by Autacoids.

It was already known that the pancreas can be excited to secrete through the nervous system. There is therefore in the case of this gland a dual control, namely, through the nervous system and through an internal secretion. In regard to some externally secreting glands—for example, the salivary glands—we only know of one kind of control, that exercised through nerves. On the other hand, some externally secreting glands are not controlled by nerves at all, but only by substances circulating in the blood; the control being in such cases purely chemical (humoral). This applies to the mammary gland and to the kidney, the secretions of neither of which are directly influenced by nerves, but are freely provoked by substances circulating in the blood. Externally secreting glands may therefore be classed under three heads, namely: (1) those that are exclusively under the influence of nerves, such as the salivary glands; (2) those that are entirely under the influence of chemical substances in the blood, such as the mammary glands and kidneys; (3) those that are influenced both by chemical substances and by nerves, such as the pancreas and gastric glands. The same distinctions appear also to obtain with the endocrine glands; although (except in the case of the suprarenal capsules) less is known about their regulation by nerves.

The doctrine of the regulation of bodily functions by chemical agents may be regarded as having been definitely established with the discovery of secretin. Since then facts have been accumulating at an ever-increasing rate in support of this doctrine, so that a complete change has come about in our conceptions of the working of the body.

Many organs are known to possess the double function of producing materials which are discharged externally and of secreting autacoids internally. The gonads were the first organs to be recognised as having this double function, since besides producing the gametes they also yield an internal secretion to the blood which affects the formation of the secondary sex characters. The discovery of secretin furnished another example. To this was added the pancreas, which not only produces pancreatic juice but also by its islet tissue furnishes insulin. To these still more recently has been added the liver, which besides secreting bile and assisting in metabolism, produces an autacoid which stimulates the hæmapoietic organs. A similar duality of function is furnished by the stomach and kidneys.

In the case of the gonads, their complete removal (castration) has been employed from time immemorial, both in animals and man, and the effects are well known. These effects were formerly thought to be produced through the nervous system, and assumed to be due to the lack of afferent stimuli from the organs in question to the nerve centres. But when it was made clear by implantation experiments and by the administration of extracts that many of the effects of castration can be removed, it was evident that the nervous system is not responsible for the phenomena but that they must result from the action of an agent produced by the gland and carried by the blood to the organ affected. This was indeed the explanation to which Berthold was forced in 1849. The explanation does not exclude the nervous system from influencing the results, but they are obtained without its co-operation.

INFLUENCE OF ENDOCRINE ORGANS ON ONE ANOTHER.

Not the least interesting feature of the study of the internal secretions is the influence exerted by one set of internally secreting organs upon others; the influence is frequently mutual. This is illustrated by the mutual influence of the thyroid and pituitary. Removal of the thyroid causes enlargement of the pituitary, with increase of its secretion. Destruction of the pituitary in the young animal arrests the development of the thyroid. Its secretion stimulates the thyroid. The thyroid in its turn stimulates the suprarenal medulla. The increase of adrenaline thereby caused provokes the liver cells to discharge their glycogen into the blood as glucose, and the hyperglycæmia stimulates the islet tissue of the pancreas to an increased secretion of insulin. This in its turn stimulates and facilitates carbohydrate metabolism and thus affects the activities of many tissues and organs of the body. In this way we can trace a chain of phenomena starting from excitation of the pituitary and linking together organs topographically distant and to all appearance functionally distinct.

Another striking illustration of mutual reaction is the influence of the pituitary upon the sex organs. The size and secretion of the pituitary is affected by the condition of the gonads: removal of the gonads is followed by an increase in size of the pituitary, while destruction of the pituitary is followed by diminution in size of the gonads and ultimately by loss of sexual functions.

It is the pars anterior of the pituitary which is concerned with the sex organs. For it can be shown that the cyclic changes in the ovary and uterus which characterise the period of sexual activity are initiated and conditioned by autacoid substances produced in the pars anterior, so that in the absence of these substances (as after removal of the pituitary) maturation of the ovum and its fixation in the uterus is no longer possible. Its activity can, however, be restored or, in immature female animals, can be aroused by implantation of anterior pituitary or by hypodermic injection of its extracts. To influence the ovary the anterior pituitary produces two distinct hormones. One stimulates the ovaries, even in immature animals, and produces maturation of the Graafian follicles. The enlarging Graafian follicles produce in their turn an internal secretion containing an autacoid (folliculin) which causes ovulation and starts changes in the uterus, preparing it for the reception of the discharged ovum if fertilised. A second hormone of the anterior pituitary causes the corpora lutea which are formed from the discharged follicles to produce another autacoid (lutin) which promotes further alterations in the uterus, preparing it for the fixation of the ovum. The corpora lutea also yield a chalone which prevents the further action of folliculin and the further discharge of ova.

All these autacoids of the pituitary and ovary can be detected in the blood. They are found in it in greater amount during pregnancy than at other times, and pass out from the blood into the urine, so that if a few drops of the urine of a pregnant woman are injected under the skin of an immature mouse, the growth of the ovaries of the latter is stimulated, the Graafian follicles enlarge and discharge their ova, corpora lutea are precociously formed, and changes characteristic of œstrus occur in the uterus and vagina. The effects thus produced on the ovaries of immature mice constitute the Zondek-Aschheim test for pregnancy now in general use. It furnishes a striking example of the application of the new physiology to clinical medicine, others being the curative effect of thyroxine in myxœdema, that of insulin in diabetes, and that of liver or stomach extract in pernicious anæmia.

FUNCTIONS OF THE PITUITARY.

The pituitary gland consists of several parts, and each of those parts yields its own specific autacoids. That the anterior lobe is concerned with growth is evidenced by the fact that it is greatly enlarged in acromegaly and gigantism—affections characterised by hypertrophy of the body in general and of the skeleton in particular—while its administration to growing animals both increases their rate of growth and causes them to become of more than ordinary size. On the other hand, if the anterior lobe is atrophied or by any means diminished in size, growth is slowed and dwarfism results; while its removal in growing animals is followed by arrest of growth. There is also reason to believe that it produces a chalone which acts antagonistically to the growth hormone. Metabolism in general and the metabolism of carbohydrates in particular is influenced by it: one result being the production of obesity, which is observed in cases of disturbance of its endocrine function, and interference with the action of the autacoids which regulate the metabolism of fat. Also, as we have seen, it exerts an enormous influence upon the gonads.

The other parts of the pituitary are also connected with many and varied functions. The pars intermedia and pars nervosa are closely interlocked and difficult to separate. The pars intermedia is formed of epithelial cells; the pars nervosa is developed from brain substance and consists mainly of neuroglia cells and ependyma fibres. In the spaces between these fibres are peculiar colloidal masses which are formed from the cells of the pars intermedia and can be traced through the pars nervosa to be discharged into the cerebrospinal fluid of the third ventricle. They are known from their discoverer as 'Herring's bodies'. If extracts are made of the pars nervosa and injected into the blood vessels, powerful effects are obtained upon the arteries, the heart, the intestinal muscle, the muscular tissue of the uterus—all of which are stimulated—and the mammary glands, which, if lactating, are caused to secrete. The kidneys are also stimulated so that the amount of urine is increased; but if the extracts are administered hypodermically instead of intravenously, the effect is antidiuretic. Such extracts act therefore in two directions upon the secretion of urine, either stimulating or inhibiting; they therefore contain two antagonistic autacoids affecting its secretion, a hormone and a chalone.

The action of extracts of posterior lobe on the uterus is powerful and specific; contraction of the organ is caused by an infinitesimal amount of the so-called 'oxytocic' hormone. Since the secretion of this lobe is discharged into the cerebro-spinal fluid, this fluid also acquires the properties of the extracts. The uterine action is most marked during gestation and the action is strongest near parturition, which it assists and perhaps initiates. An extract of the posterior lobe of the pituitary constitutes one of the most useful medicaments of the accoucheur.

Another action of extracts of the posterior lobe, probably due to a chalone produced in the pars intermedia, is that of causing expansion of the melanophores of Amphibia so that the animals become dark: this is a specific effect, no other natural substance being known to produce the same result. On the other hand, removal of this part of the pituitary body in Amphibia results in contraction of the cutaneous melanophores, so that the animals become pale and offer a great contrast to the effect of injection.

Thus the pituitary body influences by its internal secretions a large number of diverse functions. It is extremely probable that each function is influenced by a different autacoid ; some by two antagonistic autacoids : this is the case with the diuretic and antidiuretic effects. Nevertheless, up to the present, it has proved impossible to isolate any one of the active substances. By the employment of different solvents extracts have been obtained which contain more of one autacoid than of others, but no one autacoid has been got in a pure condition.

AUTACOIDS OF THE GONADS.

Although the pituitary body is the endocrine organ the secretion of which influences more numerous functions of the body and produces more diverse effect than any other, several have multiple effects. This is the case, for example, with the gonads, for besides the internal secretions of the Graafian follicles and corpora lutea which have already been considered, these organs produce other autacoids on which the secondary sex characters depend. The autacoids to which these characters are due are not formed by the reproductive cells themselves but by special cells in the connective tissue between them, known in the testis as ' interstitial cells '. That the secondary sex characters are not dependent on the true reproductive elements is evidenced by the fact that these characters are developed after destruction of the true reproductive elements. Extracts of gonads in which the reproductive cells have been eliminated contain all the substances which promote the appearance of secondary sex characters ; their administration will cause the production of these characters even in castrated animals. Thus a castrated animal, which, whatever was its original sex, may be regarded as neuter, can be made to assume the secondary characters of either the male or female sex by administration of extract of testicle or ovary as the case may be, or by implantation of portions of one of those glands. Extracts of the gonads also contain antagonistic substances which prevent the appearance of the secondary characters of the opposite sex.

TISSUE AUTACOIDS.

There is another class of autacoids, not produced in internally secreting organs and not passing into the blood, but produced in situ in the tissue they are to influence. We may term them ' local ' or ' tissue autacoids ', as distinguished from those we have hitherto considered and which may be termed in contradistinction ' blood ' or ' circulating autacoids '. The ' tissue autacoids ' have only been discovered recently, and we have very little accurate information regarding either their nature or their mode of activity. Such knowledge as we possess has been mostly derived from experiments upon the heart.

Whilst investigating the possible chemical changes produced by stimulation of the vagus nerve upon the frog's heart, Loewi (1921) found that Ringer's solution which had been used for perfusing a heart inhibited by the vagus, would, if introduced by perfusion into another frog's heart, itself produce an inhibitory effect upon the second heart. Evidently the impulses descending by the vagus have caused the formation of an autacoid which, by chemical action, reproduces the effect of the nerve itself. An electrocardiogram obtained during its action resembles that obtained during stimulation of the vagus. The autacoid produced by the vagus may possibly be the actual cause of the inhibitory effect of that nerve rather than its consequence. This substance is termed the ' vagal substance ' or the ' vago-mimetic autacoid ' : obviously it is an inhibitory substance or chalone. It can also be obtained from the mammalian heart (Rijlant). Atropine, which prevents the production of inhibition of the heart through the vagus, does not prevent the formation of the ' vagal substance ' : it does, however, prevent this substance from slowing or inhibiting another heart on which it is allowed to act. The vagal substance resembles acetyl choline in many respects and may be identical with this.

Similarly it is found that after stimulation of the sympathetic fibres to the heart an autacoid is produced which stimulates a second heart to increased rate and force—in fact, reproduces the action of the sympathetic : this may be termed the ' sympathetic substance ' or ' sympatho-mimetic autacoid '. Its action is nullified by ergotoxine, as is the action of the sympathetic. It is obviously a chemical substance produced under the influence of the sympathetic and seems to be identical with adrenaline. Being a stimulating autacoid, it is, of course, a hormone and is antagonistic to the vagal chalone. It is possible that it is owing to the local production of these autacoids in the part of the heart which is supplied by the vagus and sympathetic nerves that the inhibitory action of the one and the accelerator and augmentor action of the other is actually due.

The formation of these vagal and sympathetic substances is probably the explanation of the continuance of vagal and sympathetic action which is always observed for an appreciable time after stimulation of the respective nerves has been discontinued—a phenomenon which has hitherto received no adequate explanation. Their formation may also account for the relatively long latency period between stimulation and commencement of response, with which all who have observed the effects on the heart of nerve-stimulation are familiar, and for which a reasonable explanation has hitherto been lacking.

These observations upon the autacoids produced in the heart as the effect of stimulation of its antagonistic nerves are comparatively recent, but they serve to recall an observation made by Demoor in 1913. Demoor found in the dog that extracts of a submaxillary gland which had been caused to secrete actively for some time by stimulation of its branch from the chorda tympani would, if injected into another dog, also produce in the second animal active secretion from its submaxillary gland. He inferred therefrom that an active chemical substance is produced locally in the gland of the first animal, which has the same action on its cells as the chorda tympani and may be the actual cause of the secretion. This again may furnish an explanation of the fact that the secretion takes an appreciable time to start after the stimulation of the nerve is commenced, and a still longer time to cease after the stimulation of the nerve is discontinued; also of the observation that after stimulation of the chorda tympani, stimulation of the sympathetic supply is usually followed by considerably greater secretion than in other circumstances, this being due perhaps to the fact that there is still a remainder of active substance in the gland cells. The active substance in the case of the salivary glands may be saliva itself. Guimaris (1930) found that if saliva from any source, or an alcohol-extract of saliva, is injected into the artery supplying the submaxillary gland of the dog, free secretion is provoked, and that this will happen even if the chorda tympani has been cut and its fibres allowed to degenerate.

Cannon (1930) has brought forward evidence that a substance resembling adrenaline in its action is formed in plain muscular tissue as the result of stimulation of its sympathetic supply. He terms the substance 'sympathin', but suggests that it may be identical with adrenaline. Finkleman had previously found that stimulation of the sympathetic fibres to the intestine results in the production of a substance which when brought in contact with a second preparation of intestinal muscle will cause its inhibition: this obviously suggests the formation of adrenaline. Finally, Ch. Richet *fils* has found that extracts of kidney produce diuresis if injected into the blood.

Observations of this kind suggest that an autacoidal action of gland extracts may be of more general occurrence than has been thought, and that functional changes in cells may be correlated with the formation of autacoids specific for each kind of cell. Probably in the near future there will be discovered many more illustrations of this form of chemical control of the bodily functions. Various experiments indicate the influence upon these functions of such products of metabolic activity as acetyl choline and histamine—both of which have been found by Dale and Dudley in notable amount in various tissues and organs.

Such 'metabolic autacoids' or 'metabolites' may have a local action affecting either the tissues themselves or their blood vessels, causing the vessels to contract or dilate according to the nature of the autacoid set free (T. Lewis). Whether the metabolites are formed as the result of stimulation of nerves or by direct irritation of the tissue is difficult to decide. In any case, the facts indicate that chemical substances are formed, under the influence of nerves or as the result of direct excitation, which act directly on the tissue in which they are produced.

INHERENT AUTACOIDS.

There is yet another class of autacoids which are not produced as the result of excitation by nerves or otherwise, but appear spontaneously or are inherent in the tissue and impart to it active properties. They are chiefly known in the heart, where they have been investigated by Demoor, Rijlant, Zwaardemaker, Haberlandt, and others.

Although it has been known from time immemorial that the heart will continue to beat after removal from the body and therefore possesses in itself a natural tendency to automatic rhythm, it was long thought that this was actually due to nerves and ganglia within its substance. But the researches of Gaskell (1883) on the hearts of fishes, amphibians, and reptiles—confirmed by Engelmann and by many subsequent workers—showed conclusively that the nervous system of the heart has nothing to do with its automatism, which is inherent in cardiac muscle and is most pronounced near the entrance of the great veins and least near the exit of the great arteries. Therefore in a simple heart such as that of a fish the contractions start at the sinus venosus and traverse successively the auricle, the ventricle, and the bulbus aortæ. Gaskell observed that, if such a heart is cut across transversely into segments, the segments will beat spontaneously, but not all at the same rate: the rhythm of the sinus will be the fastest, that of the auricle next; that of the ventricle will be slower than that of the auricle, and that of the aortic bulb the slowest. In the intact heart the rate is always that of the sinus. which is accordingly termed the 'pace-maker'. Gaskell further showed that the dominance of the sinus is due to the fact that its tissue possesses greater excitability than the rest; for if the excitability of any other part is increased locally above that of the sinus—as by the application of warmth—the contractions will now start from the part which has been thus rendered more excitable. In the embryonic heart of the bird and mammal much the same conditions are found as in lower vertebrates, but as development proceeds the distinction of the several parts becomes confused, the venous sinus being merged into the right auricle and the aortic bulb into the ventricle. The only sequence to be clearly seen with the unassisted eye is that described by Harvey, namely: auricular systole, ventricular systole, pause.

It is, however, still possible to show by electrographic methods (T. Lewis) that the contractions actually start from a point in the auricle close to the entrance into it of the superior and inferior venæ cavæ. At this point the thin contractile tissue of the right auricle is marked by a slight swelling—the 'node of Keith and Flack' or the 'sinus node': here the muscular fibres are somewhat peculiar in structure and arrangement, and receive many nerve fibres derived from the vagus and sympathetic. In the same auricle—the right—there is another node of similar structure placed near the base and close to the entrance of the coronary sinus. This is the 'node of Tawara'. From the node of Tawara a circumscribed bundle of muscular fibres—the 'bundle of His'—passes through the connective tissue of the auriculo-ventricular system to the ventricles; the bundle divides into two branches, one for the right, the other for the left ventricle. Each branch ends in a network of peculiarly constructed muscular fibres, the 'network of Purkinje', which covers the interior of each ventricle underneath the endocardium and is connected everywhere with the adjacent fibres of the myocardium. The muscular tissue of the nodes, as well as that of the auriculo-ventricular bundle and that of the network of Purkinje, is different from ordinary cardiac muscle, from which it also differs somewhat in function: it is termed the 'nodal tissue' to distinguish it from the ordinary cardiac muscle.

The contractions of the heart start at the sinus node: from that point they spread rapidly over both auricles, which have their muscular tissue in complete continuity. Reaching the node of Tawara, the contractions then traverse the auriculo-ventricular bundle, and are conducted by it and its branches to the network of Purkinje; from this they spread in the muscular wall of both ventricles. The sinus node is the pace-maker in the heart of the mammal. If it is excised, the contractions assume a slower rate, and the electrocardiogram is altered in type; the rate now being that of the part of the auricle near the entrance of the coronary sinus—'coronary' rhythm. If the bundle of His is severed, the auricles continue to contract spontaneously with the 'sinus node' rhythm. The ventricles, which now have no muscular connexion with the auricles, also continue contracting spontaneously, but with a much slower rhythm. The spontaneous contractions, whether of auricles or ventricles, are dependent on the presence of nodal tissue. Separated portions of right auricle or of either ventricle, both of which contain that tissue, will continue to beat spontaneously and rhythmically: but if the left auricle, which contains no nodal tissue, is completely severed from the right, it soon ceases to beat spontaneously, although it will respond to artificial stimulation; it can also be made to resume its spontaneous contractions by addition of an extract of nodal tissue from the heart of another animal.

The inference is that an excitatory autacoid or hormone is produced in the nodal tissue which is necessary to start the spontaneous contractions, and that this hormone is formed in greatest amount in the node of Keith and Flack. This causes the rhythm of the cardiac tissue to start from that node, whence it is propagated over the whole heart in the manner above described. Demoor found that not only is the left auricle caused to contract rhythmically by adding extract of nodal tissue to the Ringer's solution bathing it, but that it and cardiac tissue generally are also rendered by such addition more sensitive to sympathetic stimulation—this effect being due to a second hormone in the extract, different from that which causes the spontaneous contractions.

As already stated, excision of the sinus node causes the right auricle to assume a slower rhythm. If it is now re-implanted in the situation from which it was removed, the original rate of contraction of the heart is restored (Rijlant), although the continuity of the fibres of the node with the rest of the heart remains, of course, severed. The explanation of this experiment favoured by Demoor is that the tissue of the node continues to produce the active substance or hormone, and that this now diffuses from it and causes increased excitability in the cardiac tissue immediately surrounding it; and thus as long as it survives the graft continues to officiate as the pace-maker. The explanation favoured by Rijlant is that the re-implanted node sets up an electric change with each contraction, and this starts the contractions of the adjacent cardiac muscle at the same rate as those of the node. Should the graft not take, it will before long cease to contract and will presently die. In that event, the heart resumes the rhythm of the coronary part of the auricle. During the activity of such a graft the electrocardiogram is normal; after degeneration it takes on the 'coronary' type.

INACTIVATION OF AUTACOIDS.

The existence in the blood of most of the autacoids of the body, although long doubted, must now be conceded. It is by their variability in amount in that fluid that their effects are shown. This variability implies that there must be some means of eliminating them; otherwise the continuance of their secretion would lead to an accumulation which would before long produce toxic effects even if the normal rate of secretion were small. If the secretion is rapid, then elimination must be equally rapid. That this is the case is illustrated by adrenaline. Unless this were rapidly eliminated or de-activated, the balancing action upon the blood pressure which Tournade has shown to occur would not be possible. We know very little in most cases as to how the elimination or de-activation is produced. In some it may be that the autacoid forms a stable chemical compound with a product of the cell on which it acts and thus becomes inactivated. This is probably the case with adrenaline, which is de-activated by aldehydes (Cramer), and aldehydes constantly occur amongst the intermediate products of tissue metabolism. Some autacoids are not de-activated, but are eliminated by the urine. This is the case with those secreted by the anterior pituitary, the ovary, and the placenta. Or, finally, the action of an autacoid may be arrested by the secretion of another one which is antagonistic to it: the reaction being assumed to be of a chemical nature.

The large number of autacoids which have now been recognised manifests their importance in physiology. A generation or two ago none of these substances was even dreamed of. Our knowledge of them is wholly the result of the observations and experiments of the last fifty years. The changes in physiology which have resulted from this knowledge constitute not merely an advance in degree but also an alteration in character. The doctrine of internal secretion forms a new departure. We must in future explain physiological changes in terms of chemical regulation as well as of nervous regulation. It is therefore justifiable to speak of the doctrine as the 'New Physiology', seeing that it has completely altered our outlook on many of the problems with which physiology deals and consequently on those met with in medicine and surgery.

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Letters to the Editor.

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Quantum-Mechanical Models of a Nucleus.

IN their recent paper,[1] Lord Rutherford and Dr Ellis have shown how the numerous γ-rays of radium C′ can be arranged in a simple and orderly manner, which suggests, as they point out, that the multiplicity of the γ-rays is largely due to the excitation of several α-particles into the same excited level rather than to the excitation of one α-particle into several excited levels. Their arrangement of the lines of radium C′ is probably not a unique scheme of this sort, but any reasonable scheme appears likely (they show) to present the same general features.

It seems desirable therefore to investigate theoretically in detail any simple model or models of a nucleus consisting of some fifty α-particles, which might show such general features. The main feature brought out by Rutherford and Ellis is that the γ-rays can be expressed in the form

$$h\nu = pE_0 - qE_1,$$

where p is an integer running from 1 to 4 and q an integer running from 0 up to perhaps 10; the value of E_1 is about $\frac{1}{16}E_0$ for radium C′ and has much the same value for radium B. For radium C′ more than one value of E_0 may be required.

There are two models which might be investigated with some chance of success; the first is a model in which each α-particle is considered to move independently in a central field (which is ultimately to be referred to the combined interactions with the other α-particles), but the whole family is affected by perturbing interactions of the form $V(r_{ij})$, between each pair i, j of all the α-particles, where r_{ij} is the distance between the α-particles i and j. Such a model is very like an atom of electrons, except that wave functions have to be symmetrical in the α-particles instead of antisymmetrical in the electrons, and this is the essential difference which allows of the states of reduplicated excitation, which do not occur at all in atoms. This model can be still further simplified from a three-dimensional to a one-dimensional form for a first discussion.

The second model is one in which each pair i, j of α-particles act on one another with a potential energy $\frac{1}{2}\lambda r_{ij}^2$. This model is obviously a rather poor physical approximation to the type of force, but it has the advantage that it can be studied exactly and not merely by the approximations of a perturbation method. A discussion of both these models has been begun, but has as yet only been carried through for the first model simplified to one dimension.

Confining attention only to the most general features, likely to be true of any suitable similar model, the following results have been obtained, which are to a large extent in excellent accord with the scheme of Rutherford and Ellis, but also seem to indicate clearly that a rather more elaborate scheme should be adopted. The energy levels of the model which arise from excitation of more than one α-particle into a single excited state are of such a configuration that the corresponding γ-rays (if they could all be emitted) would be approximately of the frequencies

$$h\nu = p(E_0 - qE_1).$$

These frequencies agree with those of the proposed scheme of Rutherford and Ellis if the scheme is only very slightly modified, so that in place of the proposed single set of γ-rays of frequencies $2E_0 - qE_1$, we have the double set of frequencies $2(E_0 - qE_1)$ and $2(E_0' - qE_1)$ with E_0 and E_0' nearly equal, and in place of the single set $3E_0 - qE_1$, the triple set $3(E_0 - qE_1)$, $3(E_0' - qE_1)$, $3(E_0'' - qE_1)$ and so on. It is, moreover, clear that the reduplication of the upper levels is to be expected when we consider the three-dimensional version of the model. Further, the theory suggests that the ratio E_0/E_1 should be numerically somewhat less than $\frac{1}{2}n(=26)$ in not too bad conformity with the observed value 16 for radium C′. The theory even suggests further that both E_0 and E_1, or perhaps rather E_1, will not vary very much between one radioactive nucleus and another. It is true that the observed values of E_1 (but not those of E_0) are much the same for radium C′ and radium B. The γ-rays of other atoms have not yet been analysed in this way.

All these features are general and the conformity very reassuring. One can, however, further estimate the relative frequency of the emission of the various γ-rays corresponding to the transitions from a state of q-excited α-particles to states of $q-1, q-2, q-3\ldots$ excited α-particles. With an interaction energy of the proposed form, the transitions $q \longrightarrow q-3$ should be absent, or at most very rare, and the transitions $q \longrightarrow q-4$, $q \longrightarrow q-5$, etc., entirely absent. The theory gives as a first approximation to R, the ratio of the frequency of occurrence of the transitions $q \longrightarrow q-2$ and $q \longrightarrow q-1$, the value

$$R\left(\frac{q \longrightarrow q-2}{q \longrightarrow q-1}\right) = \frac{q-1}{6 \cdot 5}f,$$

where f is a factor certainly less than unity and probably not so small as $\frac{1}{10}$. The absolute value of the ratio R may be heavily affected by higher order terms, and we need not be concerned if the proposed scheme does not conform closely. The feature of R that is almost certainly of general importance is that R increases with q. This feature ought to be carefully borne in mind in the construction of any amended scheme. It is not yet possible to say whether these features can be incorporated in an otherwise satisfactory scheme, and a detailed re-examination must be undertaken.

The proposed scheme for radium C′ is arranged to include values of p up to 4 and therefore transitions of the type $q \longrightarrow q-4$. These certainly do not, and the transitions $q \longrightarrow q-3$ probably do not, fit into the allowed transitions of the proposed model with the simple interactions proposed. But such transitions can be present if there are terms in the interactions depending essentially on the co-ordinates of three or more particles, not reducible to sums of terms depending on the co-ordinates of only two. Such terms are to be expected in such a close configuration, though one would scarcely expect their effect to be so large. If the proposed scheme proves ultimately to be correct, one may hope to work back from the γ-ray intensities to some knowledge of the magnitude of these triple and higher interactions.

To sum up, one may say that the scheme proposed by Rutherford and Ellis, so far as it has yet been closely analysed, *that is for frequencies only*, seems likely with trivial modifications to conform completely to the requirements of a simple quantum mechanical model so far as these requirements can yet be foreseen. Such a model, however, will make fairly stringent demands on intensity ratios, and as yet no scheme has been proposed and tested with these in mind. One may hope that further work on these lines will prove fruitful.

While these models may well be able to explain the complicated spectrum of radium C′, it is well to remember that the corresponding spectrum of thorium C′ is very much simpler and contains no families of γ-rays—except perhaps very faint ones—corresponding to those of radium C′, which have been interpreted in the scheme as transitions $q \longrightarrow q-2$, $q \longrightarrow q-3$, and $q \longrightarrow q-4$. It has of course, in addition, a very strong isolated γ-ray of very high frequency. If therefore in attempting to proceed with this analysis, which in any event I believe to be important, one is forced finally to conclude that such models will *not* explain the facts for radium C′, there is no call for surprise or disappointment. It may still be that the proposed scheme of $q \longrightarrow q-1$ transitions will account properly for the important *common* features of the γ-ray spectra of radium B, radium C′, thorium C′, and probably other nuclei. It is more than likely that the striking *differences* between the spectra of radium C′ and thorium C′ should be associated with the two extra free protons in radium C′, the atomic weight of which is of the form $4n+2$, while that of thorium C′ is $4n$.

In the models suggested above, the effect of the protons has been ignored primarily because there seems at present no simple way of incorporating them. But it is clear that the general effect of free protons present in normal and excited states will be to cause the set of low frequency transitions $q \longrightarrow q-1$ to be repeated again at higher frequencies but with the same dependence on q, the constant shift between the two sets representing an excitation energy for a proton. R. H. FOWLER.

Cromwell House,
Trumpington, Cambridge, Aug. 14.

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[1] *Proc. Roy. Soc.*, A, vol. 132, p. 667 : 1931.

Polarisation of a Beam of Electrons by Scattering.

IN view of the recent experimental work of Dymond[1] on the polarisation of electrons by double scattering, it is of interest to make calculations of the effect to be expected, without assuming, as in the author's previous paper,[2] that the number $2\pi Z\epsilon^2/hv$ is small compared to unity, a condition which is not satisfied in practice.

One finds, as before, that the asymmetry in the scattering is very small, unless :

(1) The velocity of the electrons is comparable with c. (2) Both angles of scattering are comparable with 90°. (3) The atomic number of the scattering nucleus is comparable with 137.

With both angles of scattering equal to 90°, and gold for the scattering element, the calculated percentage asymmetry (200 δ of the author's paper) is in the direction found by Dymond, and of the following magnitude, for various velocities, v, of the electrons:

v/c	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
Energy in kv.	10·5	25	45	79	127	204	340	662	∞
200 δ . . .	0·5	0·2	3·0	11·5	15·5	14	10	5	0

The asymmetry at 70 kv. is thus about five times as much as that found by Dymond. It is difficult to explain why this should be so. Multiple scattering would reduce the polarisation observed, but there should not be much multiple scattering with the foils used. It is improbable also that the Dirac theory of the electron should give a wrong result when applied to the scattering by a Coulomb field, since the results for the energy levels of an electron in the same field are known to be correct. N. F. MOTT.

Gonville and Caius College,
Cambridge, Aug. 10.

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[1] NATURE, vol. 128, p. 149, July 25, 1931.
[2] *Proc. Roy. Soc.*, A, vol. 124, p. 425; 1929.

The Spermatogenesis of Ticks.

THE spermatozoa of ticks are provided with a peculiar 'plasmal-rod' or spermatophore which has long been a puzzle to cytologists, but the careful work of Nordenskiöld (1920) on *Ixodes ricinus* Linn. threw considerable light on the subject.

Certain recent observations I have made on the red tick (*Rhipicephalus evertsi*) indicate that the spermatogenesis in this species differs considerably from that given in Nordenskiöld's account, and it exhibits certain peculiar features which are of general theoretical interest.

In sections of an impregnated non-engorged female there was found in the seminal receptacle a tangle of long, thick cords, the spermatophore-cords (Fig. 1, g).

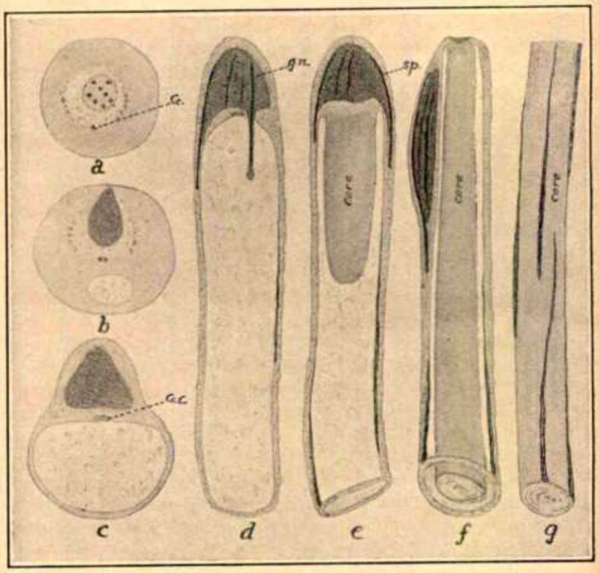

Fig. 1

These are singularly brittle and appear to snap like spun-glass under the microtome-knife, although, doubtless, they are sufficiently flexible in the fresh condition. Each cord carries on its surface a large number of longitudinally arranged filiform spermatozoa, all of which seem to point in one direction. Probably when the eggs are ripe a special secretion is poured into the receptacle, which releases the spermatozoa from the cords.

In sections of a series of male ticks of various ages it was found that each cord and its spermatozoa are formed through the activity of a *single* spermatid. The spermatids, which appear to arise in a typical manner, are unusually large, and it was at once obvious that they are too few to account for the numerous spermatozoa on the spermatophore-cords.

The nucleus of the spermatid bears about eight very small rounded chromosomes. A centrosome (Ce) and possibly mitochondria are present (Fig. 1, a). Nordenskiöld's "centrosomal corpuscle" (CeC) can also be seen ; but the structure apparently vanishes and takes no part in the subsequent development. The spermatid expands and a vacuole with semi-fluid contents arises. At the same time the nucleus enlarges, and it assumes a very finely granular or homogeneous structure with diffuse chromatin which stains only weakly with Delafield hæmatoxylin but intensely with iron-hæmatoxylin (b, c). One or more strongly basophil chromatin-cords are now formed in the nucleus and they pass to its surface. The spermatid becomes tubular, with the nucleus at the top, and as the tube gradually elongates the chromatin-threads are drawn out of the nucleus and lie on the inner surface of the wall of the tube (*d, e*). The chromatin-threads (*sp.*) give rise to the filiform spermatozoa, and the generating nucleus (*gn*) continues to produce them *pari passu* as the tube elongates. The nucleus may remain at the top, or it may slip to one side (*f*), but ultimately it becomes used up and disappears.

During this process a core of homogeneous, compact plasma grows down into the lumen from the top of the tube, immediately under the generating nucleus. The core elongates rapidly and forms a cylindrical rod which is surrounded rather loosely by the original protoplasmic tube carrying the spermatozoa (*e, f*). Afterwards the spermatozoa leave the sheath and become attached to the surface of the core. The sheath disappears, and the core (*g*) with its attached spermatozoa remains as the spermatophore-cord which is transferred from the male to the female.

There is no evidence whatever that fragments of the 'centrosomal corpuscle' become associated with each developing spermatozoon.

It may be added that the nature of the spermatogenesis varies to some extent in different species of ticks of the same genus, since some preliminary observations on the brown tick (*Rhipicephalus appendiculatis*) would appear to indicate that in this species a spermatid produces a cluster of very thin spermatophore-cords in place of one relatively stout one.

The theoretical interest of this remarkable behaviour of the spermatid lies in the fact that in the red tick, just as in certain spiders, a single spermatid gives rise to more than one spermatozoon.

In this connexion it must be specially stressed that there is not the least indication of any approach to a mathematically correct division of chromatin-substance in the production of the chromatin-threads in the generating nucleus, and the size of the resulting spermatozoa is extremely variable, in that the largest may be some three times longer than the smallest. In fact, the chromatin of the nucleus behaves as if it is entirely homogeneous in quality, and any sufficiently large portion of it is capable of producing a spermatozoon.

The upholders of the chromosome hypothesis of heredity will have to explain how it is conceivable, in such cases, for an intricate system of material 'genes' to be passed on from one generation to another.

It is hoped that a detailed account of the observations will be published shortly.

ERNEST WARREN.

Natal Museum, Pietermaritzburg.

Diamagnetism of Liquid Mixtures.

MISS TREW et Dr. Spencer[1] ont mesuré les susceptibilités magnétiques des mélanges liquides suivants : benzène-dichlorure d'éthylène, tétrachlorure de carbone-acétate d'éthyle, benzène-acétate d'éthyle, benzène-tétrachlorure de carbone, eau-pyridine, acétone-chloroforme, acétone-bromoforme, diéthyléther-chloroforme, acétone-trichloréthylène, diéthyléther-acétone. Ils ont conclu de leurs résultats que, en général, la susceptibilité magnétique des mélanges de deux liquides organiques ne suit pas la simple règle des mélanges. Cependant les mélanges de benzène et de dichlorure d'éthylène obéissent à cette règle.

Si l'on porte en abscisse la composition moléculaire du mélange et en ordonnée la susceptibilité magnétique ou la densité de ces derniers mélanges, on obtient une droite. Ce sont des mélanges idéaux. Pour les mélanges de tétrachlorure de carbone et d'acétate d'éthyle, on trouve aussi sensiblement une droite pour la densité et la susceptibilité magnétique. Pour tous les autres mélanges on obtient des courbes qui présentent un maximum dans le cas de benzène-acétate d'éthyle, pyridine-eau, acétone-chloroforme, diéthyléther-chloroforme, diéthyléther-acétone.

Selon les mêmes physiciens la mesure des susceptibilités magnétiques permet d'affirmer si des changements physiques ou chimiques se forment en mélangeant des liquides organiques et cette méthode est très sensible.

Ranganadham[2] a fait remarquer que ses mesures personnelles ne confirment pas celles de Miss Trew et Dr. Spencer. Ainsi, pour les mélanges de benzène et tétrachlorure de carbone, Ranganadham obtient une droite parfaite pour exprimer la relation entre la susceptibilité magnétique et la composition. Pour les mélanges acétone-chloroforme il trouve, entre les valeurs mesurées et celles qui sont calculées par la règle des mélanges, des écarts beaucoup plus petits que ceux qui ont été trouvés par Miss Trew et Dr. Spencer. En outre, Ranganadham s'étonne que pour les mélanges d'acétone-chloroforme la courbe donnée par Miss Trew et Dr. Spencer passe de la région diamagnétique à la région paramagnétique.

Les deux physiciens anglais ont répondu à ces observations[3] et annoncent la publication prochaine de leurs mesures sur les mélanges acétone-trichloréthylène et bromoforme-acétone.

Je voudrais qu'il me fut permis de rappeler ici deux autres mémoires sur les susceptibilités magnétiques des mélanges liquides. Déjà, en 1918, Alpheus W. Smith et Alva W. Smith[4] ont mesuré les susceptibilités magnétiques des mélanges suivants : acétone-eau, acide acétique-eau, acide acétique-benzène, acétone-alcool éthylique, et pour ces quatre couples de mélanges les courbes qui donnent la susceptibilité magnétique en fonction de la composition sont des droites. Cependant pour les mélanges d'acétone et d'eau, qui se forment avec une contraction très grande du volume, il se produit un maximum d'indice de réfraction ainsi qu'on le lira dans mon mémoire.[5] On verra aussi dans ce mémoire que l'on sait depuis longtemps que les solutions dans l'eau de l'acide acétique donnent lieu à des maxima de densité et d'indice de réfraction.

Enfin, en consultant le volume VII, années 1925–1926, des " Tables annuelles de constantes et données numériques " (Marie), partie concernant l'électricité et le magnétisme, p. 1014, nous voyons que Trifonov, en 1924, s'est occupé de la même question et a étudié les mélanges suivants : benzène-métaxylène, benzène-sulfure de carbone, acétone-chloroforme, benzène-nitrobenzène, benzène-tétrachlorure d'étain, acétate d'éthyle-tétrachlorure d'étain.

Pour aucun de ces couples de liquides on ne trouve un maximum de la susceptibilité magnétique et aucun des mélanges d'acétone et de chloroforme n'a été trouvé paramagnétique.

Ce rappel de travaux antérieurs montre avec quel intérêt les physiciens prendront connaissance du mémoire annoncé par Miss Trew et Dr. Spencer. Cependant, vu la discordance entre les résultats obtenus, on peut déjà affirmer que la mesure des susceptibilités magnétiques ne doit pas être recommandée comme une méthode d'investigation sûre de la constitution des mélanges liquides.

EDM. VAN AUBEL.

Laboratoire de physique de
l'Université de Gand,
8 août.

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[1] *Proc. Roy. Soc.*, A, **131**, p. 209 ; 1931.

[2] NATURE, **127**, p. 975, June 27, 1931.

[3] NATURE, **128**, p. 152, July 25, 1931.

[4] *Jour. Amer. Chem. Soc.*, vol. 40, p. 1218 ; 1918.

[5] *Jour. Phys.*, 3e série, vol. 4, p. 478 ; 1895.

Measurements of the Height of a Large Drop of Mercury.

IN determining the surface tension of mercury and other liquid metals, many workers have used the method of measuring the height from the maximum section to the summit of a large drop. Most agree as to the method of setting on the maximum section, but a variety of ways are used to define the top of the drop. Two recent papers[1] describing measurements made after using every care to obtain pure mercury and high vacuum, and with no essential difference in technique except in the method of defining the summit of the drop, give respectively 515 ± 6·8 dynes and 432·2 ± 0·3 dynes for the maximum surface tension of mercury at 31° C. In view of this discrepancy and the fact that it corresponds to a difference of only about 0·2 mm. in height of the drop, the following notes on methods tried out in this laboratory may be pertinent.

(1) A collimated beam of light from a small distant source set carefully at the height of the drop shines over the summit, and the top of the drop is seen in the horizontal microscope, accompanied by diffraction lines. The definition is good, and the very small correction for diffraction can be determined by setting on to a similarly disposed mercury drop in the open laboratory, when the exact surface may be located by bringing a spherometer point almost into the surface and taking readings on both point and reflection.

(2) A card ruled with slanting lines is placed behind the drop and the setting is made on the intersection of the lines and their reflection.[2] The definition is sharp, but, of course, the telescope must be focused on the card and not on the drop, and there is thus a considerable horizontal distance between the points, the vertical separation of which must be measured. This increases any error due to inaccurate levelling, and, if the aperture is small, it is not easy to see reflections from a horizontal surface using a truly horizontal telescope.

(3) If the drop is enclosed in a box and light admitted through a ground-glass window on one side while observing through a window on the opposite side of the box, the drop appears as a sharply defined black body. What appears to be the upper surface of the drop, however, is really the lowest curve on the drop which will reflect rays coming from the top of the ground-glass window so that they pass into the telescope. The position of this curve depends on the size of the drop and its position relative to the top of the window. Using a window 4 cm. from the centre of a drop 6 cm. in diameter, the following readings were taken as the window was blackened out strip by strip from the top downward:

Height from top of drop to top of window.	Reading of microscope set on apparent top of drop.
1·0 mm.	3·343 mm.
2·2 ,,	3·328 ,,
5·1 ,,	3·274 ,,
8·3 ,,	3·222 ,,

The setting on the top of the drop, using method (1), was 3·367 mm., and the correction for diffraction about + 0·01 mm. M. Kernaghan uses an enclosed drop and a ground-glass window, but the method of defining the summit is not very clearly stated. It is remarkable that the difference of 83 dynes quoted above is in the direction to be expected if the workers had used methods (2) and (3) respectively without completely eliminating the sources of error mentioned.

In spite of individual workers obtaining consistent values, the question of the value of the surface tension of mercury in vacuum remains unsettled, and it is obviously desirable that workers should check their readings for the top of the drop by using two distinctly different methods of illumination and finding if the setting is unaltered. It may be said that measurements made here, both with glass and using an apparatus entirely of fused silica made by the Thermal Syndicate, indicate a greater height for the drop than those recorded by M. Kernaghan.

R. S. BURDON.

Department of Physics,
University of Adelaide,
July 10.

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[1] Cook, *Phys. Rev.*, August 1929, and Kernaghan, *Phys. Rev.*, April 1931.

[2] Cook, l.c.

Polarity and Vapour Pressure.

IN considering the effect of polarity on the vapour pressure and association of a liquid, a simple case is its influence on the partial vapour pressures of a polar liquid in its binary mixtures with a non-polar liquid, which, except for lack of polarity, should preferably be closely related in chemical structure to the polar liquid.

It is convenient to consider as 'perfect' a solution in which the restraining force on a polar molecule about to be vaporised is the same as in an infinitely dilute solution of the polar in the non-polar liquid. Perfect solutions are then represented by the tangent to the partial vapour pressure curve of the polar liquid at the limit of zero concentration. It is proposed to consider the effect of polarity in producing deviations from this tangent. To take deviations from Raoult's law as measures of imperfection is unsatisfactory, since to do so implies that all pure liquids are perfect, whilst admitting that mixtures of liquids may be imperfect.

Let the activity of the polar liquid be equal to b times its vapour pressure. Then in a perfect solution the free energy (F_i) of the polar liquid per molecule is $kT \log_e bp_i$, where p_i is the partial vapour pressure of the polar liquid, and k is Boltzmann's constant. Let the partial vapour pressure of the polar liquid in a solution of the same concentration in reality be p: the corresponding free energy (F) being $kT \log_e bp$. The free energy of transference of a molecule from a perfect to a real solution of the same concentration is $F - F_i = kT(\log_e bp - \log_e bp_i)$, that is

$$\frac{p}{p_i} = e^{(F - F_i)/kT}.$$

For such a dipolar molecule as is under consideration, F may be identified with the energy due to the field of the dipole in a medium of dielectric constant equal to that of the real solution of the concentration involved. Similarly F_i is the energy in a medium of dielectric constant equal to that of the pure non-polar liquid (since under perfect conditions the environment of a polar molecule remains the same as in an infinitely dilute solution in the non-polar liquid). If the polar molecule be treated as two charged spheres in contact with each other, for simplicity assuming that each sphere is completely immersed in the dielectric and integrating up to a sphere, the radius of which may be called the molecular radius, it has been shown[1] that this energy is given by $\mu^2/3a^3D$, where μ is the dipole moment, D is the dielectric constant, a is the molecular radius. Therefore

$$\frac{p}{p_i} = e^{-\frac{\mu^2}{3a^3kT}\left(\frac{1}{D_i} - \frac{1}{D}\right)}.$$

Unfortunately the data required to test this relation are very scanty. The values of a necessary to give the observed values of p/p_i for heptane-ethyl iodide mixtures at 50° are given below (data by Smyth and Engel[2] and Smyth and Stoops[3]):

Mol. Fraction C_2H_5I.	Observed Partial Vapour Pressure C_2H_5I (mm.).	Ideal Partial Vapour Pressure C_3H_5I (mm.).	$\frac{1}{D_i} - \frac{1}{D}$	a (Angstrom Units).
0·1	57·3	58·8	0·0574	1·06
0·2	107·5	118·5	0·1089	1·28
0·3	151·7	178·5	0·1557	1·41
0·4	188·3	238·3	0·1982	1·50
0·5	218·0	297·8	0·2384	1·56
0·6	243·8	357·5	0·2749	1·61
0·7	268·0	417·5	0·3080	1·65
0·8	292·8	477·5	0·3379	1·68
0·9	321·0	537·5	0·3643	1·72
1·0	354·5	598·0	0·3866	1·75

These results are promising, and experimental work is now in progress with the object of testing this point of view further.

A. R. MARTIN.

Chemistry Department,
University of Aberdeen,
Aug. 7.

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[1] Martin, *Phil. Mag.*, **8**, 550; 1929: **9**, 422; 1930.
[2] Smyth and Engel, *J. Amer. Chem. Soc.*, **51**, 2646; 1929.
[3] Smyth and Stoops, ibid., **51**, 3312; 1929.

Atomic Hydrogen Occluded in Iron Nitride.

ATOMIC hydrogen in iron has so far been known to be occluded when iron is quenched from a high temperature in water or when iron is electrolytically deposited. I have observed the existence of atomic hydrogen in iron nitride prepared by heating iron in the current of ammonia gas. I confirmed it by measuring the single potential of the iron nitride in normal ferrous sulphate solution. The time voltage curve of the iron nitride showed a minimum due to atomic hydrogen at the beginning, similar to that which appeared in the curve of iron quenched and loaded with atomic hydrogen, obtained by T. W. Richards.[1]

I also confirmed the existence of atomic hydrogen by immersing the iron nitride in a solution of potassium ferricyanide and observing the formation of Prussian blue on adding the ferric chloride solution. This reduction, $K_3Fe(CN)_6$ + atomic hydrogen $\longrightarrow K_4Fe(CN)_6$, also takes place with the iron quenched in water, and thus loaded with atomic hydrogen, but never with ordinary iron.

SHUN-ICHI SATOH.

Mitsubishi Research Laboratory,
Tokyo, Japan.

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[1] *Zeit. physikal. Chem.*, **58**, 310; 1907.

Audibility of the Aurora Polaris.

IT cannot be doubted that many persons have heard a distinct sound when watching a brilliant display of aurora. Naturally they have connected the two phenomena and have assumed that the sound was emitted by the aurora. Communications regarding the auroral sound appear now and then, and recently Mr. J. H. Johnsen has collected a great number of reports on the auroral sound in his pamphlet, "Concerning the Aurora Borealis", which has been reviewed in NATURE by Prof. S. Chapman.[1] Examining these reports, one finds that the auroral sound, with few exceptions, is described as a weak but distinct swishing or hissing sound which is heard during auroral displays on calm nights and at low air temperatures. I wish to emphasise the fact that the air temperature, in the cases in which it is stated, ranges between −35° F. and −50° F.

Very few investigators of the aurora admit that the sounds which have been heard can be ascribed to the aurora, but a satisfactory explanation of the observations is not yet commonly known, in spite of the fact that such an explanation has been given by Roald Amundsen in his book "The South Pole". Amundsen says (in translation from the original Norwegian edition, p. 417): "The swishing aurora does not exist. What one hears is one's own breath which freezes in the cold air".

The 'swishing breath' is a phenomenon which is well known to many arctic travellers and to natives, but it has not often been mentioned in the scientific literature. J. v. Hann[2] quotes observations of the 'swishing breath' from Siberia, and A. Wegener[3] has discussed the phenomenon, which he has observed in Greenland at temperatures below −44° F.

From my own experience, I can confirm that when the air temperature is below −40° F. and calm prevails, one hears a swishing or hissing sound when exhaling, possibly because the water vapour of the breath immediately condenses to ice crystals which collide when falling to the ground. The sound of the freezing breath is very distinct but weak, and is, therefore, heard only when the observer is standing still and listening intently. The phenomenon is very puzzling to an unexperienced observer, and if several persons are standing together it is impossible to become aware of the real cause of the sound. In that case the sound naturally is connected with any conspicuous phenomenon which occurs simultaneously, for example, an aurora. In the arctic the sky is generally clear when the temperature is low and the air is calm, and in the zone of maximum auroral frequency an auroral display is seen on nearly every clear night. An observer standing still and watching a brilliant display then hears a weak swishing sound, rising rhythmically, and naturally he assumes that this sound is emitted by the aurora.

I do not claim that the sound which has been ascribed to the aurora was always the sound of the freezing breath, but I am convinced that such has been the case in by far the greater number of instances in which persons report having 'heard the aurora'. It would be of interest to study more closely the conditions at which the sound of the freezing breath is heard, and also to direct the attention of auroral observers to the phenomenon in order that in the future the swishing breath is not interpreted as 'auroral sounds'.

H. U. SVERDRUP.

Chr. Michelsens Inst., Bergen,
July 27.

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[1] "The Audibility and Lowermost Altitude of the Aurora Polaris." NATURE, March 7, 1931, p. 341.
[2] *Handb. d. Klimatologie*, Bd. 3, 3. Aufl., Stuttgart, 1911, p. 643.
[3] *Wiss. Ergb. d. Dan. Expd.*, 1912–13, Abt. 2, Meteorologie, Copenhagen, 1930, p. 496.

The Harvard Museum Expedition to Australia.

THE announcement made by *Science Service*, and commented upon in NATURE of July 11, evidently gives a misleading idea of the objects sought by the Harvard Museum Expedition to Australia. It is not primarily an expedition to secure specimens for a museum, but for the study of the animals of the region when alive. Such work necessarily entails the killing of a limited number of forms, so as the better to understand their habits, feeding, movement, reproduction, and so on. But the 'bag' thus sought is trivial and not to be compared to the long series valued by philatelists and many former collectors of animals and plants. The idea of vastly long series is dead so far as modern zoological museums are concerned, owing, amongst other reasons, to the fact that the public will not endow them sufficiently for such ends.

The museum at Harvard was built by Alexander Agassiz in memory of his father, Louis, these two of our greatest exponents of field work of the last century. It contains their collections, which are relatively small, although of enormous importance. Around them has been built what is essentially a teaching and research institution. The Louis Agassiz Museum is weak in Australian animals and doubtless would desire to complete its series, but it would obviously be more economical and efficient to order the specimens required from Australian dealers. This, however, in mammals, would not suit Glover Allen, who complains bitterly of his teaching handicap in never having himself seen the great marsupials in their own country.

The leader of the Harvard Expedition is W. M. Wheeler, one of the greatest of American zoologists, formerly director of the Bussy Institute, and now attached to the Agassiz Museum. His name is quite sufficient to guarantee the character of this expedition, for he is one of the makers of modern scientific entomology, the dominant theme of which is the living insect. Also attached to the museum is Dr. Jackson, who has travelled widely in his studies of the fossil and living echinoderms in respect to their mode of life. On this side the Agassiz Museum recently sent an expedition to North Australian waters under Dr. H. L. Clark, to study them and other marine bottom-living invertebrates in their natural environments; this is also a side-line of the present expedition. The director of the Museum is Tom Barbour, a real naturalist, his speciality being the reptiles of America, which he has sought in all their haunts. Fisheries and oceanic biology centre in the living animals and plants, and are represented by Henry B. Bigelow, director of the new Oceanographical Institute at Woods Hole. It is useless to extend a list where one and all the staff have that field experience that is so necessary to give life to great museums. All take their share in teaching in the Harvard School of Biology, in which Profs. Parker and Crozier are dominant personalities, eminent in their experimental studies of living matter.

J. STANLEY GARDINER.

Aug 8.

Training of Colonial Probationers in Anthropology.

IN 1930–31, the scheme arranged by the committee charged with the training of Colonial (African) probationers at Cambridge, provided forty hours lectures which were obligatory and twenty hours for optional consultation. My colleagues, Mr. R. U. Sayce and Mr. J. H. Driberg, have experience of African conditions and personal knowledge of administrative problems in Africa. For 1931–32, the Colonial Office has approved of an additional course of eight lectures on the principles of African customary law. Other subjects—languages, criminal law, Mohammedan history, evidence and procedure, common law, agriculture, phonetics, history, and geography—have to be provided for in the Michaelmas and Lent Terms, so that under present conditions the allotment to anthropology is as large as we can hope for. If the conditions change, we shall press for more, and even now are ready to provide more. There are other features in the scheme which I regard as needing modification, and hope that argument and persuasion will prevail in the long run.

I must also record the fact that early in the year we were asked to receive two officers for study leave and readily agreed to do so, subject to our existing commitments. One of them came to Cambridge and the other preferred London, and I have no reason to suspect that pressure is brought to bear upon officers to choose Oxford or Cambridge in preference to London for study leave. In Cambridge we do the best we can for them. We welcome them gladly, and—speaking for myself—we learn much that is important and interesting from them.

T. C. HODSON,
Reader in Ethnology, Cambridge.

10 Wood Lane,
Highgate, London, N.6,
Aug. 24.

The External Meatal Notch as a Primitive Character.

THE majority of the many racial variations of the human tympanic bone result from the differing degrees of development of the lateral extensions of the annulus tympanicus. These lateral extensions typically develop as anterior and posterior elements which, by uniting at their ventral margins, complete the floor of the meatus acusticus externus.

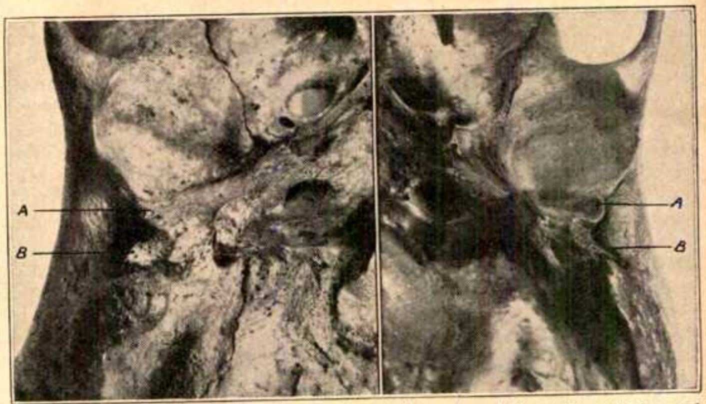

FIG. 1.—Tympanic region of two Australian skulls. *A* and *B* are the anterior and posterior tympanic moieties separated by the external meatal notch.

Failure of union of these two processes at the median end of the tympanic plate results in the persistence of the foramen of Huschke. Such failure of union in the adult may be as frequent as 32 per cent in some racial series. Failure of union at the outer extremity of the bony meatus, though producing a characteristic condition, appears to have had but little, if any, attention devoted to it. When this failure of union occurs, the auditory meatus itself consists of an anterior tympanic moiety and a posterior moiety, separated by the *external meatal notch*.

This external meatal notch is of very frequent occurrence in Australian skulls, and two examples are shown in Fig. 1.

Failure of ventral union of the anterior and posterior moieties of the tympanic plate may therefore result in (1) a persistent foramen of Huschke, so frequent in the skulls of Chamorros, (2) persistent external meatal notch, such as is frequently present in the Australian, or (3) a continuous deficiency, such as characterises the normal child at about its second year, and persists in the adolescent skull of *Sinanthropus*.

FREDERIC WOOD JONES.

University, Melbourne,
July 3.

Research Items.

Class Distinction in the Society Islands.—A study of traditional history and political grouping in the Society Islands, by Dr. E. S. Craighill Handy (*Bull.* No. 79, Bernice P. Bishop Museum), is devoted to the elucidation of the ethnic and cultural relations of the *manahune* (landless commoners) who dwelt mostly in the interior of Tahiti in the days prior to the breaking down of class distinctions by the missionary system. A preliminary investigation had indicated that they represented a survival of an earlier population that had been conquered and pushed back by the ruling dynasty, the *Hui Arii*, who were supreme in all the islands when they were discovered by Europeans. The customs and traditions of this invading dynasty were of an entirely different order from those of the earlier tribal culture. The *manahune*, who were the most numerous element in the population, were the serfs of the *arii* (feudal lords) and their supporters the *raatira* (landed proprietors). They were the wood-cutters for the royal family, the high-priest, and the warriors, the pickers of taro leaves, the fishers of eels and freshwater fish. Of the two types of house, the rectangular and the apsidal, the former belongs to the earlier culture. The *manahune* were valley-dwellers, cultivating the taro and sweet potato on irrigation terraces. The warriors' house was probably their central social and political institution, and the chief cause of war was blood-revenge. Human skulls and jawbones were preserved and reverenced. Tane, Roo (Rongo), and Tu were worshipped as patrons of woodcraft, agriculture, and war respectively. On the other hand, among the *Arii* the furniture and domestic utensils of their apsidal houses were supported on legs, their boats were composite built-up vessels, and they were distinctly maritime and not agriculturists, excelling in sea fishing which was a royal sport. They wore the *pareu*, the short skirt, as opposed to the loin-cloth, and made fine mats, used for articles of clothing and other purposes. Their outstanding contribution to Tahitian religion was the god Taaroa, their ancestor, who assumed the position of creator and supreme god of the local cult.

Pottery of Ancient Mexico.—A study of certain characteristics of the pottery of ancient Mexico, referring particularly to the types and distribution of decorative motives on specimens in the Museo Nacional of Mexico, is contributed by Sr. Eduardo Noguera to the *Journal de la Société des américanistes de Paris*, N.S., t. 22 (fasc. 2). Taking the collection as a whole, without reference to cultures, 39·7 per cent of the pottery vessels showed no decoration, the next highest percentage being shown by those with geometric motives, 27·7 per cent; anthropomorphic motives came next with 19·7 per cent. Of the pottery objects, other than vessels, in the collection, 89 per cent were anthropomorphic, 5·6 per cent zoomorphic, and 4·1 per cent skeuomorphic. When the cultural grouping is taken into account, the Aztec pottery showed the highest percentage of decorated ware. It also showed the highest percentage with geometric decoration. It is suggested that this preponderance of geometric motives is due to the fact that in other cultures decorative art developed through the stylisation of a realistic symbolism. The small number of skeuomorphic motives is attributed to the relatively backward stage of industrial development. Here again the predominance in Aztec art is due to the later and more developed stage attained by the Aztecs before the Conquest. The low percentage of phytomorphs is noticeable, and may be due to the fact that the geographical zones occupied by these cultures were of a relatively high altitude and vegetation was not so luxuriant as in the coastal regions. It is possible that a study of Maya and Huaxtec pottery on these lines would show a high percentage of phytomorphs to correspond with the more abundant vegetation of their habitat. Following the same line of argument, it may be shown that the Toltec and Aztec potteries are inferior in the percentage of zoomorphs to the Zapotecan, Mixtecan, and Tarascan cultures, owing to the fact that the two former inhabited the Valley of Mexico, in which animals were less abundant than in the habitat of the latter.

Detection of Syphilis.—In a paper presented in the *Rendiconti della Reale Istituto Lombardo di Scienze e Lettere* (parts 6-10), Dr. L. V. Blina gives the results of the application of the Wassermann and Kahn reactions to 650 samples of blood sera from syphilitic and non-syphilitic patients. In a number of cases of syphilitic infection, the Kahn procedure reacted positive and the Wassermann procedure negative, and the tendency to give negative indications as a result of therapeutic treatment proved less pronounced with the Kahn than with the Wassermann reaction. The former reaction reaches its highest degree of positivity for secondary syphilis and often shows negative with the tertiary form. These experiments are in favour of the Kahn reaction as a means of detecting syphilis, and the simpler technique and more rapid execution of this reaction give it an added advantage over that of Wassermann.

Mimicry in Indian Butterflies.—The Punjab University proposes to publish in the *Bulletin of the Department of Zoology*, of which the first part has reached us, a series of papers devoted to an intensive study of the fauna within a radius of five miles of Lahore. The first contribution, by Dev Raj Puri, deals with the butterflies, which, probably because of the extremes of climate in the summer and winter months at Lahore, are abundant only during August, September, and October. Keys and descriptions are given for the identification of families, genera, and species, and these are supplemented by thirty excellent coloured figures. In such a work, however, the lengthy synonymy of specific names is unnecessary, and since it occupies as much space as the essential descriptions, it might be drastically reduced. The author observed several new examples of protective coloration and mimicry. In *Melanitis leda*, always found resting on dry bamboo leaves under bamboo trees, the undersides of the wings resembled the colouring of the leaves. *Junonia orithya*, a common species, has wings of brilliant colour, and in rest the colours are exposed on the spread wings, but on the approach of danger the wings are folded up and only the obscure dust-coloured undersides exposed. *Pareronia hyppia* and *Delias eucharis* females resemble each other and occur together, but since the former was always entire, while the latter had sometimes the edges of the wing torn by birds, the former would appear to be distasteful and the model. Another suggested case of mimicry is that between the female of two species of Pieridæ, *Huphina nerissa* and *Ixias pyrene*.

The Evolution of the Excretory System in Cercariæ.—Lieut.-Col. R. B. Seymour Sewell (*Rec. Ind. Mus.*, 32, part 4, Dec. 1930) discusses the evolution of the excretory system in certain groups of furcocercous cercariæ. A study of the evolution and development of this system tends to show that every flame-cell pattern (that is, the number and arrangement of the flame-cells) is reached by the division of an original single-pair flame-cell system. Such a system is known only in certain miracidia: for example, of *Amphistomum, Fasciola, Gastrodiscus, Gorgodera*. The next stage in evolution is represented by the excretory system of the miracidia of the genera *Holostomum* and *Schistosoma*, in which the originally single flame-cell of each side has divided into two, so that four flame-cells altogether are present. A further division of each of these flame-cells would give four flame-cells on each side of the body, and it is such a system that seems to be the starting point in several different lines of evolution in the furcocercous cercariæ. This is the condition in the schistosomes, in which there are four pairs of flame-cells, three pairs in the body of the cercaria and the fourth in the tail-stem. The author, starting from this condition, traces the different modes of division of the flame-cells and of the grouping of the flame-cells so produced, dealing first with cercariæ which are apharyngeal and brevifurcate and then with those which are pharyngeal and longifurcate. This last series is subdivided into three groups. While recognising the difficulty of constructing a classification of the fork-tailed cercariæ based only on the excretory system, Lieut.-Col. Sewell is convinced that this system is the most important for the correct determination of the systematic position of any given species in the evolutionary series. The paper contains helpful diagrams illustrating the different modes of derivation from four flame-cells of the systems exhibiting five to twelve flame-cells, and the probable lines of evolution of the principal forms.

Chromosome Linkage in a Triploid *Œnothera*.—The triploid *Œnothera pycnocarpa*, which was supposed by Catcheside to have a ring of twenty-one chromosomes, has now been re-studied by him (*Jour. of Genetics*, vol. 24, No. 2) and a variety of arrangements found in diakinesis. This is the most detailed study that has yet been made of the diakinesis stage of meiosis in a triploid *Œnothera*. The great variety of linkages found is in harmony with the great range of genetic types, including many trisomic mutations, known through the work of de Vries to be obtained from triploids when selfed. As an example of the conditions, one nucleus is found to contain four ring pairs of chromosomes, two rod pairs, three univalents, one Y-shaped trivalent and a chain of three. Another contains five univalents, a chain of six, and a chain of eight with two attached to one of its ends. All the groupings, with one possible exception, conform to the segmental formula proposed, and are in harmony with the view that the chromosome linkages have originally arisen by crossing of species, followed by rearrangements of segments of the chromosomes.

Eocene Mollusca of North-west India.—A memoir on the molluscan fauna of the Laki and basal Khirthar Groups by L. R. Cox (*Trans. Roy. Soc., Edinburgh*, 57, pp. 25-92, pls. i-iv ; 1931) is based mainly on a collection made in recent years by Lieut.-Col. L. M. Davies, but the author has also studied the material collected by earlier geologists, from 1834 onwards, with the important result that the horizons of most of the species described in the great work by d'Archiac and Haime (1853–54) can now be fixed. The fauna is of Ypresian age and includes nearly a hundred species of gasteropods and lamellibranchs. The Laki fauna is very distinct from that of the underlying Upper Ranikot beds, but this is due partly to difference in the facies of the deposits. On the other hand, there is no great difference between the faunas of the Laki and Khirthar groups. A considerable number of the species, especially of the gasteropods, are confined to India, and those with a wider range are mainly limited to the Tethyan province. A few, however, are found in the Eocene of Europe, and one even in Jamaica.

Jointing and Tectonics of the Craven Area.—In the *Quart. Jour. Geol. Soc.*, 1931, pp. 392-421, L. R. Wager describes the jointing of the Great Scar Limestone of Craven and its relations to the tectonics of the area. The joints fall into two sets that are nearly at right angles to each other and fairly constant in direction. They are interpreted as shearing fractures due to a maximum horizontal compression in an approximately north-west–south-east direction. The jointing was produced in the early part of the interval between the Coal Measures and the Permian, and is contemporaneous with the Dent Fault, the North and Middle Craven Fault-systems, and the folding in South Craven. The North Craven Fault-system is a tear-fault, and the drag due to the relative horizontal movement has caused a local modification of the joint directions in the neighbourhood of the fault. The deep burial of the pre-Carboniferous floor in South Craven and the shallower burial of this floor in North Craven are responsible for the different reactions of the two areas to the Hercynian compressive forces. Renewed sinking of the South Craven area took place in post-Permian times, partly along the early faults and partly along newly initiated faults which followed one or other of the directions of jointing.

Photographic Vibrograph.—Messrs. Askania-Werke A.-G. Bambergwerk, Berlin-Friedenau, Kaiserallee 87-88, have issued a pamphlet (Geo. 105E) describing their latest pattern vibrograph. The instrument, which consists of two units joined by a light-tight tube, employs a photographic recording system. One unit comprises the camera, utilising 6 cm. wide bromide paper and a 4-volt lamp for illumination. Various paper speeds are obtainable, and short lengths of record can be cut off with a knife and removed in daylight for subsequent development. The vibrograph proper is normally constructed so that all three components of motion, vertical and two horizontal, are recorded side by side on the paper. Instruments can also be supplied which record only two or one of the components. The natural frequency of the units is stated to be five cycles/second, a value sufficiently low for most practical work on roads and in buildings, and variable liquid damping is provided. A useful feature is an arrangement whereby the mechanical magnification of the instrument can be altered in the ratio of ten to one. In addition, a choice of three lenses is available, thus permitting in all a choice of six values of magnification, varying from 125 to 3000 times.

Atomic Weights Deduced from Mass-Spectra.—Some new values for the atomic weights of a number of elements are given by Dr. F. W. Aston in an account of an investigation of their mass-spectra which appears in the August number of the *Proceedings of the Royal Society*. In the majority of cases these agree with the accepted chemical values. Amongst these is rhenium, which is perhaps of particular interest, Dr. Aston's value being 186·22 ± 0·07 and Honigschmid's 186·31. For the three elements selenium, tellurium, and osmium, there are, however, serious discrepancies ; the atomic weights found by the mass spectrograph for these are 78·96 ± 0·04, 128·03 ± 0·1, and 190·31 ± 0·06 respectively, against chemical values of 79·2, 127·5, and 190·9. It remains to be seen if the chemical values are actually inaccurate, but it will be recalled that in two other instances—krypton and xenon—more recent redeterminations by classical methods have tended to support the validity of the values found electrically.

Conductivity of Tetraethylammonium and Ammonium Salts.—The August number of the *Proceedings of the Royal Society* contains some data for the conductivity of various ammonium and tetraethylammonium salts in methyl alcohol, which have been obtained by Sir Harold Hartley and a number of collaborators. The measurements were made at 25° C. and show the rather curious result that the mobility of the complex ethyl ion (NEt_4^+) is seven per cent greater than that of the relatively simple ammonium ion (NH_4^+). With a single exception, the results for the eleven salts studied agree with the prediction of the Debye theory of electrolytes that the molecular conductivity should change in a linear manner with the square root of the concentration; the rate of change of conductivity with concentration also affords evidence for the essential accuracy of some recent developments of Debye's theory, observed and calculated values of the rate of change agreeing on an average to within twenty per cent. The general trend of the results, and particularly the behaviour of the good conductor tetraethylammonium perchlorate, indicates that the magnitude of the deviations from theory increases with the speed of the ions present.

Insulin Therapy.—Although our knowledge of the mechanism of the action of insulin in the body is very incomplete, there is no question of its value in the treatment of diabetes mellitus. The principles of its practical use are well defined, although the actual details may vary; in every case it is necessary to ensure a balance between the diet and dosage of insulin, such that the blood-sugar is kept within normal limits and none is excreted in the urine. The amount of insulin required will naturally vary according to the severity of the disease and the amount of food taken. The details, which vary according to the physician in charge of the case, are concerned with the methods of determining the amount of insulin required and of calculating the diet. A convenient account of the treatment of diabetes with insulin is given in a small brochure recently issued by the manufacturers of "A.B." Brand Insulin (British Drug Houses, Ltd., and Allen and Hanburys, Ltd.). Simple methods for estimating sugar in blood and urine are described, as well as a simple dietary scheme. The practical use of insulin is given in detail. Sections are devoted to the treatment of the various conditions which may complicate the disease. Although insulin rarely cures, it can undoubtedly prolong life when properly employed; a cure can only be expected when the affection of the pancreas passes off without damaging the organ permanently. In such a case insulin may tide the patient over the infection and permit of recovery of function by the gland. In many cases, however, the timely use of insulin may promote a definite improvement in the condition of the pancreas. In all, its use permits of a better dietary being prescribed, with greater comfort to the patient. Insulin has also found a use in the treatment of various nondiabetic conditions: it is employed to improve the metabolism of carbohydrate, and may be used in states of malnutrition and when it is advisable to stimulate the metabolism of these food-stuffs, as in various forms of vomiting and in liver affections. The booklet may be recommended to those in search of a short and readable account of insulin treatment, based on selected excerpts from current medical literature.

Astronomical Topics.

A Daylight Meteor.—A brilliant meteor was observed by Mr. J. R. Clarke, University, Sheffield, just before sunrise, from Loch Doon, Ayrshire, on Aug. 26 at about 4^h 15^m G.M.T. It travelled from west to east with very low apparent velocity, and was visible for about half a minute. No other reports are to hand at present.

Stellar Photometry.—Some years ago the photographic magnitudes of stars in the zone +90° to +73° declination were obtained by Parkhurst at Yerkes, and this work has now been continued by A. S. Fairley at the same observatory over the zone +75° to +60°. The method used is that of extra-focal images, obtained 6 mm. inside the focus of a Zeiss 14·5 cm. doublet of 81 cm. focal length. A series of fourteen accurately graded artificial images was impressed on each plate before development, thus providing an independent scale for the comparison of densities, which were measured in a Hartmann microphotometer. The zero point was calculated for each plate from stars in the Potsdam Photometric Durchmusterung, the magnitudes of which were first corrected for colour index (assumed from spectral type) and then reduced to the international scale. The methods employed are described in the *Astrophysical Journal*, vol. 73, p. 125, in which Fairley gives the resulting photographic magnitudes of 2354 stars down to magnitude 8·25 within the above-mentioned zone.

The Apparent Recession of the Spiral Nebulæ.—*Leaflet* 37 of the Astronomical Society of the Pacific gives an account by Mr. Milton L. Humason of the methods now adopted at Mount Wilson of measuring the radial velocities of the distant spiral nebulæ. A new spectrograph lens, designed by Dr. W. B. Rayton, has been brought into use, which greatly shortens the exposures; these, however, still have to be continued on several successive nights in the case of the fainter nebulæ. The photographic plates measure $\frac{5}{8}$ inch by $1\frac{1}{2}$ inch, and the length of the spectrum varies from $\frac{1}{25}$ inch to $\frac{1}{12}$ inch, according to the prisms used.

Up to three years ago the measures of distance extended up to 6 million light-years; they now reach 105 million. Reasons are given for assuming that the smaller and fainter nebulæ are the more distant, and it is then shown that these small faint nebulæ have also the largest velocities of recession. The question whether the recession is real, or arises from the properties of space, does not affect the use of the shift to the red as a measure of distance.

A photograph, taken with the 100-inch reflector, is reproduced, showing a group of faint nebulæ in Leo. The brightest of these is of magnitude 15·5, and is stated to be the faintest and most distant object for which a measurable spectrum has been photographed. The deduced distance is 105 million light-years, and the measured recession is 12,000 miles per second, or $\frac{1}{15}$ of the velocity of light.

Measures are given of seven other nebular groups, in which 30 nebulæ were examined. The results show that the distances estimated from apparent brightness and diameter are in excellent agreement with those deduced from the velocities of recession. So far as the results extend at present, they indicate a fairly uniform distribution of nebulæ in different regions of space.

The Nature of Cohesion.*

LIKE all other branches of physics, the subject of cohesion has been profoundly modified by the advent of wave mechanics. When atoms were regarded as miniature solar systems, there was no mathematical machinery capable of dealing with their mutual interaction. But now the outlook is different. There is no attempt in wave mechanics to follow the life-history of electrons in atoms. Rather does it give a statistical average of their distribution in space, from which may be inferred the probability that an electron may be found here or found there. Mathematically, if not physically, electrons in atoms are smeared out. Where once was thought a solar system played, is now a shimmering haze.

Wave mechanics does not give the density of these charge distributions directly. It gives instead, when only one electron is being considered, a quantity ψ, called a wave function, which may be real or complex, and the density ρ of the electron distribution is equal to the square of the modulus of ψ or to $\psi\bar{\psi}$. The quantity ψ is a function of the co-ordinates of the electron, and these are four in number, three being necessary to specify its position in space, and the fourth its direction of spin. The probability of finding the electron in an element of volume $d\tau$ is $\rho d\tau$.

When there are several electrons in an atom, its configuration may in an approximate theory be specified by a number of wave functions, $\psi_\alpha, \psi_\beta, \ldots \psi_\nu$, each a function of the four co-ordinates of an electron. For a reason not yet understood, Nature places a restriction on the choice of these wave functions: no two of them may be the same. This exclusion principle, first enunciated by Pauli, seems to be of very general validity in physics, and, in particular, accounts in a very remarkable way for many of the observed properties of atoms and molecules.

If one of the electrons, say electron 1, were alone, the probability of finding it in an element of volume $d\tau_1$, would be $\bar{\psi}_\alpha(x_1)\psi_\alpha(x_1)d\tau_1$ or $\rho_\alpha(x_1)d\tau_1$, where x_1 denotes its four co-ordinates. Similarly the probability of finding electron 2 in an element of volume $d\tau_2$, if it were alone, would be $\rho_\beta(x_2)d\tau_2$. It might be supposed that the probability of finding an electron in $d\tau_1$, another in $d\tau_2$, and so on, simultaneously, were the product of these separate probabilities, namely, $\rho_\alpha(x_1)\rho_\beta(x_2) \ldots d\tau_1 d\tau_2 \ldots$ But this result is not true. It is untrue because an important principle has been ignored, namely, that all electrons are identical and that interchanges of the electrons may occur without observable effects. Electron 1 may be associated with wave function ψ_β, or in fact with any of the set of wave functions ψ_α to ψ_ν. The correct expression for the probability may, in certain cases, be expressed quite simply, as has recently been shown by Dirac. It is $\rho d\tau_1 d\tau_2 \ldots$, where ρ is a determinant of N rows and columns, a typical term of which is $\rho(x_i, x_k) = \Sigma_\alpha \bar{\psi}_\alpha(x_i)\psi_\alpha(x_k)$. This determinantal form for ρ contains the expression given above as its leading term, but there are many other terms not previously given by an atomic theory.

The probability of finding an electron in $d\tau_1$ independently of the position of all other electrons is then obtained by integrating ρ over the co-ordinates of all the electrons except one, and may be shown to be $\Sigma_\alpha \rho_\alpha(x_1)d\tau_1$. This expression is the sum of the densities of the probability patterns of the separate electrons, and, moreover, contains the co-ordinates of one electron only, so that, apart from the spin co-ordinate it may be represented in ordinary three dimensional space. It justifies us in constructing a picture of an atom by superimposing the patterns of the individual electrons of which it is composed. Such pictures are very instructive and have been used in a variety of ways with striking success. One important result is that the distribution of electron density in the inert gases and, indeed, in many other atoms is spherically symmetrical, and so the early pictures of them as minute spheres are to some extent justified. The halogen atoms, on the other hand, are not spherical. They are like the familiar meteorological forecast, "Unsettled, with bright intervals".

The importance of the new form for the probability function ρ becomes evident when calculations are made of the *energy* of electronic systems. Electrons exert electrostatic forces on each other and the average value of the electrostatic energy can only be calculated when we know the probability that any pair of electrons will be at a specified distance apart. A detailed calculation of the energy of an atom or the interaction energy of two atoms depends then very closely on the probability function ρ.

The probability of finding two electrons in specified places independently of the other electrons proves to be $\{\rho(x_1, x_1)\rho(x_2, x_2) - \rho(x_1, x_2)\rho(x_2, x_1)\}d\tau_1 d\tau_2$, with the definitions of $\rho(x_1, x_2)$, etc., already given. The mutual energy of two electrons consists then of two terms; the first is the average of $(e^2/r)\rho(x_1, x_1)\rho(x_2, x_2)$ integrated over the whole space of electrons 1 and 2; the second is the average of $(e^2/r)\rho(x_1, x_2)\rho(x_2, x_1)$. Apart from certain terms of these expressions which cancel, the first represents the Coulomb interaction of the individual distributions of electric charge ρ_α, ρ_β, etc. This may be called the *Coulomb energy*.

The second term in the above expression is new. It has proved of the greatest importance in the theory of atomic and molecular structure. It is difficult to describe its physical nature. All that can be said is that it is the natural outcome of introducing two physical concepts into the mathematical scheme, namely, the principle of the identity of electrons, and the exclusion principle of Pauli. It is sometimes described as the 'exchange' term and the term in the energy expression arising from it as the '*exchange*' *energy*.

The 'exchange' energy depends on the spin of the electrons, while the Coulomb energy does not. It is this property of the exchange term which has made it of so much importance in the theory of atoms and molecules. In a two-electron system, as in an excited helium atom, for example, the electrons may have the same or opposite spins, and, owing to the exchange term, the energy of the states with the same spins is lower in every case than the corresponding states with opposite spin. The hydrogen molecule is another two-electron system, and here the energy is lowest when the electrons have opposite spin. This appears to be the case in the interaction of most atoms. For certain interatomic distances the energy is lowest, and, therefore, the cohesion greatest, when the electrons of one atom are 'paired' with those of the other atom. The energy of two interacting nitrogen atoms is highest when the spins of the three outer electrons of the atoms are all of them the same, and lowest when the three electrons of one atom are paired with those of the other. This latter condition corresponds to the normal nitrogen molecule, held together—as the chemist describes it—with a triple bond.

The pairing of electrons is thus brought into close

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[*] From two lectures delivered recently by Prof. J. E. Lennard-Jones, one on "Cohesion", before the Physical Society of London, and the other on the "Quantum Mechanics of Atoms and Molecules", before the London Mathematical Society.

connexion with the valency rules of the chemist, and *chemical homopolar forces* are elucidated to this extent—that they are seen to be a consequence of the same mathematical and physical principles which have been formulated for other branches of physics. This result may conceivably come to be regarded as one of the greatest achievements of the present formulation of quantum mechanics.

The new theory has been successful in explaining other forces, the nature of which was formerly little understood. For a long time it has been known that atoms, which are chemically inert, exert attractions on each other; so much so, that they aggregate together as liquids and solids if the temperature is lowered sufficiently. These attractive forces, usually called *van der Waals forces*, have now in one or two simple cases been calculated deductively from the electronic structure of the atoms. These attractive forces seem to be due not to a static polarisation of the atoms by each other but rather to a rapidly fluctuating mutual polarisation. Atoms are not actually continuous distributions of space charge. They are only to be regarded so on the average. When two atoms are subject to each other's influence, the motion of the electrons in one modifies that of the electrons in the other. They tend on the average to move in phase.

Suppose, for the sake of illustration, that an atom were represented by a linear oscillator, that is by an electron vibrating along a line through the nucleus. Such a system requires only one co-ordinate z to specify it. Then the probability-distribution of the electron in its lowest energy state is a Gaussian error curve ($e^{-\alpha z^2}$), symmetrical about the origin. If two such electronic systems, vibrating along the line joining the nuclei and specified by co-ordinates z_1 and z_2, are allowed to interact, the new probability-distribution is not simply a combination of the two undisturbed probability-distributions of the isolated systems. Calculation shows that as a result of interaction the probability of finding z_1 and z_2 with the same sign has increased, while that of finding them with the opposite sign has decreased. Now dipoles which point in the same direction attract, and those which point in the opposite direction repel. The net result is that the two electronic systems on the average attract. The attractive force for this model and for actual atoms proves to be proportional to the inverse seventh power of the distance.

All atoms and molecules exert on each other an attractive field of this type, but usually this attraction is masked by other larger attractive fields. Only in the case of inert gases or saturated molecules does it become predominatingly important. It is likely that many substances, such as the halogen hydrides, are held together in the solid state by forces of this type. There is a growing recognition, too, of the importance of van der Waals fields in many phenomena at surfaces such as in adsorption.

The problem of *ionic cohesion* largely resolves itself into explaining why some atoms have an affinity for electrons. Such atoms are usually unsymmetrical charge distributions and the nature of the affinity can be understood, though actual calculation of the magnitude is difficult.

Metallic cohesion seems to be due partly to the Coulomb interaction of space charge distributions (the Coulomb attraction referred to above), partly to the 'exchange' phenomenon, and partly to van der Waals attraction. Little is as yet known as to the relative extent to which these various factors contribute to the cohesion of a metal. The general principles seem to be understood. What is now required is a mathematical technique capable of applying them to particular cases.

Selection of Engineering Apprentices.*

How far is it practicable to use psychological tests in the selection of boys for the engineering trade? An attempt to provide an answer to this question has recently been made by the Birmingham Education Committee, under the auspices of which an investigation was conducted by Miss E. P. Allen and Mr. Percival Smith. A report describing the tests used, the methods adopted, and the results obtained has now been published.

Such a report will be of especial value to local education authorities responsible for juvenile employment. Indeed, the Malcolm Committee on Education and Industry has already directed attention to the necessity for this kind of research by authorities upon whom that responsibility rests. The present report deals with one aspect of the wide problem with which such authorities are faced: its authors have also been engaged upon a second experiment, involving still wider issues—the extent to which a series of psychological tests can be of practical use in offering vocational guidance to children when they leave elementary schools.

So far as the engineering trade is concerned, however, one of the first points to be decided was what that all-embracing term meant. In Birmingham, as elsewhere, it covers a multiplicity of occupations, ranging from those followed by practically unskilled manual workers to those needing highly skilled technical experts. For the former, the chief requirement is a varying amount of manual dexterity, and tests of such dexterity would, in their case, probably be sufficient. For those engineering branches which require skilled apprentices, however, the qualities to be sought are a combination of intelligence, mechanical aptitude, ability, and dexterity. With that combination in mind, the report uses throughout the term 'apprentice ability'. Tests were therefore used which would depend *inter alia* on mental processes, but would be definitely associated with mechanical ability.

This primary difficulty of deciding the type of qualities to be sought in connexion with so wide an industry as engineering is, of course, well known to engineers. We stress it here not merely to show its complications, but also as an indication of the care with which the investigators dealt with their problem—a care which will go far towards building up methods and results upon which confidence may fairly be placed.

The groups of individuals selected included third and fourth year apprentices (average age nineteen years) attending part-time courses at the Birmingham Central Technical College; entrants and leavers (fourteen to sixteen years of age) of a school with an engineering bias (Handsworth Junior Day Technical School); of a school with a commercial bias (Aston Commercial School); and of a general secondary school (Yardley Secondary School).

This selection of pupils from differing types of post-primary schools possesses a special interest in view of the present reorganisation of education, which is striving to relate the work of such schools to the needs of industry and commerce. Each has recently tended to make special claims concerning the aims and results of its syllabus. The following summary, taken from Section IV. of the report, would appear, so far as the engineering trades are concerned, to support the claims already made by the junior technical school: "(1) Boys who have had a purely academic training do not improve in ability to tackle these tests to the same extent as boys of a somewhat lower intellectual level who have received further education with an engineering bias. (2) Boys who have had further education with a different vocational bias (commercial) do not improve in ability to tackle these tests to the same extent as boys of a slightly lower intellectual level who have received further education with an engineering bias."

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* City of Birmingham: Education Committee. Selection of skilled Apprentices for the Engineering Trades. Report of Research. By E. Patricia Allen and Percival Smith. Pp. iv+35. (Birmingham: Education Committee, 1931.)

It is to be noted that the investigators did not use only the method of 'tests'. Criteria of apprentice ability of the individuals were supplied by instructors and the test results were compared with the respective criteria.

Priestley as a Pioneer.

UNDER the title, "Joseph Priestley and his place in the History of Science", Sir Philip Hartog delivered a discourse at the Royal Institution on April 24, a reprint of which, with a postscript dealing with some additional points, has been received. Sir Philip traces the main events in Priestley's life, bringing out the fact that he was more than a man of science; he was a teacher, theologian, politician, and defender of liberal thought. His scientific work has been variously assessed and perhaps some aspects have tended to have been overshadowed by his discovery of oxygen. Priestley made some important experiments in electricity, and his work on the "History of Electricity" includes, among other matters, a statement that the inverse square law is contained in the experimental fact that there is no electrification inside an electrified metal vessel. This was probably the starting point of Cavendish's better known investigations. Priestley also made experiments on electric discharges, which are now seen to have raised fundamental issues.

Priestley's attitude to hypotheses in science is examined, and in his indifference to his own theories and those of others, he is thought to have been influenced by Franklin. In his chemical investigations he accepted the phlogistic theory, as a pupil, with docility, since he was "no professed chemist". His practical investigations of gases, although preceded by important publications of Cavendish, led to the acquisition of much new knowledge on gases. This formed the basis of Lavoisier's theoretical revolution in chemistry. Sir Philip Hartog is inclined to allow Lavoisier more originality in the matter of the discovery of oxygen than has been usual, although he admits in more than one instance that the memoirs of Lavoisier as they finally appeared had been amplified from the original communications, a circumstance which makes it necessary to use the greatest care in dealing with this author. Although Priestley's intelligence "remained intact, bright and lively to the end", Sir Philip thinks his memory was failing him when he wrote his well-known complaint of Lavoisier's claims some years before his (Priestley's) death.

Sir Philip Hartog's discourse makes it clear that Priestley more than once was tempted to adopt Lavoisier's new view of the chemistry of combustion, but that he was restrained by the results of experiments, these being either faulty in themselves or wrongly interpreted. He nearly reached a true conception of the composition of water from his own experiments, but says he "was taught by Mr. Watt to correct this hypothesis", an event which does not help in the attempts which have been made to credit Watt with the discovery of the composition of water. One of Priestley's greatest stumbling-blocks was his confusion of the two inflammable airs, hydrogen and carbon monoxide, which was only cleared up by Cruickshank in 1801. Priestley's work on respiration and that on the growth of plants were the starting points for investigations of others, the first for Lavoisier's great researches on animal respiration.

Sir Philip Hartog believes that it is easy to understand why Priestley's work and his character have been under-estimated in the past. His electrical work and his clear views on the use of hypothesis and on scientific theory generally have been eclipsed by his chemical work, in judging which it is no simple task to divest his language of the enveloping veil of the phlogistic theory. He deserves a greater place in the history of science than he has hitherto been accorded.

Some Phenomena of the Upper Atmosphere.

THERE are three layers in the upper atmosphere in which dissociation is produced by the absorption of solar radiation. These are the layer of ozone, with its maximum concentration at about 50 km., and the two ionised layers at about 100 km. and 220 km. The absorption of solar radiation of any kind in a gas of which the density varies exponentially with height $h(ae^{-h/H})$ has a definite distribution relative to the level of maximum absorption; this distribution depends only on H. It is shown that the main regions of absorption associated with the three layers are well separated, though the dissociation of molecular oxygen which results in the formation of the ozone layer has an important influence on the whole of the overlying atmosphere, in which atomic oxygen is a permanent constituent, its concentration increasing with height. The concentration of ozone, on the other hand, must decrease with height above a certain level, a conclusion which bears on the maintenance of a high temperature in the upper atmosphere.

Milne's theory of photoelectric ionisation is applied to the earth's atmosphere, assuming that the sun's radiation even in the far ultra-violet is that of a black body at 6000°. It suggests that the ionisation of the upper layer is due to the absorption of ultra-violet radiation, probably by atomic oxygen.

Considering both magnetic and radio evidence, it is inferred that the agent responsible for ionising the lower layer consists of neutral atoms from the sun, emitted from the sun at the same time as the charged atoms that are responsible for magnetic disturbance, the number of the two kinds of particles varying in unison, from time to time. They travel together from the sun until within a few earth-radii distance from the earth, when the charged particles are deflected by the earth's magnetic field towards the polar regions, there producing auroræ, while the neutral atoms travel straight on and ionise the sunlit hemisphere.

On considering the origin of the green light of the night sky, making use of Rayleigh's recent measurement of the absolute photometric intensity of the light, it is inferred that the excited atoms that emit the light are produced continuously during the night, the energy coming from energy of dissociation or ionisation stored up during the day. The level of the emission may be assigned as between 100 km. and 200 km.

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[1] Abstract of the Bakerian Lecture delivered before the Royal Society on June 25, by Prof. S. Chapman, F.R.S.

Birthdays and Research Centres.

Sept. 14, 1849 (old style), or Sept. 26.—Prof. I. P. PAVLOV, For.Mem.R.S. and Nobel laureate in 1904 for physiology and medicine, director of the Institute of Experimental Medicine, Leningrad.

I am continuing the investigation of the highest nervous activity by the method of conditioned reflexes. This investigation includes in its scope the study of the normal activity, as well as that of different pathological states, which we are provoking intentionally, and the recovery of the normal after them.

Sept. 17, 1859.—Prof. F. D. ADAMS, F.R.S., emeritus professor of geology, dean of the faculty of applied science, and vice-principal of McGill University.

I am at present engaged in a study of the historical development of our knowledge of certain phenomena of physical geology and of our views on the nature and classification of minerals in the time antedating the rise of historical geology at the close of the eighteenth century; also in a study of certain points in connexion with the geological relations and petrography of the Palæozoic intrusions of the Monteregian Hills.

One of the most important pieces of work which could be undertaken at the present time in geology would be a comparative and at the same time comprehensive study of the great developments of the Pre-Cambrian exposed in certain typical areas such as those in North America (the Canadian Shield), Finland and Scandinavia (the Baltic Shield), and in South India and Ceylon, as recently suggested by Dr. Sederholm, of Helsingfors, with the view of advancing, so far as possible, our knowledge of the geological succession as set forth in these ancient records of the beginnings of the history of the earth.

Sept. 17, 1870.—Lieut.-Col. S. P. JAMES, F.R.S., I.M.S. (retired), medical officer and adviser on tropical diseases, Ministry of Health.

At the Malariotherapy Centre which was established by the Ministry of Health and the London County Council at Horton in 1925, psychiatric studies on the effect of induced malaria on general paralysis go hand in hand with investigations into the malarial infection itself, its natural history in man and in mosquitoes, its treatment, and its prevention. Recently attention has been devoted chiefly to chemotherapeutic experiments with a view of improving the treatment of obstinate cases of malignant tertian malaria, and to chemoprophylactic experiments having for their object to ascertain whether any known or reputed antimalarial remedy is a true preventive of human malarial infection contracted in the natural way by the bites of mosquitoes. The former experiments have not, as yet, yielded a noteworthy result, but from the latter the striking fact has emerged that the German synthetic preparation ‘ plasmoquine ’, when taken in suitable doses before and after a person is bitten by infective mosquitoes, possesses the remarkable property of preventing him from becoming infected.

These and other experiments now being conducted at Horton indicate that a subject to which attention might usefully be given is the revision of the classical chemotherapeutic method of testing antimalarial drugs (the method devised and practised so diligently by the late Dr. Roehl) in the light of the new knowledge that not all the different phases or forms of the malaria parasite which occur in the human host are amenable to the same drug, and that the problem of controlling malaria by the use of drugs is not so much a problem of finding a drug which is more effective than quinine against the fever-producing forms of the parasite as it is of finding other drugs that will be effective against the sporozoite stage, the sexual stage, and the stage responsible for relapses.

Sept. 18, 1854.—Sir RICHARD GLAZEBROOK, K.C.B., F.R.S., formerly director of the National Physical Laboratory.

The date that stands above, Sept. 18, 1854, will tell my friends that I can no longer ask their interest in or their support for personal investigations. The time for these is over, but in the future there are many problems I would wish them to carry forward to a complete solution.

Thirty years of a not inactive life have been given to the endeavour to bring home to all the need that, if we are to maintain our place in the world, we dare no longer trust to the natural advantages of our position and to the fact that during the past century great Englishmen have been the foremost to advance natural knowledge. We must apply to our daily wants the truths they wrested from Nature.

This lesson was never more necessary than to-day. There are among us men most skilled in unveiling Nature's secrets; others there are well fitted to apply the knowledge so gained to the problems of each day's life. I wish to see the work of these men helped onwards by all means in our power, while at the same time our leaders, and those they lead, grasp the truth that it is on such foundations that they must build.

Sept. 18, 1865.—Sir ALEXANDER HOUSTON, K.B.E., C.V.O., F.R.S., director of water examinations, Metropolitan Water Board.

Systematic search might usefully be made for the presence and numerical abundance of the microbes of epidemic water-borne disease (typhoid and paratyphoid) in sewages, sewage effluents, and in sewage polluted rivers. Very little is known of this subject despite the pioneer work carried out by Wilson, Gray, Begbie, and Gibson, and the Metropolitan Water Board.

The extensive work already achieved in the examination of the dejecta of enteric fever patients and of ‘ carriers ’ should be greatly extended in the direction of estimating the number and not merely the presence of the germs of enteric disease. In positive cases, the opportunity should be seized of determining the vitality of these ‘ uncultivated ’ pathogenic organisms in the materials examined at different temperatures.

Turning next to a totally different problem. Is there not room for further research on the cause, prevention, and treatment of that painful and often most intractable disease herpes zoster, and its alleged relationship with chicken-pox?

Sept. 18, 1881.—Prof. ARTHUR M. TYNDALL, Henry Overton Wills professor of physics, and director of the Wills Physical Laboratory, University of Bristol.

The activities on the experimental side of the Wills Physical Laboratory at Bristol are mainly concentrated upon three subjects: spectroscopy, magnetism and conduction through gases. In each of these branches groups of workers are engaged. My own investigations lie in the last of these, and in the mobility of gaseous ions in particular. We have recently shown that minute traces of impurity may have a profound effect upon the mobility of positive ions. Thus the mobility of positive ions in helium is raised fourfold by the elimination of all impurities. We are therefore engaged upon a re-investigation of the whole subject with improved technique. We also find that the method may be used to analyse the ions present in the various inert gases when contaminated by small amounts of known impurities, and we are thereby obtaining useful information on the phenomena of electron capture and of ionisation by collisions with metastable atoms.

Societies and Academies.

PARIS.

Academy of Sciences, July 15.—The president announced the death of Albert A. Michelson, foreign associate.—**Ch. Fabry**: An interferential level without an air bubble. A liquid, preferably oil, is contained in a vessel the bottom of which is a platinised glass spherical surface of very large radius (500 metres). By means of the interference rings produced, this can be used as a level of high precision.—**C. Camichel** and **P. Dupin**: The various modes of contraction of a liquid stream at the commencement of an efflux.—**Henri Lagatu** and **Louis Maume**: The variation of the physiological relations between the mineral constituents of a plant species.—**M. Ghermanesco**: The *n*-metaharmonic functions.—**René Pallu**: Study of the system H_3PO_4, $Ba(OH)_2$, CO_2, H_2O.—**Agostino Puppo** and **Pietro Longo**: The storm of July 24, 1930, in the Treviso-Udine district. A correction of a misprint in the *Comptes rendus*, June 8, 1930.—**A. Guilliermond**: The mode of formation of the anthocyanic pigments in the flower of *Iris germanica*. The anthocyanic pigments in the flower of *I. germanica* are preceded by the production of oxyflavonols.—**Léon Binet** and **J. Magrou**: Sulphur and growth. The high proportion of glutathione in tissues during the period of proliferation suggested a study of the influence exerted on growth by various sulphur compounds. The activating action of sodium hyposulphite on growth has been demonstrated in the case of cress and of the tadpole.—**C. Levaditi**, **J. Bardet**, **A. Tchakirian**, and **A. Vaisman**: The distribution of gallium in the organism. From the point of view of its distribution in the blood and tissues (rabbits) gallium behaves like bismuth, tellurium, and mercury.—**Bordier**: The remarkable action of diathermic d'Arsonvalisation at a distance.

July 20.—**G. Ferrié**: *Compte rendu* of the general meeting of the International Radio-Scientific Union held at Copenhagen on May 27–June 6, 1931. Details of the various committees and the work allotted to each. —**L. Blaringhem**: A mutation of the common wallflower (*Cheiranthus Cheiri*).—**Gabriel Bertrand** and **P. Serbescu**: The toxic power of aluminium compared with that of iron, nickel, and other metals. Aluminium and iron possess about the same toxic power, both much less than that of nickel and copper. There is no definite proof that small repeated doses of aluminium are toxic.—**M. de Broglie** and **L. Leprince-Ringuet**: The artificial disintegration of aluminium.—**C. Sauvageau**: The rôle of Aglaozonia of parthenogenetic origin.—**H. Milloux**: Certain integral functions and their derivatives.—**Lucien Féraud**: Arithmetical study of the permanent stability in the neighbourhood of an equilibrium point.—**Alfred Rosenblatt**: The movements of viscous liquids symmetrical with respect to an axis.—**Pierre Dive**: An exclusive property of ellipsoidal homoids.—**G. Fayet**: The orbits of the planets Neptune and Pluto.—**Auguste Claude**: The use of geometric loci for the representation of observations of passage in the meridional telescope.—**L. Bouchet**: The electromotive forces of two liquid batteries and their variations with the dilution of the solutions.—**F. Holweck** and **P. Chevallier**: A 150-kilowatt triode capable of being taken apart.—**Horia Hulubei**: A system of bands of mercury in the neighbourhood of its resonance ray.—**J. Cabannes** and **Mlle. D. Osborne**: The depolarisation of lines of the CO_3 ion in the spectrum of the light diffused by a calcite crystal.—**Jean Becquerel** and **Louis Matout**: The decomposition of the absorption bands of xenotime by a transverse magnetic field. The conditions of symmetry in relation with the crystalline symmetry. A new interpretation of the magneto-electric effect.—**Constantin Salceanu**: The invariant of magnetic rotation of some organic substances in the fused state. —**Mlle. Quintin**: The hydrolysis of copper sulphate. —**René Audubert**: The rôle of water in photovoltaic cells. The experiments detailed establish that water plays an essential part in photovoltaic phenomena, its influence being mainly exercised in the adsorption layer at the surface of the electrode.—**Tcheng Datchang**: The purification of the protactinium fixed on tantalum oxide, with reference to the estimation of protactinium in radioactive minerals. In determining the proportions of protactinium present in radioactive minerals, it is essential that radium, ionium, and polonium should first be removed. Details of satisfactory methods of separation of these three elements are given.—**Albert Portevin** and **Pierre Chevenard**: The graphitisation of steels at a low temperature.—**P. Laffitte** and **M. Patry**: The deflagration and detonation of mercury fulminate.—**Georges Lévy**: α-Ethylnaphthalene and its hydrogenation products.—**A. Mailhe** and **Creusot**: The transformation of toluene and of xylene into methane. A quantitative study of the hydrogenation of these two hydrocarbons in the presence of reduced nickel as catalyst at varying temperatures.—**Émile André** and **Charles Vernier**: The rotatory power of ricinolamide.—**F. Dupré la Tour**: The polymorphism of malonic, succinic, and glutaric acids as a function of the temperature. Each of these acids exists in two forms, with a definite transition temperature.—**Louis Glangeaud**: The structure of the primary massif of Algiers.—**J. Malavay**: The geology of Mauritania of the Nord.—**Y. Milon** and **M. Sire**: The interdependence of the Tertiary and Quaternary formations in the Vilaine and Mayenne valleys.—**Ch. Poisson**: Phenomena due to the meeting of a monsoon and a trade wind on the southern Indian Ocean.—**H. J. Maresquelle**: The action of *Bacterium tumefaciens* on regeneration, in the root of *Taraxacum dens leonis*.—**Pierre Gavaudan** and **Robert Cazalas**: New observations on the spermatogenesis of the Characeæ. The nature of the granulated band and the appearance of carotene and of chlorophyll in certain spermatocytes. —**Charles Pérez**: Organogenesis of the substitution buds in *Chlorogaster*, parasite of the hermit crab.—**A. Policard**: Histochemical researches on the initial lesions of experimental pulmonary silicosis (silica plaques).—**Aloncle**: The synergism of hypophysine and thymine.—**A. Leulier**, **B. Pommé**, and **R. Delaye**: The distribution of potassium in healthy or pathological muscle.—**E. Roubaud**: Cyclic evolutive fatigue and tireless strains in the common green fly *Lucilia seratica*.—**E. Chatton** and **Mme. M. Chatton**: The conjugation of *Paramœcium caudatum* determined experimentally by modification of the associated bacterial flora.—**Mlle. D. van Stolk, J. Guilbert,** and **H. Pénau**: Carotene and vitamin A. The absence of xanthophyll in the carrot has been proved, also the presence of more than one carotene, differing in their physico-chemical properties, but all possessing physiological activity.—**A. Paillot**: The gattine of the silkworm.

Geneva.

Society of Physics and Natural History, May 21.—**M. Decker**: The synthesis of Bichler and Napieralski. The author recapitulates the history of a very important synthesis in the field of the alkaloids. It had its origin in a work of Bichler, published in 1893, and appears again in the works of Pictet and of Decker in 1909; it served as the starting-point of the work of Robinson in England in 1915, and was presented as a novelty in 1930 by Spāth of Vienna.—**Jean Deshusses** and **Louis Deshusses**: Some insects specially injurious to cultivation in French Switzerland. The laboratory of agricultural chemistry (Châtelaine-Genève) points out cases of new, or little known, parasitism, the agents of which are Diptera or Lepidoptera. Fifteen insects are described which cause damage to cultivation in Geneva and French Switzerland. The most interesting are: *Ophionya pinguis* and *Phytomyza continua* on chicory, *Argyroploce antiquana* on the Japanese artichoke, *Evetria buoliana* on various pines, *Dioryctria abietella* on the Douglas pine, *Perrisia violæ* on the cultivated violet.

Leningrad.

Academy of Sciences, *Comptes Rendus*, 1931, No. 2.—**G. Nadson** and **G. Filippov**: The formation of new stable races of micro-organisms under the influence of X-rays. (3) Formation of races in *Sporobolomyces*. The authors describe the regularities in the process of the dissociation of cultures of *Sporobolomyces* with the formation of new races described in a previous paper. The action of X-rays may produce organisms more complex than the original. For example, *Sporobolomyces* may be obtained from *Torula*, or from *Cryptococcus*. Forms with atavistic characters can also be obtained.—**G. Nadson** and **E. A. Stern**: The action of the ultra-violet and X-rays on the yeast cell. Both kinds of rays produce similar changes in the yeast cells, but the action of ultra-violet rays is more rapid than that of X-rays. The exposure results at first in an excitation, then in a depression, degeneration, and death. The rays act on the cell itself, not through the changes in the medium.—**W. Tranzschel**: An æcidium of *Puccinia pygmæa* Erikss. on *Berberis*. *Puccinia pygmæa* parasitic on *Calamagrostis* proved to be able to produce æcidia on *Berberis*. Differences of these æcidia from those of *P. graminis* are described. It is probable that *P. baryi* and *P. gibberosa* also produce æcidia on *Berberis*.—**G. Vereschagin**: The influence of Lake Baikal on the summer thermic régime of the river Angara. Determination of the temperatures of water in Lake Baikal and the river Angara flowing from it.—**N. S. Smirnov**: Two new species of Rotatoria from the Ussuri region. Descriptions of *Lepadella rezvoji* sp. n., and *Testudinella tridentata* sp. n.—**S. Tchernov**: The identity of *Gymnodactylus microlepis* Lantz and *G. fedtschenkoi* Strauch. Differences between the two species do not exceed the limits of individual variability in *G. fedtschenkoi*.

Melbourne.

Royal Society of Victoria, June 11.—**Charles Oke**: The Aculagnathidæ, a new family of Coleoptera.—**W. J. Harris** and **R. A. Keble**: Victorian graptolite zones, with correlations and descriptions of new species. Gives history in research in Victorian graptolithology, details of twenty zonal associations and tabulation, and an attempted correlation of zones with those of the northern hemisphere. Photographic illustrations of zonal species and descriptions of new species of zonal and subzonal importance include the following: *Diplograptus austrodentatus*, *Phyllograptus nobilis*, *Goniograptus palmatus*, *Brachiograptus etaformis*, gen. et sp.nov., *Didymograptus forcipiformis* Rued, and *D. dependulus*.—**A. B. Edwards**: The geology and petrology of the Black Spur area (Healesville). A series of acid igneous lavas (rhyolite and dacite) are mapped and described in this area. The lavas are intrusive into Silurian sediments and are considered as of Upper Devonian age. They include four varieties of dacite, one of which, a new Victorian type, contains phenocrysts of quartz and hypersthene. The dacites are part of a series associated with rhyolite and granodiorite. An explanation is given of the pyrogenetic reactions by which biotite is formed from hypersthene and also from ilmenite.

Sydney.

Royal Society of New South Wales, July 1.—**C. A. Sussmilch**: The Bathurst Senkungsfeld: The district immediately surrounding the town of Bathurst commonly known as the Bathurst Plains has an undulating surface with a general elevation of about 2400 ft. It is surrounded on all sides by higher tablelands. The change in elevation from the Bathurst region to the high tablelands surrounding it is everywhere an abrupt one, the dividing line being a well-marked scarp. It is considered that the scarps are fault scarps, and that the lower Bathurst block is a *Senkungsfeld* or 'sunk-land'. The most striking of these scarps is that separating the Mt. Lambie tableland from the Bathurst area. This consists of two faults with a combined throw of about 1700 ft. It is not considered that this area actually subsided, but that during the uplift which produced the existing tablelands, the Bathurst district lagged behind and was not uplifted as high as the surrounding regions. The Bathurst Senkungsfeld is drained by the Macquarie River, which leaves this lower area at its north-west corner by an almost impassable gorge which traverses the Orange tableland; the differential uplift was sufficiently slow to have enabled the Macquarie River to keep pace in cutting down its channel in the more rapidly uplifted Orange tableland.

Vienna.

Academy of Sciences, July 9.—**E. Beutel** and **A. Kutzelnigg**: The deposition of sulphide films on metals.—**A. Kailin** and **H. C. Hardt**: The velocity of catalysed hydrogenation. Experiments were made with nickel precipitated on kieselgur as catalyst acting on the esters of cinnamic acid.—**A. Zeller**: Resistance experiments on red algæ. Mixtures of salts, isotonic with natural sea-water, but with one or more constituents missing, were used. The seaweeds were first immersed in the mixtures, then brought back into complete sea-water and the damage compared.—**K. Brunner**: New derivatives of 3·3-dimethylindolin.—**H. Schober**: The spectrum of rhenium. The arc spectrum in the visible region between λ5400 and λ8000.—**K. Graff**: The clearness of the winter sky during twilight on the island of Mallorca. **K. Graff**: Visual measurements of planetary colours. Various colours were met with from *B*7 (pure white) to *K*8 (red). Mars was one colour class redder, Uranus two classes bluer.—**E. Dittler** and **O. Kuhn**: The genesis of bauxite in the Upper Sann valley. Bauxite is the last residue on solution of andesite.—Eleven separate communications follow from the Experimental Biological Institute; director, H. Przibram. These concern the regeneration of limb-bones after operation on newts, and the regeneration of feet and antennæ after operation on locusts, etc.—(165). **L. Chen**: Regeneration of long bones after removal of one-third from within the limbs of the newt *Triton cristatus*.—(166) **L. Chen**: Regeneration after implanting of sixths of the femur of the salamander *S. maculosa* in the upper thigh of the newt *T. cristatus*.—(167) **J. Gebauer**: Autoplastic replacement of long bones in the limbs of *T. cristatus*.—(168) **H. Przibram**: Antenna and leg regeneration in the locust *E. herculeana*.—(169): Antenna and leg regeneration in the walking leaf insect *Phyllium siccifolium*.—(170): Antenna and leg regeneration in the European locust *Bacillus rossii*.—(171): Antenna and leg regeneration in the locust *Diapheromera femorata*.—(172): Antenna and leg regeneration in the locust *Dixippus morosus*.—(173) **H. Przibram and F. Friza**: Antenna and leg regeneration. Comparative inquiry on the position and rôle of Johnston's organ.—(174) **P. M. Suster**: Leg regeneration after extirpation of the ganglion in *Sphodromantis bioculata*.—(175) **P. M. Suster**: Antenna regeneration after extirpation of ganglion in *Sphodromantis bioculata*.—**P. Krüger and F. Furlinger**: Histology and chemistry of tetanus and tonus substratum. It is suspected that the chemical metabolism of striated and smooth muscles may be different. Experiments have been made with frogs and analyses made of the phosphate and glucose contents of the different muscles.—**F. Duspiva**: The physiology of the melanophores of fish embryos.—**E. Schally**: The observation of streaks in chemical studies. (4) *D*-streaks and allied phenomena. When various liquids of like refractive indexes are mixed, transitory double-shaded streaks appear, depending in some cases on different velocities of diffusion.—**F. Hölzl and W. Stockmair**: The mobility of some iron-containing ions. Experiments on conductivity of nitro-prussides.—**F. Palm**: Geometrical research on graphical tables for the solution of complete cubic equations.—**K. Strubecker**: Cubic relations among non-Euclidean screws.—**G. Stetter and R. Premm**: Radium Institute Communication (279). Attempts to register α-ray spectra of very weak intensity.—(280) **R. Premm**: Mass spectrum of the positive rays of thorium C.—(281) **F. Hecht**: Criticism of age determination by the lead method.—(282) **P. Krafft**: Absorption spectra of the *M*-series for the elements bismuth, lead, thallium, and gold.—(283) **M. Blau and E. Kara-Michailova**: The penetrating radiation of polonium.—(284) **M. Blau**: The fading of the latent image on exposure to α-particles.—**H. Burchardt**: Regulation of the secretory activity of the seminal vesicle. Experiments on guinea-pigs and rats. The epithelial cells of the mucous membrane vary in height and width. Under pressure of undischarged semen they return to the resting stage.

Official Publications Received.

BRITISH.

Cambridge Observatory. Annual Report of the Observatory Syndicate, 1930 May 19–1931 May 18. Pp. 3. (Cambridge.)

Live and Let Live: a Plea for the Preservation of Wild Life. Pp. 10. (Agra: Association for the Preservation of Game in the U P)

The University of Leeds Report on the Department of Mining, Sessions 1928–30. Pp. 14. (Leeds.)

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1930. Pp. 44. (Entebbe. Government Printer)

FOREIGN.

Proceedings of the American Philosophical Society. Vol 70, No. 2. Pp 103-213. (Philadelphia.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol 7, No. 1, R.P. Nos. 329-338 Pp. 213. (Washington, D C.: Government Printing Office)

Journal of the Federated Malay States Museums. Vol. 16, Parts 3 and 4, July Pp. 175-506. (Kuala Lumpur.)

Malayan Forest Records. No 9: Growth of Malayan Forest Trees, as shown by Sample Plot Records, 1915–1928. By J. P Edwards. Pp. ii+151. (Kuala Lumpur: Director of Forestry.) 2 dollars; 4*s*. 6*d*.

Collection des travaux chimiques de Tchécoslovaquie. Rédigee et publiée par E. Votoček et J. Heyrovský. Annee 3, No 7, Juillet. Pp. 333-378. (Prague: Regia Societas Scientiarum Bohemica.)

Diary of Societies.

FRIDAY, SEPTEMBER 11.

INSTITUTE OF MARINE ENGINEERS. (As NATURE, Sept. 5.)

TUESDAY, SEPTEMBER 15.

LONDON NATURAL HISTORY SOCIETY (at London School of Hygiene and Tropical Medicine), at 6 30.—J E S. Dallas: Peasant Life in Alpine Districts.

WEDNESDAY, SEPTEMBER 16.

ROYAL AERONAUTICAL SOCIETY (at Science Museum, South Kensington), at 9.15 P M.—Glenn Martin. The Development of Aircraft Manufacture (Wilbur Wright Memorial Lecture).

FRIDAY, SEPTEMBER 18.

FARADAY SOCIETY (at Chemical Society), at 5 30.—Prof. W. J. Muller: The Passivity of Metals.

CONGRESSES.

SEPTEMBER 1 TO 19.

INTERNATIONAL ILLUMINATION CONGRESS. (For Programme see NATURE, Aug. 29)

SEPTEMBER 6 TO 12.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS. (For Programme see NATURE, Sept. 5.)

SEPTEMBER 9 TO 12.

INTERNATIONAL PROFESSIONAL ASSOCIATION OF MEDICAL PRACTITIONERS (at Budapest).

SEPTEMBER 13 TO 18

INSTITUTE OF METALS (For Programme see NATURE, Sept 5)

SEPTEMBER 13 TO 19.

INTERNATIONAL MEDICAL EDUCATIONAL CONGRESS (with special reference to Balneology) (at Carlsbad).

SEPTEMBER 16 TO 24.

INTERNATIONAL GEOGRAPHICAL UNION (at Paris).

SEPTEMBER 18 TO 20.

NATIONAL SMOKE ABATEMENT SOCIETY.

Saturday, Sept. 19, at 11 A.M.—R. Blackmore: The Progress of the Electrical Grid.
At 12 noon.—R. E. Gibson: Some Notes on the Production and Use of the New Smokeless Fuel 'Dryco' in Liverpool.

Sunday, Sept 20, at 11 A.M.—Regional and Statutory Smoke Abatement Committees.
Councillor W. Asbury: The Sheffield, Rotherham and District Smoke Abatement Committee.
Dr. J. Johnston Jervis: The West Riding of Yorkshire Regional Smoke Abatement Committee.
Dr. J. Bennett: The Manchester and District Regional Smoke Abatement Committee.
The Greater London Joint Smoke Abatement Committee.
The Midlands Joint Advisory Council for Smoke Abatement.

SEPTEMBER 18 TO 21.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Lady Margaret Hall, Oxford).

Friday, Sept. 18—H. T. Tizard: Presidential Address.
Prof. A. M. Carr-Saunders: Some Problems of Professionalism.

Saturday, Sept. 19.—E. N. Simons: How the Manufacturer can Help the Librarian.
B M. Headicar: Practical Methods of Arrangement, Indexing and Routine in the Business Library and Information Bureau
Col. Sir Frederic Nathan: International Abstracting and Indexing.
Dr. Albert Predeek: An Ever-Ready Printed Catalogue.
Annual General Meeting.
F. A. Hoare: Films as a Medium of Information in Education, Science and Industry.

Sunday Sept. 20.—Sir Francis Goodenough: The Report of the Board of Education Committee on Education for Salesmanship.
C. A. Macartney: The Publications of the I L O and the League of Nations
Miss Margaret E. Cleeve: The Library and Information Department of the Royal Institute of International Affairs.
J. P. Maxton: The Sources of Information in Agricultural Economics.
G. A. A. de Voogd. Documentation in Business Organisation.
Dr. E. Shenkman: The Russian Five-Year Plan in its special relation to British Industry and Commerce.

SEPTEMBER 23 TO 26.

INTERNATIONAL CLIMATOLOGICAL COMMISSION (at Innsbruck).

SATURDAY, SEPTEMBER 19, 1931.

CONTENTS.

PAGE
Nationalism and Science in China 469
The Schneider Trophy Contest 471
A Plea for Prejudice. By J. A. T. 473
Short Reviews 475
Rumford and the Royal Institution: A Retrospect. By T. E. James 476
Faraday's London Friends. By H. G. Wayling . 482
The British Association Centenary Meeting . . 483
International Union of Physics, Brussels Meeting, 1931 485
Obituary:
  Sir Thomas Stanton, C.B.E., F.R.S. . . . 485
  Dr. L. W. Sambon. By A. J. Engel Terzi and S. Maulik 486
News and Views 487
Letters to the Editor:
  A Focusing Method for Producing Electron Diffraction Patterns.—Dr. A. A. Lebedeff . 491
  Acromegaly in the Far North.—Dr. Michael Perkins; Prof. C. G. Seligman, F.R.S. . . 491
  An Oxidisable 'Active Nitrogen'.—Dr. E. J. B. Willey and S. G. Foord 493
  Cytology of *Anchusa* and its Relation to the Taxonomy of the Genus.—S. G. Smith . . 493
  Thrips tabaci as a Vector of Plant Virus Disease.—Geoffrey Samuel and J. G. Bald . . . 494
  Lines of Large Frequency Shift in the Raman Spectra of Crystals.—Prof. R. Tomaschek . 495
  The Fine Structure of Spectral Lines of Light Scattered by Liquids.—St. Rafalowski . . 495
  Vitamin A and the Antimony Chloride Reaction.—E. Emmerie, M. v. Eekelen and Prof. L. K. Wolff 495
  Effect of Light on the Surface Tension of Boys's Soap Solutions.—Prof. L. D. Mahajan . . 496
  Inheritance of Melanism in Moths.—A. W. McKenny Hughes 496
  The Structure of the Spectrum Se III.—J. S. Badami and Dr. K. R. Rao 496
  Group-Capt. Martin Flack.—Sir Leonard Hill, F.R.S. 496
  Radioactivity and Earth Movements.—Prof. Arthur Holmes 496
Research Items 497
Science and Curative Medicine 499
Activity Coefficients and the Debye-Hückel Equation 499
Archæology and Surveying in Southern Rhodesia . 500
Exhibition of British Optical Instruments . . . 500
Evolutionary Tendencies in the Jaws and Teeth . 501
University and Educational Intelligence . . . 501
Birthdays and Research Centres 502
Societies and Academies 502
Official Publications Received 504
Diary of Societies 504

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Nationalism and Science in China.

After spending half a million dollars over a period of ten years and the dispatch of five scientific expeditions to the Gobi Desert, the Central Asiatic Expedition of the American Museum of Natural History, of which Dr. Roy Chapman Andrews is the leader, has been refused permission to continue its work in Mongolia by the Chinese authorities. This refusal comes at a moment peculiarly inopportune in the interests of science. The expedition was about to open up a new field of exploration, which would have been of the greatest palæontological and, possibly, of anthropological interest.

Up to 1928 this American expedition had been in most friendly and cordial relation with the Chinese authorities, scientific organisations and individual investigators. Indeed, for some considerable time a proposal to establish a branch of the American Museum at Peking had been under consideration, and one of the palace buildings had even been selected for the purpose by Dr. Kungpa King, director of the Peiping Museum of Art. But in 1928 these friendly relations came to an end, largely owing to the activities of the Chinese Cultural Society, now the Commission, for the Preservation of Antiquities. The entire collection of fossils and other specimens made by the expedition in 1928 was seized by the Commission and released only after prolonged and tedious negotiation. Permission to revisit Mongolia in 1929 was refused, and resumption of work was allowed in 1930 only on the understanding that the work of the expedition would then be brought to a close. Results obtained in that year, however, seemed to justify reconsideration. Entirely new fossil fields of Pliocene age were discovered east of the Kalgan-Urga Trail. In consequence, application was made for a renewal of the permit in order to follow up this new and important discovery in 1931 and 1932.

In a letter under date June 5 last, the Commission for the Preservation of Antiquities has informed the authorities of the American Museum of Natural History that there is no longer any necessity for permitting members of the Museum to make further trips to carry on the work in Mongolia. It adds, however, that in the future every facility will be accorded American scholars to visit Peking for the purpose of examining geological material from Mongolia "to conform with the principles of non-discrimination between nationalities in respect of science". The grounds for the statement that the necessity for the permit hitherto granted no longer exists, are given in the course of this communication. In addition to the fact that the American expedition has repeatedly declared its intention of winding up its work in Mongolia and discontinuing its trips to that area, the Chinese Government, it is stated, has now organised a Western Frontier Scientific Expedition to proceed to Mongolia, Kansu and Sinkiang " to carry on various scientific researches".

There is a subtle irony in the phrasing " principles of non-discrimination between nationalities in respect of science " which will be appreciated. The achievement of the Chinese authorities in the direction of the attainment of this object merits recapitulation. Action similar to that against the American expedition has been taken against the Swedish expedition in Chinese Turkestan under Dr. Sven Hedin; against the French Trans-Asiatic expedition of Dr. Georges Hardt and P. Teilhard de Chardin; and Sir Aurel Stein, as has been recorded recently in these columns (see NATURE, July 25, p. 144), has been forced to abandon his expedition in Chinese Turkestan after repeated vexatious delays and difficulties raised upon pretexts entirely without foundation. It is sufficiently clear that the Chinese authorities are sincere in the expression of their desire to show no discrimination between nationalities. They propose to exclude them all!

Vigorous, if misleading, not to say untruthful, propaganda by the Commission in the Chinese press has secured popular support for this hostility to foreign expeditions of scientific exploration. It must not, therefore, be concluded that the interest of the Chinese people in drawing a ring-fence around the field of research within their territory, or in the preservation of their antiquities, is greater than it would be in a western population. The agitation has gone beyond the indictment that these scientific expeditions are taking priceless material out of China; it has not hesitated to inflame popular opinion by imputing political motives to them, and accuses their leaders, Sir Aurel Stein, for example, of subversive speeches against the Chinese Government.

A brief survey of the present situation, which Prof. H. Fairfield Osborn, president of the American Museum of Natural History, contributes to *Science* of August 7, gives the text of the letter received from the Commission for the Preservation of Antiquities, and includes in addition a communication by Dr. Roy Chapman Andrews, in which he sets forth the scope, methods and achievements of the expedition in geology, palæontology and archæology since its inception in 1920. It is a remarkable record, and although already sufficiently well known, it was well worth recapitulation in this context. Between the years 1922 and 1930, it has discovered and developed one of the world's great fossil fields with no less than twelve distinct fauna—Lower Cretaceous to Pleistocene. In addition to the dinosaur's eggs, which attained what was, perhaps, in the circumstances, an unenviable notoriety, and the remarkable series of skulls of the animals which laid the eggs, cretaceous mammal skulls and associated parts of skeletons were found which are the only mesozoic skulls known, with the exception of *Tritylodon* from South Africa. It is unnecessary to pursue further this list which, on one hand, is an almost unique record in the sum total of data new to palæontological science, and, on the other, is a monument to the scientific knowledge, organising ability and powers of endurance of those who were responsible for and took part in the expedition. But what will weigh even more with those interested in the branches of research with which the expedition is concerned, when they reflect on the consequences of this premature ending of its activities, is that it is in this field, if anywhere, that we are, perhaps, most justified in looking for further evidence bearing on the descent and earliest history of man—the main objective of the expedition when it was initiated eleven years ago. No Chinese expedition, however expertly manned and however well-equipped when it takes the field, will compensate for the loss of the experience gained in those five journeys of the American scientific workers to Mongolia.

The claims for consideration of the Central Asiatic Expedition on the ground of achievement are strong. But are they stronger than those of Sir Aurel Stein, Sven Hedin, P. Teilhard de Chardin and others to whom in future China will be closed as a field of exploration? Like the American expedition they have co-operated, or have offered to co-operate, with Chinese scientific organisations and individuals, each in their special field. China has gained, not lost, by the work of these great explorers. By their additions to the sum of human knowledge, she has transcended the bounds of nationality and has entered into the universal realm of science. While men of science of all countries have been looking to China for evidence bearing upon problems of world-wide import, her own horizons have been broadened and her students trained. In other circumstances the organisation of a Chinese expedition to Mongolia might have been welcomed as a valuable and progressive measure in the interests of scientific research without any thought as to whether it was an encroachment on a field in which America had secured a right.

Notwithstanding the difficulties of the present political situation, China has won, and continues to hold the sympathies of influential elements in the western world for her desire to assimilate what is most suited to her needs in western culture, and to join in the movement for the advancement of science. Is she by her own action to be placed, as Prof. Osborn has phrased it, in "the column of backward, reactionary and non-progressive nations"?

The Schneider Trophy Contest.

THE eleventh contest for this trophy for marine aircraft was arranged to take place on Sept. 12 at 12.30 P.M., over a triangular course above the Solent and Spithead off the Isle of Wight. Owing to the last-minute withdrawal of the French and Italian challengers, the event resolved itself into a mere flight around the 350 kilometres (217·5 land miles) course by one of the British entrants in order to qualify. The flight was completed on Sept. 13 by Flight-Lieut. Boothman, R.A.F., flying a Supermarine S6B. seaplane, fitted with a Rolls-Royce R engine, at an average speed of 340·08 miles per hour. During the flight he also broke the world's speed record over a measured distance of 100 km. with flying start, at 342·9 m.p.h. The trophy, having now been won by Great Britain on three consecutive occasions, becomes our property, and the Schneider Trophy competition thus ceases to exist.

It has been felt in many quarters that it would have been an act of sportsmanship on our part to have postponed the competition until such time as the French and Italian competitors were ready to race, but it must be remembered that there is much more in this event than the actual race. It is really a competition amongst designers to produce machines capable of flying at speeds greater than those already attained, and engines able to give the necessary power for a sufficient time to complete the distance. The actual flying of the race, with its demand upon the courage, skill, and physical endurance of the pilots, is really only the grand culmination of the whole scheme. The French and Italians were, presumably, confident of being able to do this when they took the initiative in challenging Great Britain. It is known that they have built machines and trained teams to manipulate them, so that their withdrawal at the last moment can only be construed as an admission that the performance of their products falls so far behind what they suspected of ours that actual participation in the race was merely a waste of effort.

It is also becoming increasingly evident that the regulations governing this competition, which were intended, when laid down, to promote a general advance in the design of a useful sea-going aircraft, are no longer adequate to guard against the competition being won by a freak machine of very little use except for that specific purpose. The closing of this chapter in seaplane development will consequently make an opportunity for some public-spirited person or body to offer a fresh trophy under rules more suited to modern requirements. Newspaper reports have already hinted at the name of M. Schneider's successor.

The figures of the speeds of the winners of the succeeding races give an interesting clue to the phases of development through which the design of aircraft and engines has passed since the inception of this competition:

Year.	Machine.	Country.	Average Speed (m p.h.)
1913 . .	Deperdussin	France	45·75
1914 . .	Sopwith	Gt. Britain	86·75
1920 . .	Savoia	Italy	107·12
1921 . .	Macchi	,,	110·84
1922 . .	Supermarine	Gt. Britain	145·62
1923 . .	Curtiss	U.S.A.	177·38
1925 . .	,,	,,	232·57
1926 . .	Macchi	Italy	246·49
1927 . .	Supermarine	Gt. Britain	281·65
1929 . .	,,	,,	328 63
1931 . .	,,	,,	340·08

The speed of 45·75 m.p.h. in 1913 is misleading, as the pilot did not cross the finishing line correctly, and had to complete another lap. His real flying speed was in the neighbourhood of 70 m.p.h. Thus from 1913 to 1914 there was a small improvement, consequent partially upon improvement in design, but more upon experience in handling machines under racing conditions. The period 1914–20 does not show any great improvement in proportion to the time that elapsed, but it must be remembered that the seaplane was relatively neglected during the War period, the energies of combatants being directed to the improvement of land machines, operating under much different conditions. The step 1920–21 marks a distinct improvement in aerodynamic design of the seaplane, which, although only 3·72 m.p.h. faster, carried only a 200 h.p. engine, as compared with the 550 h.p. of its predecessor. In 1922 the Supermarine flying boat increased the speed considerably, but with a large increase of power, having a 450 h.p. engine. The 1923 Curtiss seaplane marked a decided change in the aerodynamical outlook. It was the first of the post-War competitions in which a seaplane had been used in preference to a flying boat. Previous opinion had held that while a seaplane could be built with finer lines and less head resistance, it could not be made seaworthy enough. Later experience has proved this to be wrong, and all winners since 1923 have been seaplanes. This machine also showed a decided attempt to deal with the problem of reducing the head resistance of the exterior non-lifting parts, such as the floats, engine radiators, etc. Attention to these details resulted in an increase of speed from 145·62 to 177·38 m.p.h. with only 15 h.p. additional.

Having realised the importance of reducing head resistance by good streamlining and limiting frontal area to the minimum possible, the competition then resolved itself into a battle of the engine designers to give more power from an engine without unduly increasing, primarily the frontal area, and secondarily the weight, either of itself, its accessories, or its fuel and oil. Their success can be judged by the fact that in the next five competitions, 1925–31, the horse-powers were 600, 800, 875, 1900, and well over 2000 respectively. In the case of the last two competitions there was actually not only a decrease in frontal area of the engine, but also its shape was modified to conform to the requirements of good streamlining of the nose of the machine in which it was installed.

At the same time, improvements in the actual aircraft have been continuous, although not so radical. The dispersing of the excess heat from the engine-cooling water has been one of the principal problems, and on the 1931 machine practically the whole of the wings, the tops of the floats, and the sides of the body are covered with a thin annular shell through which the engine-cooling liquid passes, giving a maximum surface exposed to the air without any extra head resistance. The cooling of the engine oil is carried out in a similar manner. A further problem to be surmounted this year arose from the fact that the take-off, climbing, alighting, and taxying test have been arranged so that they are preliminary to, and continuous with, the actual speed flight, instead of being carried out separately as in previous years. This means that more petrol has to be allowed for, which affects both the size of the tanks and that of the stronger structural members necessary to carry the extra weight.

It should be useful now to examine critically what has been attained as the result of the eighteen years' development of this type of marine craft, and to endeavour to profit by these conclusions in framing rules for a new competition. It is quite certain that such machines as are being used to-day are useless in themselves for any other purpose. There are certainly advantages in the fact that national prestige and that of individual firms is increased, and doubtless many engineering lessons have been learned in the course of these experiments that will help to improve the breed of British aircraft, but M. Jacques Schneider's original idea of developing useful sea-going aircraft has been almost entirely submerged in the mere race for speed.

Flying at 400 m.p.h. in the present form of aircraft is much too unsafe to be used as an ordinary means of transport. Such machines are uncontrollable at all speeds lower than about 100 m.p.h., which makes it impossible even to fly them, let alone land or get off in crowded places, or on any but relatively smooth water. Also, the accelerations when turning at these speeds would certainly be distressing, and possibly dangerous, to passengers not physically trained to them. High maximum speed is certainly desirable in order that air travel may exploit it as the advantage that it has over all other means of transport, but it must be accompanied by a more elastic speed range, giving lower minimum speeds and slower accelerations within that range. Another matter in the exploitation of speed is that in order to save time a machine should fly in a straight line from point to point. A really useful seaplane should, therefore, be amphibian in its alighting and getting-off methods, at least for emergency landings.

The question of carrying a useful load has also been entirely lost to sight. The present-day type has practically developed into an engine with wings fitted to it, the body being cut down to the very minimum required to accommodate the unfortunate but necessary pilot. Even if the machine is capable of lifting any surplus load, it certainly has no accommodation for it, because of the desire to keep down frontal area and its accompanying head resistance. It is significant to compare such machines with modern passenger-carrying flying boats, which in spite of the fact that they have been just as keenly developed, by sometimes the same designers, have not progressed far beyond 100 m.p.h. yet in average cruising speeds.

Lastly, there is the question of robustness and its inevitable accompaniment—useful life. No one who has seen and handled, and admittedly been compelled to admire, a modern racing seaplane can contemplate its being used under the rough and tumble of everyday traffic. The working life of the engine on such machines is probably no more than a few hours, even in the hands of the most highly skilled mechanics that the engine-maker can train.

The conclusion that one is inevitably led to is that if such contests of the future are to be national in character, as they have tended to be recently, the energies of the participants should be directed towards producing machines of some use to the world in general. The race for mere speed and record beating is always desirable because of the moral stimulus resulting from any form of competition, but it should be left to the wealthy amateur or commercial enterprise that has direct interests in it, as is done in most other walks of life.

A Plea for Prejudice.

The Place of Prejudice in Modern Civilization (Prejudice and Politics): being the Substance of a Rectorial Address to the Students of Aberdeen University. By Sir Arthur Keith. Pp. 54. (London: Williams and Norgate, Ltd., 1931.) 2*s.* 6*d.* net.

THE gist of Sir Arthur Keith's rectorial address at Aberdeen is expressed in its concluding sentence: "Under the control of reason, prejudice has to be given a place in the regulation of human affairs". If we understand what the distinguished author means by 'prejudice', his thesis is so reasonable that we must begin by lifting our hands to heaven for the publication of the address in its entirety. For by the perusal of isolated extracts we had been regretfully led, like many others, to dissociate ourselves in private thought and conversation from the rector's position, whereas after reading the whole we wish we had given the address ourselves—it is so well put. Moreover, in its insistence on the value of feeling, the address is a useful counteractive to the partiality or abstractness of science.

Perhaps the most delightful thing is that this plea for prejudice should come from Keith, whom we, being backsliders, have always regarded with admiration as one of the staunchest champions of reason. Drive out Nature with the fork of logic, and she is sure to come home to roost. Thus Keith, of all men, pleads for prejudice!

Everything depends, however, on what the word is taken to mean, and the author leaves us in no dubiety. How charmingly he puts it: "In the parliament of human nature, as in that of our national affairs, there are two houses—an upper, the 'head'; a lower, the 'heart'. . . . The legislators who serve in the lower house or heart are our feelings and passions, our hopes and fears, our likes and dislikes [at home, by the way, in the lower or basal centres of the brain]. . . . The progress of civilization has been possible just because man has been able to bring his lower house or heart more and more under the control of his upper house or head," that is to say, his reason, his logical faculty, his power of conceptual inference or of experimenting with general ideas (which is at home in the cerebral cortex, as who should say). We understand, then, that our prejudices are our inborn likes and dislikes, and the rector's thesis is that they must be given an assigned place in our thought and action.

Among 'prejudices' Sir Arthur Keith includes our loyalty to our Alma Mater and our love for our mother, our national and local patriotism, our pride of race, and so much more that the word becomes synonymous with our deeply enregistered inborn feelings. Whether we call them, with Thomas Reid, "original and natural judgments", or regard them with modern psychologists as part of the primary unconscious, matters little. There they are, activating and motivating us, colouring our thought and action, undeniable realities. "They turn favoured opinions into facts. A fact to the faithful is a prejudice to the sceptic. . . . Prejudices and sentiment are first cousins." Just as Carlyle, speaking of man, said "Prejudice, which he pretends to hate, is his absolute law-giver", so Keith in his enthusiasm for prejudice declares, with all his anthropological learning behind him, that "man has become what he is, not by virtue of his head, but because of his heart". Inevitably one shakes one's head, for who shall escape his prejudices in favour of that member?

This brings us to the second part of the rector's argument. Prejudices form a powerful part of our inheritance, grafted into us because they have been of survival value, or, in the author's teleological language, because of their "evolutionary purpose". "Nature has organised the lower house of man's heart to serve her ulterior object—the production of higher and better races of mankind." This almost verges on the theological—not that we think the worse of it for that!

But however we phrase it, part of Nature's tactics or part of the process of human evolution was the segregation of new varieties or sub-species into distinct tribes (possibly hormonic in origin), and in addition to selection there has operated the factor of isolation—a term applied to all the ways of narrowing the range of intercrossing. Seas and rivers, mountains and deserts, and the like, were useful in this isolating, but Nature "established her real and most effective barriers in the human heart". Automatically those tribes survived that had the strongest prejudices in favour of keeping themselves to themselves in their marriages, the strongest antagonisms to other tribes—the ‘ race-prejudices ’ of to-day ; and not less powerful than these was that “ strange bubble of the human blood —the inbred love of independence ”. “ Nature made sure of her tribal teams by making this love of independence a dominant passion ”, whence the world-wide success of the Scot.

So far the rector’s argument seems unassailable, except that, for more or less legitimate rhetorical (in the true sense) purposes, he uses the term ‘ prejudices ’ in a very wide way. We are full of ancient prejudices, which have powerful hands and feet, and some of them were of survival value in the establishment of tribes in prehistoric times, “ standing to our historic period as a year does to a day ”.

Now, however, comes the crux of the argument : Prejudices were once of racial value, but is it not time that we subjected them to criticism and sifting, repression or sublimation ? No doubt, the deep inborn feelings are still in some measure part of our heritage—“ a tribesman’s heart, with its loves and hates, its likes and dislikes, its heritage of prejudices, still beats in every human breast”. But is our primary unconscious exempt from evolution? Does our ‘ tribesman’s heart ’ live a charmed life in the arcana of the changeful germ-plasm ? Are we not always summoning our primeval prejudices before the tribunals of reason and of socially-acquired sentiments ? May we not safely relegate a good many of them to a rationalised shelf in that museum of relics which willy-nilly we carry about with us, embodied or enminded ?

Now, Sir Arthur Keith’s convinced answer is that we should hold by our prejudices. “ Race prejudice, I believe, works for the ultimate good of mankind and must be given a recognised place in all our efforts to obtain natural justice for the world.” The ideal of all mankind sleeping peacefully under one tribal blanket is, he says, Utopian ; and even if it were possible, it would cost too much in the involved miscegenation. The price of universal peace is the loss of our racial birthright. On the other hand, the price of racialism is said to be the continuation of “ Nature’s old scheme of intertribal rivalries and eternal competition ”. So the two prices have to be weighed against one another. In spite of Sir Arthur Keith’s heart (‘ the future of my dreams is a warless world ’), his head wrings from him the conclusion that “ Nature keeps her human orchard healthy by pruning ; war is her pruning-hook. We cannot dispense with her services”. But there is a wide difference between Nature’s discriminate sifting (natural selection) and the very indiscriminate and dysgenic thinning which man illustrates in modern warfare. It is a woeful confession of human ineptitude if we cannot find for natural selection, which civilization insists on rejecting, any better substitute than modern war. The rector says that if we accept Nature at all, we have to accept her altogether. But this is just what we do not do. To use his attractive teleological language, one of Nature’s ends is just to make man discontented with following her, and it is that ‘ divine discontent ’ which man expresses in every effort to raise the struggle for existence into an endeavour after well-being.

In an admirable way, Sir Arthur Keith weighs racialism against deracialisation, self-determination against leagueism, nationalism against mongrelising, using the ‘ head ’ most deftly to give the ‘ heart ’ a hoist up ; and we can find little to object to in his practical conclusion : “ Give our prejudices a place in our civilization, but keep them under the control of reason ”. In other words, we should be impelled by our ‘ head ’ to scrutinise our ‘ heart ’ from time to time, giving some of its prejudices a pat on the back and subjecting others to a Lenten discipline.

We venture to lay emphasis on Sir Arthur Keith’s conclusion, which we might sum up in the words “ pay heed to reasonable prejudices ”, for we must in all these discussions of high affairs avoid the “ this or that ” fallacy. We cannot divest ourselves, for example, of our national prejudice, and there is no reason to try to do so, unless it becomes insular and chauvinistic. At the same time it is becoming increasingly possible to think sympathetically and understandingly of other nations and their interests, and to begin at least to look at all human problems in the light of the growing interdependence of the peoples of the world. We need not think of our country less though we think of the world more. We may preserve and even strengthen our appreciation of what is precious in nationality, and yet become, though not with ease, loyal citizens of the world. We do not agree with the distinguished rector that this culture of our tribal heart would necessarily involve us in any “ pooling of our blood ”.

Similarly, while it is our deepest personal conviction that human progress at this critical time depends upon bringing strict science to bear on all our practical problems, we are not thereby forced to depreciate the worth of certain elements in our primary unconscious or of the higher values which lie for the most part beyond scientific inquiry. Science is not the only right-of-way towards truth.

We cannot leave this thought-compelling address without expressing our admiration of its fine style, as picturesque as it is pithy, as lucid as it is lightsome. It must have been delightful to listen to, especially in a place where the *genius loci* has such a notably hard head. This is said "without prejudice".

An advocate cannot speak on two sides at once, but when a similar occasion arises, as it will, we hope Sir Arthur will take for his subject the pruning of prejudices; for we are sure that he could deal with that supplementary subject with the same convincing illumination that his present plea illustrates. J. A. T.

Short Reviews.

Deserts and the Birth of Civilizations. By A. J. McInerny. Pp. 46. (Paris: Herbert Clarke, 1931.)

MR. MCINERNY attacks an old problem at a new angle. Like others before him, he would see the influence of the desert in the origin and growth of civilisation. He differs from them in making it solely responsible. In fact, the motto of his essay is "No desert, no civilisation"; and he goes so far as to suggest that any attempt to cultivate desert lands by irrigation at the present day would be a mistake and a possible danger. While it is beyond question that the formation of the great Saharan Desert was crucial in the early history of mankind, few archæologists would be prepared to follow the author in attributing the whole subsequent development of civilisation to the action of the desert areas. In Mr. McInerny's view, they have acted as laboratories for the purification of the air and the release of ozone, thus creating an atmosphere propitious to the development of intelligence and the bleaching of the skin—in short, producing the white man.

Mr. McInerny points to the fact that, with certain exceptions, the great civilisations of the past lie to the north of a series of desert belts, and argues from this that it is not to migrations or to temperature that we are to look for the cause of advance in culture, but in the flow of purified air from the desert zones towards the north. The similar flow towards the south, to the negro or dark belt, could only mitigate, but not eradicate, the more unfavourable conditions of the damp atmosphere, laden with organic impurities, of the tropical forested area. Mr. McInerny is not very successful in explaining away the exceptions in the civilisation of the Yangtse valley and that of Central and South America, where the deserts lie to the north; and if migration is eliminated, the air currents of western Europe seem to be a difficulty. In fact, the author tries to prove too much. Had he endeavoured to show that the character of the atmosphere was one of a number of factors in the problem, he would have had a better chance of carrying conviction.

Hunger and Love. By Lionel Britton. Pp. xi + 705. (London and New York: G. P. Putnam's Sons, Ltd., 1931.) 7*s.* 6*d.* net.

LIONEL BRITTON first became known to the reading public as the author of "Brain, a Play of the Whole Earth", sponsored by Bernard Shaw, praised by Hannen Swaffer, and proclaimed a work of genius by St. John Ervine. His new novel has an introduction by Bertrand Russell. One therefore approaches it with high expectations. It is not customary to review novels in this column. After reading the book, the reviewer is not convinced that its contents justify any departure from the usual practice of NATURE. True, there are frequent, almost too frequent, references to protons and protoplasm. These in themselves are not sufficient to justify the claim that the author has written the novel of the machine age. It is a long soliloquy, in which the hazy outline of Arthur Phelps occasionally obtrudes to remind the reader that it is intended to rank as fiction rather than philosophy.

It took Lionel Britton eight years to write the book: the reviewer took six months to read it. Only the prospect of having to write a short notice of its contents sustained him to the end. Britton says a good many penetrating things about contemporary civilisation. The reviewer shares many of his prejudices and most of his opinions, when they are not susceptible of proof. Unfortunately, his way of stating them is prosy, prolix, and disorderly. People who like *Ulysses* may like "Hunger and Love". Scientific workers, who generally attach importance to intellectual tidiness and coherent expression, will be inevitably repelled. Of the few who start it, still fewer will finish its seven hundred and five closely printed pages. It has captured the temper of contemporary biological realism far less successfully than Charlotte Haldane's "Brother to Bert" or the earlier novels of Mr. Wells.

An Introduction to Human Experimental Physiology. By Dr. F. W. Lamb. Pp. xii + 335. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.) 12*s.* 6*d.*

THERE can be no question that the best study of man is upon man himself, but the arrangement of organised experiments for class work on this principle presents many difficulties. Dr. Lamb, as the result of ten years' trial, has succeeded in compiling a workable course of about fifteen lessons on each of the three systems—blood, respiration, and circulation.

Not only will this scheme of investigation of normal man serve as a most desirable preparation of medical students for work in the wards, but also the selection and presentation of the experiments prescribed will satisfy the demands of scientific education. In schools where the classical physiology occupies the preliminary years, this book might well form the basis of a course in clinical physiology during the period given to the study of medicine.

Rumford and the Royal Institution: A Retrospect.

By T. E. JAMES.

BENJAMIN THOMPSON, knighted by George III., and created Count von Rumford by the Elector Palatine of Bavaria as a reward for his services, was born at North Woburn, Massachusetts, on March 26, 1753, and he died at Auteuil, near Paris (where he had settled), on Aug. 21, 1814, aged sixty-one years. His career in early youth was a response, as in many other instances in a new colony, to the varied and often lowly occupations near at hand. For a time he was in the medical faculty at Harvard, and he also engaged in schoolmastering. No one could have foretold that he stood on the threshold of events from which emerged, as if preordained, the governing factors of his life. A matrimonial venture at twenty soon ended in convenient separation. There was a child of the union.

FIG. 1.—Count von Rumford, F.R.S. From the painting after Moritz Kellerhoven, in the National Portrait Gallery, London.

Thompson was a major of New Hampshire militia when the American War of Independence broke out, but he became suspect as one showing 'unfriendliness to the cause of liberty'. Removing to Boston (or shall we say escaping ?), he was arraigned there; finally he cleared himself of the charges against him. In 1776 Boston was evacuated and Thompson's selection to carry the news to England confirmed his allegiance to the mother-country. In favour here, he occupied a post in the Colonial Office, becoming afterwards an under-secretary (1780), charged with military duties relating to the British forces. Next, he appeared in service in America as a lieutenant-colonel in George III.'s American Dragoons. Returning to England in 1783 (then thirty years of age), he retired on half pay, with the rank of colonel.

So far, vicissitudes had had triumphant and material issues. Thompson's record as an experimental philosopher begins during these latter periods. It forms a chapter by itself, too diverse for inclusion here. However strange it may seem, he had been familiar with the discoveries and implications of contemporary science. They did not attract him as diversions, but met natural promptings. In 1779 he was elected a fellow of the Royal Society and in 1792 he received the Copley Medal. Later (1799), he was a member of Council of the Society.

In 1784, Sir Benjamin Thompson, newly knighted, entered on a completely novel mode of life. The Elector Charles Theodore of Bavaria pressingly solicited his services at Munich to initiate schemes in mitigation of social and economic disorders in his dominions. Leave of George III. having been obtained, our soldier-philosopher set forth, actually remaining at Munich for ten to eleven years—the keystone of the arch of progress being military persuasion, to use a mild word, in co-operation with civil authority. Suffice that, as an apostle of order, he routed chaos. Meantime his philosophical studies were pursued, coupled with a vast output of political and economic writings. The following unpublished letter (in holograph *) will, perhaps, be of interest, as indicating two kinds of leanings:

MUNICH, 10*th May*, 1797.

Gentlemen, I send you herewith my Seventh Essay,† which I shall be glad to see published as soon as possible. You will send me 12 copies of it (through Mr. James Meyer of Leaden-hall Street) as soon as it is out of the press. You will please to send me at the same time—or rather immediately on the receipt of this letter—a collection of all the Pamphlets that have been published on the subject of Mr. Pitt's Bill for making better provision for the Poor. You will direct Mr. Meyer to order his Correspondent at Flamborough to forward these articles to me *immediately* by the Diligence, addressed to myself at Munich.

I have hitherto been prevented from sending you my Essay on the "Construction of Kitchen fire-places" by an earnest desire to make that Publication as perfect as possible. I have hopes however of being able to forward it to you in a few weeks.

I am, with much Regard and Esteem,
Gentlemen,
Yours most sincerely,
RUMFORD.

Messrs. Cadel, jun^{r}. & Davies,
London.

P.S.—You will please to make presents in my name of the *Seventh* Essay to all those to whom I requested Presents might be made of my *Sixth*.

Before returning from Bavaria it was sought to make Count von Rumford a Minister at the English Court, representing Bavaria. Rejection was emphatic. He was a British-born subject. Thereupon the Count resumed residence in London as a private citizen. The rebuff had unsettling elements; he entertained the idea of a domicile in America, but gave it up, and certainly there were difficulties, for he had incurred legal disabilities. In the end, America saw him no more, although his fame had crossed the ocean, and had received ample recognition.

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* Archives, Patent Office Library. By courtesy of the Librarian.

† Essay VII, "Of the Propagation of Heat in Fluids", is prefaced thus: "It is certain that there is nothing more dangerous in philosophical investigations, than to take anything for granted".

It was at this time that Count Rumford published his historic suggestions which ultimately formed the basis upon which the Royal Institution was founded in 1799. Drawn up in pamphlet form extending to 50 pages, this issue was widely circulated in North America and elsewhere.[*] The title ran thus:

"Proposals for forming by Subscription in the Metropolis of the British Empire A Public Institution for diffusing the knowledge and facilitating the general introduction of Useful Mechanical Inventions and Improvements, and for teaching, By courses of Philosophical Lectures and Experiments, The Application of Science to the Common Purposes of Life."

In 1802, Rumford left England for Paris, never revisiting us. To everyone's surprise, he married, in 1805, Mme. Lavoisier, widow of the great chemist, but a separation followed in 1809. His daughter's comment on this venture referred to it as a bold, imprudent step, completing many vexations. By now the strain of military duties had, without doubt, weakened his bodily powers; maybe in some degree his faculties.

Posterity must envisage many blanks and imperfections in any real biographical estimate of this remarkable man. Rumford was more than a dual personality in whose study on that basis the springs of conduct could receive adjustment. A restless youth, followed by moods of militarism, was the ally throughout of a natural philosophical bias. The latter did not, however, tutor the senses, or restrain a riot of philanthropic fancy and effort. Could he have made philosophy the dominating influence, eschewed certain illusions and reaffirmations made in middle life, a calm and dignified passage into that older state which has finality in sight might have been prophesied with some approach to certainty. But it was otherwise.

RUMFORD'S GIFTS FOR SCIENCE.

Allusion may be made at this point to a period in Rumford's life when he made certain endowments for scientific purposes, applicable in England and in America. Writing to Sir Joseph Banks in July 1796, he intimated his desire to establish a prize medal in gold (with silver replica) in recognition of studies in the philosophy of heat or light, the awards to rest with the Royal Society of London. Whether preliminary discussions on the subject had taken place with Banks is not known. But by that time Rumford had been a fellow of the Society for seventeen years. He had bid farewell to Munich, was again visiting London, enjoying its scientific life—as witness, he dined twice at the Royal Society Club in 1796. The terms of this Rumford gift need not be recapitulated; but it may be noted that the original design for the medal (1797) did not bear the effigy of Rumford. This early pattern was abolished in Victorian times and the portrait-head of Rumford adopted in perpetuity for the obverse of the medal.[*] The initial allotment was made to Rumford himself in 1802 and as for the year 1800; he did not receive it until 1804, when it was sent to him at Paris by the hand of the president, Sir Joseph Banks—"the first opportunity I have had, though decreed a year and a half ago", wrote Banks. The American Academy of Arts and Sciences received on the same date as the Royal Society a similar offer, addressed to John Adams, covering 5000 dollars, but restricted to researches made in "any part of the continent of America, or in any of the American Islands". They placed the bust of Rumford, in uniform, on the medal, which the English Society could not, in all the circumstances, have done. The Academy's first award was not made until 1839.

BEGINNINGS OF THE ROYAL INSTITUTION.

It is recorded that on June 29, 1799, at a meeting of the Managers of the new foundation, the Earl of Winchilsea, as president, acquainted them that he had had the honour of mentioning it to His Majesty King George III., who had been graciously pleased to honour it with his patronage, and to allow it to be called the Royal Institution. It was incorporated on Jan. 20, 1800, and arms, crest, and supporters were granted on Jan. 31.

George Finch, ninth Earl of Winchilsea and fifth Earl of Nottingham, who was chosen first president, occupied a position confirmed and retained for fourteen years. Since he was not, in the precise sense, a man of science, we are referred to general considerations, and those of a personal nature, as justification for such marked and extended confidence. Doubtless he was an acceptable colleague in Rumford's view, on the ground of events in the Earl's career, parallel in certain respects with those in his own. Born at St. James's, Westminster, in 1752, and educated at Eton and Christ Church, Oxford, George Finch succeeded to the peerage in 1769. He died in London on Aug. 2, 1826, aged seventy-three years, bearing the contemporary reputation of being "a nobleman of the old school and a high bred gentleman in his manners". Burley-on-the-Hill, Oakham, Rutlandshire, was the family seat and the Earl became, in course of time, lord-lieutenant of the county.

The American War of Independence found Winchilsea a staunch adherent of George III. He made Rutland an intensive recruiting area for an infantry regiment, raised (so the story went) at a cost of £20,000, serving abroad himself as a volunteer, and becoming (1780) lieutenant-colonel of the 87th Foot. When he settled in England, he enjoyed considerable social and political influence. A member of the Board of Agriculture, he was held in high repute as a practical and discerning landowner, most helpful in days of national difficulty. Loudon ("Encyclopædia of Agriculture", ed. 1825 and 1831) states that the cottages which the Earl of Winchilsea had built had a kitchen, parlour, dairy, and two bedrooms over; also there were several with small holdings attached of from 5 to 20 acres. He also encouraged the practice of letting portions of the pasture to labourers. Another custom was that the cottagers took small portions of farmers' fields to use as gardens—an early step towards our modern allotment system. At the time of the Napoleonic threat of invasion he embodied and commanded, in 1803, a volunteer corps. He was invested a Knight of the Garter in 1805.

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[*] No copy of this pamphlet exists at the Royal Institution. In 1870 it was reprinted for issue in the *Proceedings*, from a copy at Althorp. There is also one in the British Museum. An original and complete copy of the pamphlet may be seen in the Patent Office Library, bound in at the end of an octavo set of Rumford's Essays, London edition.

[*] Ellis, "Life of Rumford" (1873), says that the head of Rumford on the Royal Society's Medal is from a portrait of him painted in Munich which hung in his house at Brompton, and was presented to the Society by his daughter in December 1831. No such portrait was ever given to the Royal Society.

Winchilsea was elected into the fellowship of the Royal Society in 1807, signing the charter book the following year. In 1822, he accompanied George IV. on his Scottish tour. He was unmarried; and we like to think that he may have made the acquaintance of the youth, Faraday, who entered the service of the laboratory (1813) in the year that he vacated the presidential chair that he had so long occupied.

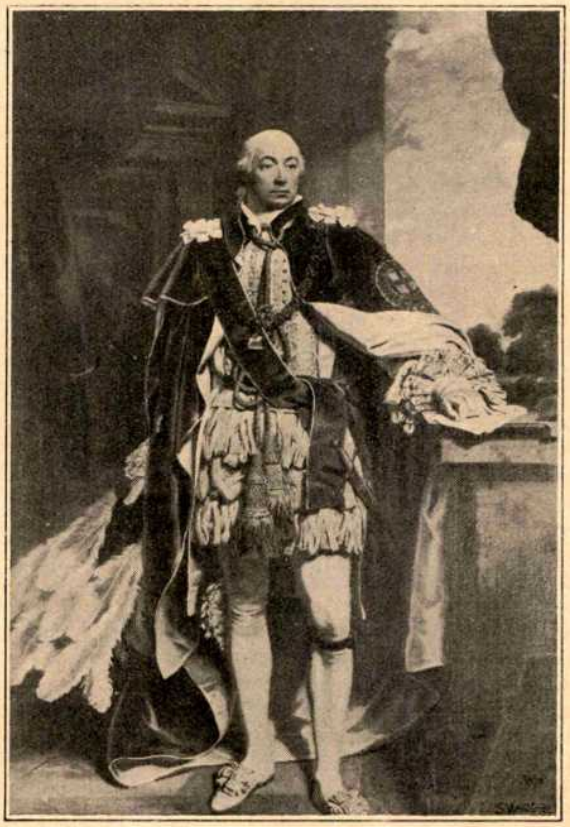

Fig. 2.—The Earl of Winchilsea, K.G., F.R.S., President of the Royal Institution, 1799–1813. Painted by S. Woodforde, R.A., 1808. By courtesy of Miss Jasmine Finch.

Empowered with authority for the introduction of a scheme of philosophical lectures, which, in due course, would be continued in a specially designed theatre, Count Rumford was not long in taking decisions respecting a beginning. In 1799, he made inquiries of Thomas Garnett, M.D., then occupying a professorship in the Andersonian Institution, Glasgow, and very favourably known for his successful experimental presentation of philosophical subjects, for information respecting the plan of courses at that centre.

At the time, these men had never met each other. However, Rumford was sufficiently satisfied with the past and present qualifications of Garnett to make him an offer to transfer to London. Accordingly, Garnett resigned office in October 1799, and was appointed, with managerial approval, the first professor of natural philosophy and chemistry in the Royal Institution. It was certainly the belief of Garnett (a widower) that he and his children would be housed in Albemarle Street *; further, that he would be allowed to practise as a physician. But in these matters Rumford seems to have made arbitrary reservations. Notwithstanding these preliminary drawbacks, Dr. Garnett engaged with the utmost zeal in a series of morning and evening lectures, which proved highly attractive, and at which there were crowded audiences. But an incident of significant import for the professor reveals itself in the terms of a letter from Rumford to Sir Joseph Banks, dated May 29, 1800:

> I am very sorry to find, on making enquiry of Dr. Garnett, that your information was accurate respecting his having ascribed the late discoveries of our friend Volta to the French. . . . I have, however, insisted on its being rectified as far as it is possible, in some future lecture.

This letter was followed the next day by another from Count Rumford, stating that Dr. Garnett proposed to rectify his error, in the subjoined terms:

> Having by mistake, on Wednesday, in the course of my public lecture ascribed to the French philosophers a new and interesting discovery relative to galvanism, which, on enquiry, I find belongs to Professor Volta, of Milan, I feel it to be my duty to state this fact in a public manner, in order that Professor Volta may not be deprived in any degree of the honour of a discovery which so justly belongs to him alone. The first news of this discovery, which arrived in this country in the beginning of last month, was communicated to the president of the Royal Society. . . .

In all likelihood, Dr. Garnett would have set the matter in its proper light without the despotic action of Rumford. There is every warrant in the circumstances of his temperament and career for this assumption.

A scheme drawn up by Garnett for a full course of lectures in 1801 became a final stumbling-block. At a meeting of the authorities on Feb. 2, 1801, they resolved that the lectures should commence as soon as the new theatre could be got ready for them, and that Count Rumford be authorised "to take all such steps on the part of the managers as shall be necessary in that business", and that Sir Joseph Banks, Henry Cavendish, and Count Rumford act as a committee to superintend the drawing up and publication of a suitable syllabus. It was further resolved that no syllabus of lectures or other account of what is doing or done, or to be done, at the Royal Institution be published by any person or persons without the permission of the aforesaid committee, or the express leave of the managers, signified in writing.

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* Count Rumford himself had quarters in the Institution's house at this period.

There was thus a fresh stranglehold, and Garnett was unequal to the occasion. On Feb. 16, 1801, the above decisions were communicated to Dr. Garnett, and at the same time it was decided to engage Mr. Humphry Davy as assistant lecturer on chemistry, director of the Chemical Laboratory, and assistant editor of the *Journals*. He was to be allowed to occupy a room in the house, and be furnished with coals and candles. It is noteworthy that both Banks and Rumford were present when these courses were adopted.

THE ROYAL INSTITUTION IN 1800.

A glimpse of internal arrangements in which our forerunners participated may be of interest. Early there were set apart two reading-rooms, in addition, a "Conversation Room". In the former, various scientific periodicals, home and foreign, were available, and it was claimed that effectual measures were in force for securing continental issues without delay; that, indeed, they frequently came to Albemarle Street "whilst yet wet from the press". The "Conversation Room" (so inscribed over the door) was supplied with a collection of maps "to assist agreeable talk". Major James Rennell assisted in this daring venture. Also, it was possible for frequenters to obtain, "at the most reasonable prices", from the housekeeper's quarters below, soups of various kinds, tea, coffee, chocolate, and what were euphemistically designated "other refreshments".

The clerk was enjoined to be constantly provided with writing-paper of all kinds, and pens and ink. As to letters, these were taken away every evening for the General Post, by a postman who, at stated hours, was wont to pass along the street with a clanging bell to proclaim his mission. The Royal Institution paid the postman one guinea a year for call services in lieu of the usual allowance of one penny for each letter, and hence it was not necessary for members to put money into the hall post-box with their letters. Such, then, were the postal and other facilities enjoyed at the Royal Institution in 1800.

In 1801, Count Rumford reported that a complete kitchen for a small family, with a roaster of simple construction, a cottage fireplace grate, and a small boiler with steamers had been installed in the housekeeper's room, and these could be examined by callers. A principal kitchen was promised of larger order, to contain many novel fixtures, and to be open for demonstrations. The merit of any new method of cooking or of any new prepared dish might be judged from the actual experiment. Accordingly, a dining-room was in view in which the managers might order "experimental dinners" to which the proprietors and subscribers could be invited; the attendant expense to be defrayed by "those who partake of them".

In this year, too, as if through other hands, mention is made of the provision of some elegant bookcases, intended to shelve the library gifts of friends of the Institution. The managers welcomed donations, save works of professedly political tendency; whilst in each volume entry was made of the name of the donor, and date, on the ground that "it was agreeable to the principles of justice and to those of an enlightened policy not to forget acts of generosity". The *Journal* for 1802 contains an interesting classified catalogue of the library thus far established.

YOUNG AND DAVY.

In July 1801, Dr. Thomas Young, fortified with the recommendation of Sir Joseph Banks, and reported by Count Rumford as "a man of abilities equal to these undertakings", was instituted professor of natural philosophy, editor of the *Journals*, and superintendent of the house, with rooms. Rumford went elsewhere, but his control was not withdrawn. Young had been elected a fellow of the Royal Society in 1794, at the early age of twenty-one years. His reputation in the world of science and also in Egyptian hieroglyphics is well known.

Young did not remain long in his post, resigning in 1803. It has been handed down, on authority, that he was not successful as a lecturer to mixed audiences. A medallion in Westminster Abbey by Chantrey commemorates this gifted man. It is regrettable that Young is not represented at the National Portrait Gallery.

By this time many of the original schemes projected by Rumford, in particular the applications of science to domestic purposes, had suffered eclipse, through engendered passive resistance or chill indifference, and his authority and influence had waned. The school of mechanics, the workshops, the models, the kitchens became receding propositions—the lectures, laboratory, and library emphasised the Institution. The charter of a new and revised establishment awaited, however, the vision and genius of Humphry Davy. But if the old principles had been worn threadbare, they died hard. Thus, Banks to Rumford (1804): "It [the Royal Institution] is now entirely in the hands of the profane. I have declared my dissatisfaction at the mode in which it is being carried on, and my resolution not to attend in future." Again: "The Institution has irrevocably fallen into the hands of the enemy, and is now perverted to a hundred uses for which you and I never intended it. Adieu, then, Institution!" We realise that the parting of the ways had been reached. From the very start Banks had been a constant supporter of

Rumford, though it is hard to believe that he passed all the coin as sterling.

Humphry Davy was knighted in 1812, created a baronet in 1818, and was elected president of the Royal Society in 1820, following Wollaston. Drastic and fundamental changes in the management of the Royal Institution came about during Davy's time. They were consequent on his discoveries, his lectures, his outlook. There were many obstacles, many critics, and much need for philosophical serenity. In 1809 a report stated that "if the support of scientific men is to be obtained something must be done to give the Institution more the form of a public establishment than that of private and hereditary property". It was not long before the decision was taken to seek parliamentary authority for an Act for altering and amending the charter. This received the Royal assent in 1810. A lecture, comprehending a new plan, by Davy, left nothing unsaid. We quote from his words:

> Besides the diffusion of knowledge by popular philosophical lectures, and by other more elementary and more scientific lectures, the new plan will also embrace a design for the promotion of knowledge by experiments and original investigations.

Sir Humphry Davy married in 1812, and on April 5, 1813, he resigned the post of professor of chemistry and director of the Laboratory of the Royal Institution. It is recorded that on his resignation:

> Earl Spencer moved: That the thanks of this meeting be returned to Sir Humphry Davy for the inestimable services rendered by him to the Royal Institution. The motion was seconded by the Earl of Darnley and agreed to unanimously.

Davy's merits were recognised further by his election as honorary professor of chemistry.

FARADAY.

Michael Faraday, born in London in 1791 (which, as a matter of historic coincidence, was the year which marked the creation of Sir Benjamin Thompson, at the hands of the reigning Duke of Bavaria, Count von Rumford), sprang from the ranks of the humbler classes. His father was a working blacksmith, whose home, Jacob's Well Mews, when Faraday was a small child, was within a quarter of an hour's northerly walk of Albemarle Street. Drawn from a family of select and positive religious fervour, traits of this character tinctured the whole of Faraday's ultimate outlook on life and its obligations. Once he wrote, "In my intercourse with my fellow-creatures, that which is religious and that which is philosophical have ever been two distinct things".

Faraday was equipped only with a scanty day-school education, but he had an inquiring mind, strongly imbued in quite early youth with a love of books and what they could teach him; moreover, he was full of curiosity regarding the very popular scientific discoveries of the period. We hear of his attendance at elementary philosophical lectures in his locality, and of making, in spare moments, simple experiments in chemistry and in electricity.

A member of the Royal Institution—a Mr. Dance —occupies a niche in history, for it was through his good offices that Faraday was enabled, by the merest friendly acquaintanceship extended to a frank, industrious, eager youth, to attend four of Sir Humphry Davy's last lectures in the theatre at Albemarle Street. Highly interested in all he saw and heard at these discourses, during which he made notes, and encouraged further by the same friend, he sent the script to Davy. The reply was encouraging. Faraday was then engaged in bookbinding work, and he had been able to secure some occupation in writing or copying from Davy at a time when the professor was injured in one of his eyes by an explosion of the lately discovered nitrogen chloride. Later on, Faraday himself did not escape the results of explosions. In the year 1812, on Christmas Eve, there came a letter from Sir Humphry. In it he said:

> I am far from displeased with the proof you have given me of your confidence, and which displays great zeal, power of memory, and attention. I am obliged to go out of town, and shall not be settled in town till the end of January; I will then see you at any time you wish. It would gratify me to be of any service to you; I wish it may be in my power.

In the following year matters took better shape. The post of assistant in the Laboratory had become vacant and Davy offered it to Faraday at a wage of 25*s*. a week, with two attic rooms at the skyline of the house. He was introduced to the managers as one of good habits, active and cheerful in disposition, and intelligent in manner. His duties were to assist the various lecturers and professors in preparing for, and during lectures; and he had instructions regarding cleaning, care of apparatus, models, and so on. Though only twenty-one or twenty-two, he seems to have held a watching brief amongst the faithful, little realised, we may be sure, by those on the floor of the theatre. Writing to a friend, he said:

> The opportunities that I have had of attending and obtaining instruction from various lecturers in their performance of duties attached to their office, has enabled me to observe the various habits, peculiarities, excellencies, and defects of each of them, as they were evident to me during the delivery. I did not wholly let this part of the things occurrent escape my notice; but, when I found myself pleased, endeavoured to ascertain what had affected me; also, when attending to Mr. Powell or Mr. Brande in their lectures, observed how the audience were affected, and by what their pleasure and their censure was drawn forth.

Faraday left England in the autumn of 1813 in order to accompany Sir Humphry and Lady Davy on a European tour. They travelled in France, Italy, Switzerland, and the Tyrol, returning to London in April 1815. Re-engagement at the Royal Institution as assistant in the Laboratory happily followed, on increased monetary terms, and with apartments. On June 12, 1821, residence in the Institution having been arranged, Faraday married. In 1824 fellowship of the Royal Society was attained; also, in this year he joined the Geological Society, having interest probably more on the mineralogical side of the science than any other. Later, he served on its council. The outstanding event of 1825 was his election at the Royal Institution as director of the Laboratory and superintendent of the House; in that year, too, came his memorable discovery of benzene, announced to the Royal Society in a paper dated June 16, 1825.

By the time he was thirty-eight (1830), Faraday had accomplished a full measure of practical research. He was, moreover, on the threshold of establishing a physical link, namely, the connexion between electricity and magnetism. But he was ever alive to the needs of the Institution as a corporate body, and of its traditions. He kept continually in mind that the Royal Institution had objects of national importance to carry out; that it required sustaining energy, must be efficacious, and maintain its position, well defined years back by Davy. Apart from research, a great debt of gratitude for fulfilment is due therefore to Faraday, and must be part of the festival of thanks.

The inauguration of juvenile lectures and the discourses at Friday evening meetings were features of this period. At the former, those young people who cared to remain found Faraday ready to talk and explain. He had ease of his own in descending from the topmost rung of the ladder of science to convey in the minds of youthful listeners the scientific principles of 'common things'.

Faraday's connexion with the Royal Society was, of course, close and distinctive. He was a member of council in 1830 when the choice for the chair lay between H.R.H. the Duke of Sussex and Sir John Herschel, the astronomer and physicist. In 1832 and again in 1838 he received the Copley medal for his discovery of magneto-electricity and for researches in specific electrical induction respectively. Royal medals were allotted to him in 1835 and 1846, also the Rumford medal (1846). He was on five occasions Bakerian lecturer. On the last of these (1857) the subject was "Experimental Relations of Gold (and other metals) to Light". His final contribution to the Society was "On Regelation", read on April 26, 1860. In this he referred to the work of Tyndall and others. The Royal Society invited him to be its president in succession to Lord Wrottesley, but he stood aside in fixity of purpose. Visitors at the forthcoming centenary celebrations will be able to see at the rooms of the Royal Society the canvas by E. Armitage, R.A., portraying a deputation thereon, in 1857.

As scientific adviser to the Trinity House for a long series of years, Faraday made numberless reports, and paid constant visits to lighthouses.

In 1861, when sixty-nine years of age, Faraday conceived that the end of his scientific pilgrimage was within sight. Hence, writing to the managers of the Royal Institution, he reminded them of forty-nine years' service. His life had been a happy one, and all he desired. In its progress he had tried to make fitting return to the Royal Institution, and through it to science. The course of time had given development, maturity; now he had to face gentle decay. The managers, however, desired his retention of office in such manner as might appear convenient to himself.

In 1866 Faraday received from the Society of Arts its Albert medal—"for discoveries in electricity, magnetism, and chemistry, which, in their application to the industries of the world have largely promoted Arts, Manufactures, and Commerce". This was, in all probability, the last British recognition of his achievements that life permitted him to receive. The Prince Consort, in compliance with the wishes of Queen Victoria, had placed a house at his disposal on Hampton Court Green. There Faraday died on Aug. 25, 1867.

TYNDALL.

John Tyndall was a moving figure in philosophy and in those manifold applications of science which distinguished the nineteenth century, tokens of newness of ideas and newness of things. Chosen in May 1853 to be professor of natural philosophy at the Royal Institution, he was a colleague of Michael Faraday for fourteen years. In 1867 he succeeded the master at Albemarle Street, and his future career lay there, embracing in all thirty-four years. Throughout, he maintained a high reputation as a lecturer, writer, and publicist.

Tyndall was born in Ireland in 1820. His early education, though restricted, was broadly amplified through intensive individual effort. He was at the University of Marburg from 1848 until 1851. About this period a lifelong friendship began with T. H. Huxley. The publication of an essay on the cleavage of slate rocks was the proximate cause of his joining the latter in a visit to the glaciers of Switzerland in 1856; they issued afterwards a joint paper on the structure and motion of glaciers. For some years Tyndall was scientific adviser to the Trinity House and the Board of Trade, but he resigned these offices in 1883. Elected a fellow of the Royal Society in 1852, he received the Rumford medal in 1864; and he was on four occasions Bakerian lecturer.

At his first Friday evening lecture at the Royal Institution, delivered on Feb. 11, 1853, Tyndall remarked that he had engaged in it "not without fear and trembling, for the Royal Institution was to me a kind of dragon's den where tact and strength would be necessary to save me from destruction". Many words of wisdom have been uttered from behind the lecture table of the Royal Institution. Words of Tyndall uttered in 1879, in a discourse on the electric light, are singularly appropriate to recall just now—"it is Faraday's spark which now shines upon our coasts, and promises to illuminate our streets, halls, quays, squares, warehouses, and, perhaps at no distant day, our homes".

Tyndall died at Hindhead, near Haslemere, on Dec. 4, 1893.

Faraday's London Friends.

By H. G. Wayling.

FARADAY was essentially a Londoner. Although he was born on the south side of the Thames, he spent the greater part of his life in the northern districts between Regent's Park and Oxford Street, or at the Royal Institution in Albemarle Street, Piccadilly. From the following addresses of some of his scientific acquaintances the metropolis of his day becomes alive again. To visit all these highways and byways on foot would certainly be a tiring tramp. Failing, however, the use of a motor car, all the thoroughfares may be found on any good map of London.

One of the founders of the Royal Institution was Sir Joseph Banks, who lived at No. 32 Soho Square, a little west of Charing Cross Road. He died in 1820, so that Faraday would only know him as a gouty old autocrat. At the same house resided Dr. Robert Brown, amanuensis and librarian to Sir Joseph. Brown became one of the leading botanists in Europe, and sealed his claim to scientific recognition by the discovery of the Brownian movement, a topic which Faraday selected for one of his popular lectures at the Royal Institution. South of Regent's Park and parallel to Portland Place is Charlotte Street, where William Nicholson died. In conjunction with Sir Anthony Carlisle, who dwelt not more than a stone's throw away at No. 6 Langham Place, he effected the decomposition of water electrolytically. As the experiment was carried out at the Royal Institution in 1800, Faraday would know these co-workers, when in a few years later he became interested in the study of natural philosophy.

Still farther west and south of Regent's Park is Baker Street, a name well known to readers of Sherlock Holmes. Crossing it at right angles is Dorset Street, where, at No. 1, lived William Hyde Wollaston and, after him, Charles Babbage. The former, who was the interim president of the Royal Society, after the death of Sir Joseph Banks, was of the opinion that a wire carrying an electric current has a tendency to rotate on its axis; but Faraday, who watched Wollaston's unsuccessful attempts to achieve this feat, succeeded in making a similar wire revolve round the pole of a magnet. When Babbage became the tenant of the house in Dorset Street, he entertained extensively. John Dalton stayed here when he came from Manchester to lecture at the Royal Institution, where Faraday at the rehearsal of these discourses acted as audience and critic all in one. Among other guests of the inventor of the calculating machine was Sir David Brewster, who occasionally left the capital of the north to visit that of the south. Branching off Baker Street is Blandford Street, where Faraday worked as a bookbinder's apprentice.

Not far from here and in a south-easterly direction is Cavendish Square, connected to Oxford Street by a short thoroughfare called Holles Street. In this byway lived Davies Gilbert, a close friend of Davy and his successor to the presidency of the Royal Society. As practically every prominent member of that distinguished society would at one time or another pass through the doors of the Royal Institution, then their research laboratory, Faraday would experience the force of the saying, "the friends of thy friends are my friends." As chairman of the Royal Institution for a recognised period, Charles Hatchett would be another of Faraday's acquaintances. Hatchett was a mineralogist of some distinction, and incidentally, the father-in-law of W. T. Brande, who succeeded Davy as professor of chemistry at the institute in Albemarle Street. Hatchett lived in his later years in Lindsey Row, Chelsea; a terrace of big houses facing the river. Brande was born in Arlington Street, a southern tributary of Piccadilly.

Mrs. Marcet, whose "Conversations on Chemistry" whetted the youthful appetite of Faraday for experimental science, lived in Great Coram Street, Russell Square. Her tea parties were well patronised by several fellows of the Royal Society. Berzelius tasted her hospitality and Maria Edgeworth at times assisted her in these social amenities. Among Faraday's friends were many Quakers. William Allen, who resided in Plough Court, Lombard Street, was one of them. The firm of Allenbury is still in possession of the premises. Allen lectured before the Royal Society, and like most adherents of his particular faith, was earnest in all good works. Another, whose name is among the most notable who have lectured at the Royal Institution, was Thomas Young. Although a member of the Society of Friends, he modified his tenets and comportment with the changing times. This remarkable genius dwelt at No. 48 Welbeck Street, parallel to Harley Street, as befitted a physician of his social status. Then there were William and Richard Phillips, the sons of a publisher in George Yard, Lombard Street. They were fellows of the Royal Society and also prominent members of the Geological Society. It was Richard Phillips who induced Faraday to undertake public analytical work to augment his slender income.

William Haselden Pepys was another Quaker. He kept an instrument-maker's shop in the Poultry, also not far from Lombard Street, being, like many other of his co-religionists, within easy access of the Friends' meeting house in Gracechurch Street. When young Faraday wrote to Davy requesting that a situation might be found for him in the Albemarle Street laboratory, Sir Humphry showed the letter to Pepys and asked for his advice. "Set him to wash bottles" was the reply; a suggestion that Davy did not think worth accepting. Davy lived at No. 26 Park Street, Grosvenor Square, that is, in Mayfair, where his aristocratic wife entertained in great style. A more modest acquaintance of the subject of our theme was Peter Mark Roget, whose electrical jumping spiral may still be seen in the Science Museum at South Kensington. He lived at No. 18 Upper Bedford Place, just north of Russell Square, Bloomsbury. As secretary of the Royal Society, Roget had intermittent correspondence with Faraday—in particular, that on the manufacture of optical glass.

The mention of this topic reminds us that we might cross the river for a change, passing over London Bridge and proceeding down the Borough High Street. Along this route we enter Newington Causeway, once called Blackman Street. Here Sir James South had an observatory and laboratory. With the assistance of Sir John Herschel, he undertook the manufacture of various kinds of glass; and it was a modified form of this experimental ware, containing lead borate, that Faraday employed in his investigations on the relationship between magnetism and polarised light. Mr. Rollo Appleyard, in his recent biography, tells us that Sergeant Anderson, who acted as general factotum to Michael Faraday at the Royal Institution, served his apprenticeship in Sir James South's laboratory in Blackman Street. A short distance ahead is Newington Butts, where the great natural philosopher himself was born.

Returning to the neighbourhood of Oxford Street, where so many of his admirers lived, we pay a call to Hanover Square, which is on the other side of the road to Cavendish Square. At No. 12 resided Mrs. Mary Somerville, a frequent visitor to the Royal Institution. As there is a memorial plaque on its walls, the building can be easily identified. Mrs. Somerville relates that Wollaston, one day, in his usual quiet mysterious way, closed the shutters of her drawing-room; then holding a glass prism in the path of a beam of light that came in through a chink, exhibited to her the dark lines of the solar spectrum. Sir Charles Lyell met his future wife at one of Mrs. Somerville's dinner parties, and when he set up housekeeping he lived for many years at 53 Harley Street, only a few steps away. Lyell accompanied Faraday to investigate the cause of a terrible explosion that occurred at Haswell Colliery, Durham. During his local inquiries Faraday was shocked to find that the foreman of the mine demonstrated some of the tragic details with a lighted candle in his hand, having thoughtlessly given the professor himself a sack of gunpowder on which to sit and watch the demonstrations.

Among the familiar portraits of Faraday is one in which he appears in company with J. F. Daniell, whose name still persists in a well-known voltaic cell. Daniell was born in Essex Street, Strand. He lectured at the London Institution, Finsbury Circus, a rival academy to that off Piccadilly.

Dr. J. A. Paris, the biographer of Davy, was also well acquainted with Faraday. On one occasion when Paris paid a visit to Faraday's laboratory, he criticised adversely the apparently filthy appearance of some of the glass tubes. The next morning a short note was left at the doctor's house, No. 27 Dover Street, containing this laconic statement: "the 'oil' you noticed yesterday, turns out to be liquid Chlorine".

Part of his time Faraday lectured at Woolwich Academy. Here he co-operated with S. H. Christie, a Londoner—born at No. 90 Pall Mall; with Peter Barlow, whose familiar wheel is a type of electric motor; with the chemist Marsh, on whose test for arsenic all analysts rely; and with William Sturgeon, who was the first to use soft iron in the construction of electromagnets. Faraday's first biographer, Dr. Bence Jones, lived in Brook Street, Grosvenor Square. Being the secretary of the Royal Institution, Jones would have exceptional opportunities of knowing his subject both in private and public life. Another of his biographers and close friend was Dr. J. H. Gladstone. He was by marriage related to Lord Kelvin, who accepted his relative's hospitality at No. 17 Pembridge Square, Notting Hill, whenever he could be induced to leave his professorial duties in Glasgow.

The British Association Centenary Meeting.

THE centenary meeting of the British Association will be formally opened on Wednesday next, in the Albert Hall, at 3 P.M., when the Right Hon. J. C. Smuts will assume the presidency in succession to Prof. F. O. Bower, and will receive the invited delegates of societies and institutions, and of universities, colleges, and cities in which the Association has held meetings in the past. On the second day, in the Central Hall, Westminster, at 9 P.M., General Smuts will deliver his presidential address on the subject of "The Scientific World-Picture of To-day".

General Smuts will ask, in his address, what the effect of the recent scientific advances is on our conception of the world. On one hand, we have the ordinary common-sense view of the world, which is based on practical experience and tradition but does no longer square with the principles of science. On the other, we have the scientific world-view of the last century, which left the common-sense nature of the material world essentially unaffected, but could find no proper place for the factors of life and mind, and which thus reduced the world to the picture of a fixed deterministic mechanism. Both common sense and mechanistic science are profoundly affected by the new physical concepts, especially those of space-time and the quantum and their consequences. Matter, in the old sense, is completely transformed, and immaterial electrons and radiations take its place as the substance of the world. Our whole view of the nature of the material world seems to be upset and revolutionised.

Building on these great discoveries, a new world-view has recently arisen which yet, like the older science, emphasises almost exclusively the physical measurable aspects of the world. The world is constructed into a system of mathematical symbols. Matter, in the old sense, having disappeared, the world is made out to be a highly abstract intellectualised shadow world. On this view, however, a world emerges which cannot in any sense be considered real or possess any attribute of power or dynamic quality.

While acknowledging the enormous advance made by physics recently, it is suggested by General Smuts that it would be a mistake to emphasise them exclusively, and that the older concept of organic evolution is no less important for our world-view. The relations between the new concepts of space-time and the quantum on one hand, and those of life and mind on the other, are therefore discussed, and an attempt is made to connect up the system of the new physics with that of organic evolution. By thus avoiding the merely physical view of the world and linking it up with the facts of biology and psychology, which are equally valid with those of physics, a world-view results which, while destructive of the common-sense view of matter, also differs from both nineteenth-century mechanism and the more recent mathematical symbolism. It is shown that this is an evolutionary universe, essentially genetic and holistic; that it has passed through various phases from its microscopic origins to its present macroscopic status; and that inside this macroscopic system the phase of life and mind is emerging as a new high level in the universe. It is finally suggested, as a result not only of organic evolution but also of the new physics, that the essential character of the universe does not preclude new creation, and that there are indications of a certain measure of free movement and creativeness throughout the world which increases in life and mind and in the emergence of new values. Within the deterministic limits of the universe the human spirit may thus have an assured status and a certain measure of creative free play.

General Smuts's address will be published in full in a Supplement to next week's issue of NATURE, together with summaries of the addresses of the presidents of Sections of the Association. The programmes of the Sections, including the subjects of the presidential addresses, were given in our issue of Aug. 8. In addition to several discussions of high scientific importance there mentioned, the evening discourses to be delivered during the meeting are of particular interest. Sir James Jeans will take as his subject " Beyond the Milky Way " ; Sir Oliver Lodge, " A Retrospect of Wireless Communication " ; Sir Arthur Keith, " The Constitution of Man's Family Tree " ; Sir P. Chalmers Mitchell, " Zoos and National Parks " ; and Dr. S. Kemp, " Oceanography in the Antarctic ".

Special facilities will be offered for visits to a number of public resorts of scientific interest ; and these include the Royal Botanic Gardens, Kew, where the director, Sir Arthur Hill, is arranging an exhibition of plants named after botanists, with portraits of the botanists themselves. The exhibit will be placed in the alpine house at the end of the herbaceous ground. An exhibit of this character should be of general interest, since it will serve to explain the somewhat obscure generic names of a number of well-known plants. In the limited space, it is not possible to have a fully comprehensive exhibit, but a selection will be made of well-known plants named after distinguished botanists and travellers. Among them will be found the Swedish creeping plant *Linnæa*, allied to the honeysuckles, which was named in honour of Linnæus and was the favourite plant of the great naturalist ; the *Dahlia*, which was named after Dr. Andrew Dahl, the Swedish botanist who was a pupil of Linnæus (Dahl brought this favourite garden plant into cultivation, but unfortunately no portrait of him appears to exist) ; *Matthiola*, the stock named in honour of Pietro Matthioli (1500–1577) ; *Lobelia*, named after Mathias de Lobel (1538–1616) ; *Cunninghamia*, after Richard and Allan Cunningham ; *Darwinia*, commemorating Erasmus Darwin, the father of Charles Darwin ; *Gesnera*, after Conrad Gesner ; *Eschscholzia*, which was named after the botanist Dr. Eschscholtz ; *Cinchona*, which bears the name of the Countess Chinchon, the wife of the Viceroy of Peru, to whom the introduction of the knowledge of the drug is usually ascribed ; *Camellia*, named in honour of George Joseph Kamel, who travelled in the East ; *Magnolia*, named after Pierre Magnol (1638–1715), professor of medicine at Montpellier ; *Tradescantia*, named after John Tradescant (died 1638), who was gardener to Charles I. ; *Sparmannia*, the well-known South African plant, which was named after Dr. A. Sparmann, the Swedish botanist who accompanied Capt. Cook on his second voyage round the world and introduced this well-known greenhouse plant to cultivation ; *Fuchsia*, named in honour of Dr. Leonard Fuchs (1501–66) the author of the celebrated " Herbal " ; and *Kniphofia*, the " Red Hot Poker ", named after Johann Hieronymus Kniphof (1704–1763), a professor of medicine at Erfurt.

A very large number of delegates and other visitors from abroad are attending the meeting. Many of these are presenting papers or taking part in discussions in the various sections, among them being the following :

Section A : Dr. J. Bjerknes, Bergen ; Prof. A. S. Eve, Montreal ; Dr. H. Spencer Jones, Cape Town ; Prof. J. C. McLennan, Toronto ; Prof. M. N. Saha, Allahabad ; Prof. F. Schlesinger, New Haven ; Dr. B. F. J. Schonland, Cape Town ; Prof. W. de Sitter, Leyden ; Prof. P. Zeeman, Amsterdam.

Section B : Prof. N. J. Bjerrum, Copenhagen ; Prof. J. N. Brønsted, Copenhagen ; Prof. P. Debye, Leipzig ; Prof. H. von Euler-Chelpin, Stockholm ; Prof. V. Henri, Marseilles ; Prof. P. Karrer, Zurich ; Prof. R. Kuhn, Heidelberg ; Prof. H. Wieland, Munich ; Prof. A. Windaus, Göttingen.

Section C : Prof. H. A. Brouwer, Delft ; Prof. J. W. Jongmans, Heerlen ; Prof. P. Niggli, Zurich ; Prof. P. D. Quensel, Stockholm ; Dr. E. O. Ulrich, Washington.

Section D : Prof. H. Fairfield Osborn, New York.

Section E : Prof. J. H. Wellington, Transvaal ; Prof. W. Werenskiøld, Oslo.

Section F : Edgar Atzler, Berlin ; Dr. Hermuth Boller, Vienna ; R. L. Hall, Grahamstown ; Pierre Jolly, Paris ; Henri Laugier, Paris ; Dr. Elton Mayo, Massachusetts ; Dr. H. S. Person, New York.

Section G: Brig.-Gen. C. H. Mitchell; Dr. Elihu Thomson, Lynn, Mass.

Section H: Dr. R. Broom, Douglas, S. Africa; Dr. H. C. van Riet Lowe, Cape Town; Prof. Sergio Sergi, Rome; Prof. V. Suk, Brno; Dr. G. Thilenius, Hamburg.

Section I: Prof. Frank Allen, Manitoba; Dr. R. Alexander, Pretoria; Prof. D. W. Bronk, Pennsylvania; Dr. C. K. Drinker, Harvard; Prof. Yandell Henderson, Yale; Prof. C. Heymans, Ghent; Dr. J. M. Rivers, New York.

Section J: Prof. W. Köhler, Berlin; Prof. H. Piéron, Paris.

Section K: Prof. F. E. Lloyd, Montreal.

Section L: Prof. F. Clarke, Montreal; the Hon. S. Rivers Smith, Tanganyika.

Section M: Dr. W. Lawrence Balls, Giza; Dr. D. J. Hissink, Groningen.

Among other visitors from abroad whose names do not appear in the handbook and time-table of the sectional meetings, but who will probably take part in some of the proceedings, we notice the following: Dr. C. G. Abbot, Washington; Prof. Max Bodenstein, Berlin; Prof. Niels Bohr, Copenhagen; Prof. A. H. R. Buller, Manitoba; Dr. J. McKeen Cattell, New York; Prof. R. Chodat, Geneva; Prof. E. J. Cohen, Utrecht; Prince Conti, Florence; Baron de Geer, Gothenburg; Prof. W. K. Gregory, New York; Prof. W. Heisenberg, Leipzig; Prof. G. Hevesy, Freiburg; Prof. A. E. Kennelly, Harvard; Prof. J. P. Lotsy, Velp; Prof. A. B. Macallum, London, Ont.; Senatore Marconi, Rome; Prof. R. A. Millikan, Pasadena; Dr. Th. Mortensen, Copenhagen; Dr. H. Nagaoka, Tokyo; Prof. J. Perrin, Paris; Dr. H. M. Tory, Ottawa; Prof. R. Willstätter, Munich; Prof. R. W. Wood, Baltimore.

International Union of Physics, Brussels Meeting, 1931.

A MEETING of the International Union of Physics was held in Brussels on July 12, and was attended by representatives of about fourteen countries. Prof. Gerlach, of Munich, and Dr. Rupp, of Berlin, were also present by the invitation of the president. A revised set of statutes, prepared by the executive committee, was considered and passed.

At the previous meeting of the Union an invitation had been given to hold a meeting in England so soon as it was possible for all nations to take part. Sir Richard Glazebrook, as representing Great Britain, expressed his pleasure that, under the new statutes, this condition was now satisfied, and cordially welcomed the German visitors to the meeting. He then renewed the British invitation, saying, however, that he had been informed that there was a very strong desire that the Union should visit America on the occasion of the Chicago Exhibition in 1933, and that it was for the Union to decide. A telegram was then read from Prof. Millikan, cordially inviting the Union, and this invitation was strongly supported by Dr. Kennelly and Dr. Schlesinger, the American delegates.

After some further discussion, the General Assembly of the Union decided unanimously to accept the invitation to Chicago, and to invite Prof. Millikan to become president of the Union in succession to Sir William Bragg, whose term of office had expired.

Discussion then followed on matters brought forward either by national committees or by individual physicists. Among these were the proposals of the British National Committee as to the definition of the calorie and a name for the unit of thermal conductivity, and of M. Cotton as to names for magnetic units. As the result of the discussion, a sub-committee was appointed to deal with symbols, units, and nomenclature in physics and to report to the General Assembly. At the first meeting of this sub-committee, held on July 12, Prof. Kennelly in the chair, the following resolution was agreed to unanimously:

> That this Commission recommends to the Executive Committee of the International Union of Physics that the following two propositions be communicated to the next General Assembly as recommendations from this Commission.
>
> 1. That the Unit of Heat when measured in units of energy be the Joule, defined as equivalent to 10^7 ergs.
> 2. That the gramme-calorie is the amount of heat required to raise the temperature of one gramme of water from 14·5° to 15·5° of the International Scale of Temperature.
>
> *Note on Proposition* 2.
>
> "According to existing measurements, the gramme calorie is equivalent to
>
> $4{\cdot}18_6$ Joules.
>
> "The definition is consistent with the decision of the International Steam Tables Conference in 1929 to adopt as a unit suitable for their purpose an International Kilocalorie equivalent to 1/860 of an International Kilowatt Hour, the difference being that between the Absolute Watt* and the International Watt."

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* International Watt = 1·00039 Absolute Watts.

Obituary.

Sir Thomas Stanton, C.B.E., F.R.S.

THE death at Pevensey Bay on Aug. 30 of Sir Thomas Ernest Stanton tragically ended a distinguished career largely devoted to the service of the State. He was one of the greatest research engineers Great Britain has produced, and a worker whose name will rank with those of Rankine and Osborne Reynolds, under the latter of whom he studied and carried out some of his early work.

Sir Thomas, who was sixty-five years of age, had retired in December 1930 from the post of superintendent of the Engineering Department at the

National Physical Laboratory at Teddington, a position he had occupied for nearly thirty years. Born on Dec. 12, 1865, the son of Thomas Stanton of Atherstone, he was educated at Atherstone and Manchester Grammar Schools, whence he proceeded to Owens College, where, after experience with Messrs. Gimson and Co., engineers, of Leicester, he was appointed demonstrator by Osborne Reynolds in the Whitworth Laboratory, a position he held for five years.

In 1896, Stanton removed to Liverpool, on appointment to the senior lectureship in engineering at University College. Three years later he became professor of civil and mechanical engineering at Bristol, a position he held until 1901, when he joined the staff of the National Physical Laboratory, which was then in the earliest stages of its development.

Stanton proceeded to build up the Engineering Department to its present position of eminence. Few have exerted a wider influence in the application of laboratory methods to engineering problems. For some years he was also in charge of the aerodynamical work of the Laboratory. His personal researches covered an extensive field, including the study of wind pressures on structures, the resistance of materials to intermittent stresses, lubrication, the heat-transfer and friction between solid surfaces and moving fluids, and the movement of projectiles at speeds exceeding the velocity of sound. These and other researches have formed the subject of numerous papers presented during the past thirty years to the Royal Society, the Institution of Civil and Mechanical Engineers, and the more important engineering journals. His book on "Friction" (1923) is also very widely known. So recently as May last he delivered the thirty-seventh Sir James Forrest Lecture, on "Engineering Research," before the Institution of Civil Engineers.

Stanton was admitted a fellow of the Royal Society in 1914 and served on the Council during 1927–29. He was a D.Sc. of the University of Manchester, a fellow of the Royal Aeronautical Society, and a member of the Institutions of Civil and Mechanical Engineers. For his work in the War he received the C.B.E. in 1920 and he was knighted in 1928.

Despite a somewhat retiring disposition, Stanton's advice was much sought, for it was known to be kindly, sound, and sagacious. He was genial and unassuming, and his popularity with his colleagues was amply evinced on the occasion of his retirement from the Laboratory. During the past year his life had been clouded by ill-health. He married in 1912 a daughter of Mr. John Child, of London, and he leaves, besides Lady Stanton, a daughter aged eighteen years and a fourteen-year-old son, to whom we offer our deep sympathy.

Dr. L. W. Sambon.

It is with deep regret that we have to record the sudden death of Dr. L. W. Sambon in Paris on Aug. 31. By his death a striking personality has passed away.

Sambon was born in Italy in November 1865. He was of Anglo-French parentage, his father being Comm. Jules Sambon, an antiquarian and numismatist of repute, and his mother an Englishwoman. He was educated in England and Switzerland, and later studied medicine at St. Bartholomew's Hospital Medical School and in the University of Naples, where he took his medical degree.

From an early age Sambon took great interest in numismatics, archæology, natural history, and volcanology. As a medical student, he rendered valuable service during the great cholera epidemic in 1884, and was awarded for his work bronze and gold medals by the Italian and French Governments. In 1897 he settled in London, where he devoted himself to medical research at a time when tropical medicine was almost in its infancy. His first article on "Acclimatisation of the White Man in Tropical Lands" roused a great deal of controversy, but it had a good effect. It brought him in contact with Manson, who was at that time Medical Adviser to the Colonial Office, and their association was interrupted only by the death of Manson.

In the summer of 1900, Sambon carried out the now classical malarial experiment in the Roman Campagna (Ostia) with Dr. George C. Low and one of us (T.).

Sambon was for many years a lecturer at the London School of Tropical Medicine. He published many papers on sunstroke, blackwater fever, malaria, sleeping sickness, pellagra, typhoid, schistosomiasis, and so on. He was at the time of his death carrying out investigations on cancer, in Westmoreland—a subject on which he had already published several reports. He wrote much on the history of medicine. He studied the surgical instruments of ancient times and utensils found in Roman graves, and his interpretations of these relics have thrown considerable light on the medical knowledge of past ages.

Sambon has been called volcanic, he has been accused of being a dreamer and a visionary, but whatever theories he may have advanced, which may have been at the time considered far-fetched, those theories undoubtedly fertilised the fields in which he worked.

A. J. Engel Terzi.
S. Maulik.

We regret to announce the following deaths:

Dr. Aristides Agramonte, president-elect of the Pan-American Medical Congress, known for his work on bacteriology in Cuba, who associated himself with the work of clearing the Panama Canal zone of disease, aged sixty-two years.

Prof. Errol Lionel Fox, professor of chemistry at Washington College, Chesterton, Maryland, on July 17, aged thirty-eight years.

Dr. Russell A. Oakley, principal agronomist in the Division of Forage Crops and Diseases of the Bureau of Plant Industry, United States Department of Agriculture, on Aug. 6, aged fifty-one years.

News and Views.

THE celebration of the centenary of the birth of James Clerk Maxwell is to be held in Cambridge on Oct. 1 and 2, following immediately on the Faraday celebrations and the British Association meeting. About ninety delegates have been nominated by the principal academies and learned societies of the world and by the home universities. Amongst the delegates are Profs. Kennelly and Millikan from the United States; Profs. Cotton and Brillouin from France; Prof. Max Planck, Prof. Debye, Prof. Bohr, Prof. Siegbahn, His Excellency the Marchese Marconi, General Smuts, Prof. Zeeman, and Prof. Nagaoka. The University of Cambridge has also invited a number of guests and will have the pleasure of welcoming at the celebration many of those who worked in the Cavendish Laboratory in its first years under Maxwell—Dr. William Garnett, Sir Ambrose Fleming, Sir Richard Glazebrook, Sir Napier Shaw, Sir Arthur Schuster, Prof. W. M. Hicks, and others. Before the opening of the celebration in Cambridge, it is expected that many of the delegates will attend the unveiling of memorial tablets to Faraday and Maxwell in Westminster Abbey. The Royal Institution and the University of Cambridge have obtained the permission of the Dean and Chapter for the placing of these memorials, and it has been considered appropriate that they should lie, with the Kelvin tablet, in close proximity to the Newton tomb. The Master of Trinity, Sir J. J. Thomson, will unveil the tablets at noon on Sept. 30.

THE official proceedings in Cambridge of the Clerk Maxwell celebrations open with the Vice-Chancellor's luncheon in Corpus Christi College on Oct. 1. At 2.45 P.M. a procession is to be formed to the Senate House, where the Chancellor will welcome delegates and receive addresses. The Master of Trinity will then deliver the memorial lecture. After this will follow an 'At Home' in Peterhouse, Maxwell's first home in Cambridge, and in the evening a reception will be held in St. John's College. On the morning of Friday, Oct. 2, addresses will be given in the Arts School by Prof. Max Planck, Sir Joseph Larmor, and Prof. Niels Bohr. In the afternoon an address will be given in the Cavendish Laboratory by Sir James Jeans, also short addresses by contemporaries of Maxwell: Dr. Garnett, Sir Ambrose Fleming, and Sir Oliver Lodge. An exhibition of Maxwell apparatus and manuscripts is being organised, and visitors will have an opportunity of seeing the work of the laboratory. The proceedings will be closed by a banquet given by Trinity College. The addresses given at the celebration together with a contribution by Prof. A. Einstein are to be published by the University Press in a commemoration volume.

THE National Portrait Gallery has a collection of portrait sketches in pencil on sheets of drawing-paper which includes a head of Michael Faraday, bearing the date 1831. A friendly letter in Faraday's handwriting addressed to William Brockedon is appended. Various other well-known people of the period—for example, Brunel, drawn in the same medium—form a small collection of much interest in contemporary portraiture. Some in the series have received slight additions by coloured chalk in order to enhance the effect. William Brockedon, son of a local watchmaker, was born at Totnes in 1787. He died in London in 1854. He was a painter of repute, an author, and an inventor. In the year 1834, Brockedon was elected a fellow of the Royal Society. In all, he exhibited 36 pictures at the Royal Academy, and 29 at the British Institution. He founded the Graphic Society in 1831, an association of one hundred artists. Also, in 1830, he helped in founding the Royal Geographical Society, and was a member of the first council of that body. As an inventor, Brockedon was well known. One of his patents referred to a substitute for corks, composed of vulcanised india-rubber; another (1843), a process for compressing pure blacklead powder (obtained from Cumberland's dwindling sources) into compact blocks from which lead pencils were afterwards fashioned. Brockedon was the author of "Illustrations of the Passes of the Alps", two vols., 1828–29.

MR. SNOWDEN, Chancellor of the Exchequer of the new National Government, introduced his emergency budget in the House of Commons on Sept. 10 and a White Paper (Cmd. 3952. London: H.M. Stationery Office, 3*d.* net) was issued setting out the proposed reductions in national expenditure. The measures proposed are based largely on the report of the May Committee, reference to which was made in our columns in the issue of Aug. 8. We criticised then the principle of singling out research activities for curtailment, and it is gratifying to find that Mr. Snowden has at any rate mitigated the blow. Whereas the May Committee recommended the abolition of the Empire Marketing Board, it is now proposed to reduce its grant by a quarter of a million; and the suggested reduction of £250,000 in the grant to universities and university colleges has been made £150,000, which, it is explained, will not affect annual grants, in that it represents an accumulated balance normally used for non-recurrent purposes. In other directions, the recommendations of the May Committee have been followed more closely. The vote for the Ministry of Agriculture and Fisheries is to be reduced by £580,000, which involves postponement of new developments for agricultural research and also of the Government grant towards the reconstruction of the Royal Veterinary College. It will also be impossible to operate the new fisheries research ship during 1932. The Colonial Development Fund will be restricted to £750,000, thus saving £250,000; while the expenditure of the Forestry Commission will be reduced by nearly half a million pounds, by restricting afforestation schemes.

THE flood-lighting of London has been criticised on the ground that it is an unjustifiable expenditure of public money at a time when economy should be practised. The cost, however, is being entirely defrayed by certain firms and other bodies connected with the electrical and gas industries. It was originally organised in honour of the International Illumination Congress. The headquarters of the Congress were in London, but meetings were held in several other cities, including Edinburgh and Glasgow. At the Edinburgh meeting, Mr. Clifford C. Paterson, president of the Congress, presented a paper entitled "The British Standard Specification for Street Lighting", which should prove very useful in improving the illumination of many of our streets. Many improvements have been introduced into the 1931 specification. An important point is the introduction of the phrase 'average illumination' into the specification. It is now specified that, in any tender, values must be given of both the maximum and average illumination on the roadway. A great obstacle in the way of starting average illumination is the difficulty hitherto experienced in practice in measuring it. For practical purposes it is now found that it is unnecessary to measure the illumination in the street by means of a photometric device. The data are best obtained by calculation from the known candle-power distribution data of the fitting that is to be used. A graphical method is given of computing the average illumination, and this eliminates much of the laborious arithmetical work involved.

THE eleventh Shipping, Engineering, and Machinery Exhibition being held at Olympia was opened on Sept. 10 by Sir Austen Chamberlain, First Lord of the Admiralty. Referring to the interest and sympathy of the Government in general, and the Admiralty in particular, to the exhibition, Sir Austen remarked that upon no section of enterprise has economic stress fallen more heavily than on those branches of trade, commerce, and industry which are represented in the exhibition. It speaks well, however, for the vital strength of these trades that even in such times they can provide so magnificent and novel an exhibition. The organisers of the exhibition are Messrs. F. W. Bridges and Sons, Ltd., who have the support of the British Engineers' Association (Inc.), the Society of Motor Manufacturers and Traders, Ltd., and the British Marine Oil Engine Manufacturers' Association. The honorary president is Admiral of the Fleet Lord Wester Wemyss, while Dr. H. S. Hele-Shaw is the chairman of the honorary committee of experts. The exhibition will remain open until Sept. 26, and during that time official visits will be paid to it by more than fifty engineering and scientific societies. The exhibits cover a very large field, and there are few which are not, indirectly or directly, the outcome of scientific research.

THERE are altogether some 300 exhibitors at Olympia, and about 40,000 copies of the advanced catalogue, printed in three languages, have been sent all over the world. The official catalogue is on sale at the exhibition at 1*s*., and visitors can from this easily find the position of the exhibits they are most interested in. A classified index is first given, under such headings as electrical machinery and apparatus, engines, gauges, instruments (electrical, navigating, and scientific); this is followed by a list of exhibitors and by descriptions of the exhibits, the latter covering nearly 300 pages, and being given according to the order in which the stands are arranged. How largely scientific instruments have been adopted for the control of engineering processes can be seen by the inspection of the exhibits of the various instrument makers. For example, Messrs. Elliott Bros. (London), Ltd., have on view a collection of heat economy and control apparatus, including automatic boiler control, flue gas analysis, smoke density, and temperature equipment, such as will be found in a modern power station. This exhibit is typical of many others. An exhibit which was attracting much attention on the day of opening was the latest Admiralty type of echo sounding gear with transmitter and hydrophone, made by Messrs. Henry Hughes and Sons, Ltd. But there are many other exhibits of great scientific interest. As the exhibition will remain open until Sept. 26, many visitors to the Faraday Exhibition at the Albert Hall will no doubt also visit Olympia, and we note that an official visit to the exhibition is to be made by the British Association on Sept. 25.

IN his presidential address to the annual conference of the Sanitary Inspectors' Association at Bridlington last week, Sir Leonard Hill directed attention to some problems of population. In Great Britain the annual excess of births over deaths per 1000 living, which was 12 at the end of last century, is now less than 3, so that if the decline continues, soon the population will become stationary. Three children per family are required to maintain the population and make good losses, but no-child or one-child families are becoming the rule among the masses. We ought to be able to send to the dominions and colonies 250,000 young virile emigrants annually, for if the British and Australians cease to breed enough virile colonists to till and defend Australia, how can we stem invasion by the Japanese, who are multiplying at the rate of a million a year? Luxury, decay of virility, doles, the employment of mercenaries, and limitation of breeding has preceded the downfall of empires in the past; yet if kept within bounds, who can doubt that limitation of breeding is an excellent thing? But if the white man is limiting his breeding by birth control, which is now practised in all classes of the community, we must see to it that the coloured races are also taught the method of doing so. At present such races are kept down to the level of the food supply by high infant mortality, famines, and epidemic disease. A less cruel world can only be brought about by a rational limitation of the birth-rate, but this must be coupled with realisation of the duty of keeping up a virile race. At present, unfortunately, the unskilled and less desirable portion of the population continues to breed more than the skilled and better classes.

ON Sunday, Sept. 13, the Institute of Metals began its annual autumn meeting in Zurich and more than two hundred members were present, including about a hundred foreign members from fifteen different countries. This cosmopolitan gathering — presided over by Dr. Richard Seligman—considered twenty-five important original communications, dealing with a wide range of metallurgical and engineering problems and discoveries. Abstracts of some of the papers presented on the first day of the meeting appear elsewhere in our pages (p. 502). The meeting terminated on Sept. 15 with a steamer trip on Lake Zurich. A series of tours were arranged for the meeting, in the course of which several large metal works were visited.

THE subject of the tenth autumn lecture, given by Mr. U. R. Evans on Sept. 13, before the annual autumn meeting of the Institute of Metals, was "Thin Films in Relation to Corrosion Problems". He pointed out that the thin oxide films which are responsible for the apparent stability of such metals as aluminium and stainless steel are usually too thin to give interference tints; they are invisible whilst in contact with the metallic basis, but are perfectly visible when removed from it. Although the films produced by air alone give some protection, the stability can be increased by special treatment with oxidising agents. The slightly thicker films produced on heating in air give rise to beautiful interference tints (such as the temper-colours on iron); but they tend to crack and have usually little protective value. Almost all methods of removing a film—whether an 'invisible' film or a film thick enough to produce an interference tint—depend on treatment which will dissolve the metal immediately below, thus allowing the film to peel off. For films on aluminium, nitric acid or gaseous hydrogen chloride has been used; for iron, a solution of iodine; for other metals, anodic treatment in a chloride or sulphite solution.

MOST natural oxide films, Mr. Evans explained, are not wholly impervious to ions; they contain weak points. To be useful they must be 'self-healing'; in other words, the secondary corrosion product must be precipitated so close to the weak points in the film as automatically to seal the defect. The movement of electrode potential with time provides a valuable method of observing whether, in any particular case, the weak points are healing up or are extending. A corrosion product can only be protective if produced very close to the metal. When part of the surface of an immersed metallic specimen is 'screened' from oxygen, any weak points on the screened area will tend to develop, whilst on the 'well aerated' part they will tend to heal up; foreign bodies lodging in condenser tubes often cause local attack, probably as a result of their screening action. Under conditions where metal is continually bent, or abraded, or bombarded by air bubbles, whilst in contact with a corrosive solution, the mechanical erosion will often prevent self-healing, and corrosion will then continue. Such cases cannot be explained on purely mechanical or purely chemical principles; both influences must be taken into consideration: consequently a greater collaboration between engineer and chemist is called for than has been obtained hitherto.

THERE have been many artificial ice rinks constructed in various parts of the world during the last fifty years. The essential principle of all of them is practically the same. The refrigerating plant cools a liquid which does not readily freeze; the liquid is then led through long tubes on the ice 'plate'. The tubes are placed so close together that they practically form a continuous surface of iron and any intervening gaps are caulked. A thin layer of ice about 20 mm. thick suffices, so the amount of water required is not large. Water sprinkled on the plate freezes almost at once, and the plate is undercooled to such an extent that the upper surface of the sheet of ice is kept below the melting point. The factor that governs the extent of refrigeration required is the temperature of the air above the ice. Indoor rinks are usually heated to such an extent that inactive spectators feel comfortable; the atmosphere therefore becomes unpleasant owing to its large vapour content. In the *Escher-Wyss News*, vol. 40, there is an interesting article on open-air ice rinks, with special reference to the Dolder ice-rink recently opened at Zurich. It has proved a great success; even if it rains during the night and morning, it is quite fit for skating for the rest of the day. After a shower the surface of the ice is as smooth as a mirror, as some of the rain water always freezes. The rink is situated on the heights north-east of the Dolder Park, in a sheltered position in a forest clearing, and is surrounded by fir and pine trees. At night time it is brilliantly illuminated. Owing to the crowds which frequent it, the surface of the ice wears down rapidly and it has to be freshly watered every day. The question of installing an ice factory in connexion with the rink was considered, but owing to the large number of domestic refrigerators in Zurich and the difficulty of transport it was abandoned.

AN interesting and comprehensive wood preserving exhibit is being arranged by the British Wood Preserving Association in connexion with the forthcoming meetings of the forestry subsection of the British Association. The exhibit will be staged in the Department of Botany, Imperial College of Science, Prince Consort Road, South Kensington, and will remain open during the whole meeting. A large portion of the exhibit consists of fence posts of many species of home-grown timbers collected from estates in Great Britain, which illustrate markedly the advantages of preservative treatment if timber is required to give a good life in service. Side by side with posts of timber naturally undurable, which have been made to give a life of from twenty to twenty-five years through proper treatment, are specimens of the same timbers, from the same sites, which show considerable decay in from two to six years through not having been treated. Other exhibits will show how timbers, such as Douglas fir, which do not take preservatives readily, even under pressure, can be made to absorb preservatives readily and evenly through being 'incised' before treatment. A section of the exhibit is to be devoted to the attacks of fungi and insects upon timber used in buildings, both at home and abroad.

UNDER the joint auspices of the British Association, the British Institute of Adult Education, and the Commission on Educational and Cultural Films, an exhibition is being held in South Kensington during the week of the Association's meeting, showing some mechanical aids to teaching and learning. Among other exhibits, there is to be a section for those many ingenious devices and mechanical aids which have been invented by teachers for helping their pupils to understand special points. Any teacher who is willing to lend an exhibit is asked to communicate a description of his apparatus to the honorary organiser of the Teachers' Exhibits Section, Mr. E. J. Atkinson, 4 Hawkins Crescent, Harrow, Middlesex. As it has only now been found possible to include this section, teachers interested are asked to communicate with the honorary organiser without delay.

SIR JAMES JEANS will speak under the auspices of the British Institute of Philosophy on "The Mathematical Aspect of the Universe" at University College, London, on Oct. 13, at 8.15 P.M. The public can obtain tickets (for which there is no charge) on application to the Director of Studies, University Hall, 14 Gordon Square, W.C.1.

LORD RUTHERFORD is to preside over a dinner of past and present scholars of the Royal Commission for the Exhibition of 1851, which is to be held at the Mayfair Hotel, Berkeley Square, on Monday, Sept. 28, at 7.15 (for 7.30). More than a hundred scholars have signified their intention to be present, but there are probably many others who have not yet received the notices, especially those who have left their universities abroad *en route* for the centenary meeting of the British Association. Mr. Evelyn Shaw, secretary to the Commissioners, would be glad if any research scholars of the Royal Commission who have not previously seen the announcement of the dinner, and wish to be present, would apply at once to him at No. 1 Lowther Gardens, Exhibition Road, S.W.7, for a dinner ticket, the price of which is 11*s*. 6*d*., exclusive of wines.

NEW speed records were set up at Calshot on Sept. 13, when the Schneider Trophy was won for the third consecutive time by Great Britain. Flight-Lieut. J. N. Boothman flew the course at the average speed of 340·08 miles an hour, an increase of 11·45 miles an hour on the speed reached in the last race. Later, Flight-Lieut. G. H. Stainforth made four flights along the three kilometres speed course; his average speed was about 379·05 miles per hour. Lieut. Stainforth's machine was a Vickers Supermarine Rolls-Royce, *S1596*, and the times for his four flights give the following speeds: first run, 373·85 m.p.h.; second run, 388·67 m.p.h.; third run, 369·87 m.p.h.; and fourth run, 383·81 m.p.h.

ONE of the most noteworthy of the many successful flights of the German airship *Graf Zeppelin* was the Arctic cruise which took place in the end of July this year. Dr. H. Eckener has announced through a German scientific news service some of the preliminary results of this voyage of exploration. From Leningrad the course was northward to Cape Kanin, to the east of the White Sea, and then to Franz Josef Land and 82° N. latitude. A visit was then paid to the unknown west coast of Northern or Nicholas Land and Taimir Land, after which the airship passed westward over the Yenesei mouth and the Kara Sea to Novaya Zemlya, which was traversed from north to south. The whole cruise was most successful, and was favoured by fine weather, with good visibility. The area of sea between Franz Josef Land and Northern Land is little known. The limits of Northern Land were determined and two islands discovered. Corrections were made to the charts of Franz Josef Land. A feature of the cruise was the large number of photographs and films that were taken, which should prove of great service in revising and adding to the maps.

THE physical and chemical survey of national coal resources is one of the most important tasks undertaken by the Fuel Research Board, which has an organisation now covering practically all the coal-producing areas of Great Britain. Survey Report No. 19 (London: H.M. Stationery Office, 2*s*. 6*d*. net) has been issued, containing the results of an examination of the Lower Mountain Mine Seam of the Lancashire coalfield. This seam is worked over the northern area of the coalfield, and the Survey reports on samples taken in the Burnley, Accrington, and Bacup district. The figures show the seam to contain coal with valuable properties. Its caking index is high, and typical samples have an exceptionally low sulphur content (0·4–0·6 per cent). Taken in conjunction with a low content of ash which is often highly refractory, it is clear that the coal may be used for the preparation of high-class metallurgical coke. It is the custom of the Survey to examine individually the component bands across a seam. Thus it was found that the sulphur and ash giving high average figures for the seam was at times mainly concentrated in a thin band, suggesting that an apparently indifferent coal might, by a suitable cleaning process, be made to yield a high-grade product.

WE have received the eighth number of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Cambridge (May 1931). The number is quite up to the standard of its predecessors, and the three editors may be congratulated on their production. The greater number of articles and poems are by, and about, the workers in the Sir William Dunn Institute, but other well-known names jostle those of mythical personages in its pages. A personal acquaintance with a number of the victims, as well as authors, will give the reader greater interest in the magazine: but much amusement should be obtained by those who are conversant with recent papers on different aspects of biochemistry. The price is 2*s*., which should be sent to the editors at the Sir William Dunn Institute: this is considerably cheaper than the price of most of the forms of entertainment of equivalent amusement value.

MESSRS. Baillière, Tindall, and Cox announce the early publication of Baillière's "Encyclopædia of Scientific Agriculture", in two volumes, to the production of which some eighty leading scientific workers in agriculture have contributed.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Focusing Method for Producing Electron Diffraction Patterns.

IT is a well-known fact that divergent electron beams of uniform velocity can be focused by means of magnetic fields. This focusing device is used, for example, in cathode ray oscillographs. It has been found that the focusing principle can be applied successfully to experiments in which electrons are diffracted. The chief advantage, among others, lies in the considerable gain in intensity as compared with the usual methods.

The arrangement is illustrated by the diagram (Fig. 1.). Electrons are emitted from a short spiral filament or flat spiral A. A hollow metal cone B is placed at a short distance from the filament. This cone has a narrow hole (about 0·2 mm. in diameter) at its apex. The accelerating field is applied between the filament and the cone. M is the coil which produces the magnetic field and S the specimen under investigation, which is placed at such a distance from the coil that the field is practically zero. P is the photographic plate or the fluorescent screen.

The direct rays, after passing through the field coil, converge towards a point Z on the plate. The diffracted rays which emerge from the specimen describe a series of cones, the angular opening of which is determined by the individual spacing to which they belong. These cones intersect the plate in ellipses. If, however, the diameter d of the diffracting specimen is small compared with its distance D from the plate, these ellipses become very nearly circles. The region in which a series of identical cones intersects the plate has consequently a definite width, that is, the focusing is, strictly speaking, not ideal. The width is approximately $(r/D)^2d$ where r is the radius of the ring. In the accompanying photographs (Fig. 2), r/D is of the order of 1/10 for the largest ring and d about 5 mm. The width of the rings due to the imperfect focusing is therefore only about 5/100 of a millimetre.

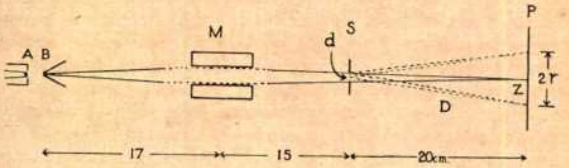

FIG. 1.

The magnetising current necessary for the focusing depends for a given apparatus essentially upon the velocity of the electrons. The adjustment is so sensitive that the current can be used directly for calibration. In the present apparatus it can be read to about 1 per cent. The determination of the electron wave-length λ is further simplified by the fact that the magnetising current is simply inversely proportional to λ over a fair range.

The use of wide beams also facilitates the otherwise rather difficult preparation of the specimens. It is, for example, feasible to use fine metal gauzes for their support. Local unevenness of the samples becomes less important owing to the averaging effect of the large area exposed.

The intensity of the diffraction patterns is high on account of the large exposed area of the sample. With a single plate Wimshurst (Wommelsdorfsche Kondensatormaschine) giving about 100 microamperes at 20-60 kv., the diffraction rings from metals, salts and paraffins can easily be observed on a fluorescent screen. The time of exposure of a photograph varies from a fraction of a second to a few seconds. The photographs accompanying this note have been obtained under these conditions. The distance specimen to plate was 20 cm.

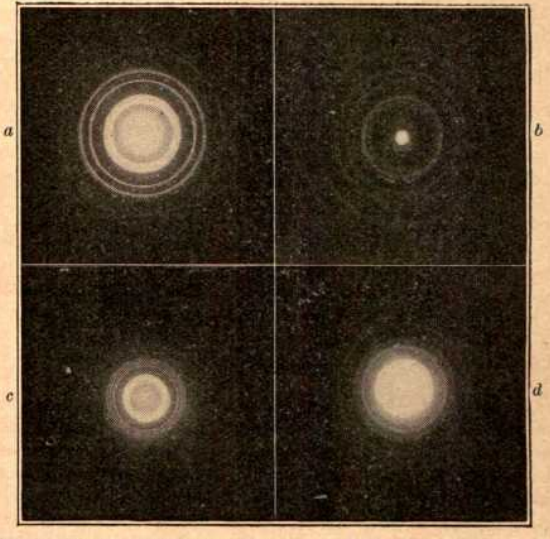

FIG. 2.—Electron diffraction patterns. *a*, Sodium chloride; *b*, gold leaf; *c*, paraffin; *d*, gold film produced by cathodic sputtering.

I wish to express my deepest gratitude to Sir William Bragg for permission to do this work in the Davy-Faraday Laboratory and to Dr. A. Muller, of the same Laboratory, for constant help and valuable advice.

A. A. LEBEDEFF
(Optical Institute, Leningrad).

Davy-Faraday Laboratory,
Royal Institution,
July 23.

Acromegaly in the Far North.

IN his letter in NATURE of Aug. 8 on the pituitristic character of Egil Skallagrimson, Prof. Seligman has brought forward a remarkable subject which made a forcible impression on myself some years ago. His opinion of the Gardariki skull confirms the existence of pituitary disorder among the viking Scandinavians, but he does not allude to the very peculiar features which distinguish Egil's case from common clinical conditions, nor to the interesting heredity which the sagas record.

Egil closely resembled his father, Skallagrim, and paternal grandfather, Kveld Ulf, in "growth, appearance, and bent of mind" (Egla S. xx., xxxi.); while the name of the latter suggests that he recalled his maternal grandfather, Ulf the Fearless, who was ancestor through a son, Hallbjorn, 'Half-Troll' (half-giant), to the equally remarkable family of Ketil Haeng, culminating in Grettir the Strong, whose bones, like Egil's, were dug up in a churchyard and admired for their astonishing size (Gretla S. lxxxiv.).

Gigantism seems to have become endemic in the

Fyrdafjord district of Sogn (Norway), where Skallagrim was able to find a dozen near his home who were "more like giants in growth and seeming than mortal men . . . all the strongest men and many shape-strong", men who, like their chief and his father, used to run 'berserk' in fits of uncontrollable rage followed by exhaustion (Egla S. xxv., xxvii.).

After the emigration to Iceland three of these giant families can be recognised by the same features reappearing in their descendants: that descended from Skallagrim, that of Giant-stead, and the descendants of Ani, among whom we may note a grandson, Steinar, who was "of all men the biggest and mighty of strength, an ugly man, crooked of growth, long-legged and short of body . . . quarrelsome and headstrong" (Egla S. lxxx.). Here again are signs resembling pituitary disorder, coupled with a morose, uncertain temper. Thorir, 'Long-chin', one of the most famous berserks, and Ofeig, 'Clumsy Foot', are other cases where characteristic pituitary features appear in a berserk family.

Egil and his father were noted for premature greying of their black hair with baldness at twenty-five. The father and grandfather of Grettir, in the line of Ofeig, 'Clumsy Foot', were also prematurely grey. The precocity, both mental and physical, of Egil and his brother may be associated with this premature senility, and possibly indicate a correlated excess of either adrenal or pineal function. Skallagrim had several children who died young, but there is no suggestion that they suffered from a total premature senility, and in such case the father and Egil the surviving son would scarcely live to the ages of 88 and 81 respectively, or perform astonishing feats of strength on the day of death.

Grettir, far from being precocious was distinctly backward, and seems unexpectedly feeble in the development of genitalia (Gretla S. xiv., lxxv.): possibly in his case pituitary disorder passed into a stage of hypo-function, but he was in full vigour when killed at 35. Although mentally very alert and a clever poet like Egil and Skallagrim, Grettir like his father was noted for laziness, which also suggests hypo-function. On the other hand, the Egil family were unusually brisk; but Thorbjorg the Fat, a granddaughter of Egil, may have developed pituitary hypo-function. Egil had also, and Grettir was credited with a son who died at 17, after promising to develop into something altogether extraordinary (Gretla S. lxvii.)

The tendency to berserk (*hamask*), so obviously resembling the running *amok* of Malays, was closely interwoven with "shape-changing" or being "shape strong" (*hamrammr*, vide T. R. Eddison, 1930, "Egil's Saga", notes, p. 245 ff.; and Du Chaillu, 1889, "Viking Age", ii. p. 425). The latter may broadly be regarded as peculiar behaviour in the dusk, such as sleepiness and surliness (Kveld Ulf), berserk fits (Skallagrim), mad drinking fits (Egil), dusk prowling, supposedly in animal shape (Storolf Haengson), terror of the dark (Grettir). We may imagine that evening terrors would provoke an adrenal release which might become translated, in those with constitutional adrenal excess, into a fit of berserk rage. Berserk fits, being involuntary, may also be compared with the 'uncinate' epileptiform seizures of pituitary hypertrophy, and there seems to be a strong hysterical element, because the subject was believed to be impossible to wound, which may mean that he was insensible to pain and did not bleed from non-arterial traumata.

As regards heredity, I have traced 52 male and 19 female descendants of Ulf the Fearless in 12 generations. Seventeen of the males are recorded as peculiar in one or more of the above ways, 6 others probably were so, but details are not available in the sagas at my hand, and of these 4 males evidently transmitted the heritage: 4 males transmitted without being noticed as unusual themselves. Females naturally have attracted less attention, but 3 of the 19 seem to have been unusual and 8 transmitted. Skallagrim and Grettir were each the offspring of berserk families on both sides—among 14 members of the associated families, 7 seem to have been peculiar; while the two other berserk families from Fyrdafjord referred to above include 7 peculiar among 9 individuals. In brief, half, of both sexes, may be believed to have had a peculiar hereditary constitution; and the condition seems not to be sex-linked. These details are drawn from the well-known sagas of Egil, Grettir, Laxdale, Burnt Njal, and the Norse Kings: lack of space makes publication of the genealogical table inadvisable, while it may yet be improved by reference to the sagas of Ketil Haeng and others not yet translated. It is certain that descendants of Ulf the Fearless settled in Greenland, because, soon after its discovery, fourteen ships reached that land from Borgafjord of Skallagrim's settling, and Breidafjord the home of Grettir's mother, through whom he derived from Ulf: it is therefore quite possible that the Gardariki skulls include some of Ulf's descendants.

The description of the unusually tall Grettir as "a handsome man . . . with a face rather broad and short, red-haired and somewhat freckled" (Gretla S. xiv.), places him at once as that well-known German-resembling Caledonian type which attracted the attention of Tacitus; it also suggests the much more ancient Cro-Magnon with dysharmonic face, a conspicuously giant type.

On the other hand, the Egil family, with its black hair, great height, thick skull, prognathism, precocity, and fits of rage, is curiously parallel to the tall negroid in everything except indolence, which was certainly displayed on the Grettir side, and pigmentation of the skin. *Hamrammr* may even be compared with the 'Leopard Society' prowling of West Africa. This parallel is interesting, because rock-tracings at Tanum in South Sweden introduce us to sea raiders and settlers who were familiar with the leopard, the camel, the ostrich, and the turtle, as pointed out by Du Chaillu ("Viking Age", ii. p. 124). Some are represented of immense size, many are prognathous—with a suggestion of the acromegalic chin—some have unusually long legs and short bodies like Steinar, several are remarkably fat; often pictured fighting with vigour, they might well represent ancestors of Egil. Also the Fomorians, supernatural giants, who exactly parallel the Scandinavian Trolls in Irish tradition and played the part of vikings in their earliest history, were explained as "sea-raiders from Africa" by the medieval scholarship in Keating's well-known "History of Ireland". As a hypothesis, the tall and fair Scandinavian, or even taller red Caledonian, raiding up and down the Atlantic coasts in very early days, might conceivably contact with the tall negroids of Jaloff, and thus acquire with captured women the seeds of a black-haired stock unbalanced in many ways and marked by excessive height, such as that producing Egil Skallagrimson.

MICHAEL PERKINS.

5 Little Cloisters,
Westminster Abbey, S.W.1.

APART from the high scientific value of Prof. Hogben's comments,[1] there is an immediate practical application.

Cases of infantilism—not the most severe—due to hypo-function of the anterior portion of the pituitary, though not very uncommon, are extremely difficult to treat, since no harmless reliable extract of the gland suitable for hypodermic injection is yet on the market and authorities are still doubtful as to how far anterior pituitary extract is absorbed when given by the mouth. If, as suggested, the gland is stimulated by light, then such individuals should profit by a stay during the darker part of our English year at higher altitudes, in areas with more sunlight than we get in this country. It happens that for some years I have been interested in a case of moderate infantilism due to anterior pituitary deficiency, and the improvement during a year in Switzerland (beginning in the autumn) at a height of about 3000 feet, with bright days and a good deal of snow in winter, greatly exceeded the progress made in any previous year in a boarding-school in the south of England, the hours of work indoors not being very different. That the psychic conditions were more favourable in Switzerland should, however, be taken into consideration.

C. G. SELIGMAN.

Toot Baldon, Oxford,
Sept. 3.

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[1] NATURE, 128, 375, Aug. 29, 1931.

An Oxidisable 'Active Nitrogen'.

IN the earlier part of this century it was often the practice to decolorise flour by exposing it to dilute nitrous gases obtained by sparking air, and in studies made by Leetham (1903) and Cramp and Hoyle (1907) it was found that the bleaching properties of the gases thus prepared were much enhanced if the air were ozonised before it entered the small H.T. arcs in which the nitrogen oxides were formed; this effect could be traced to an increase in the yield of nitrogen peroxide when ozone was present in the air supply.

In 1912 Lowry investigated the phenomenon quantitatively by photographing the nitrogen peroxide absorption spectrum in a column of gas 64 ft. long, this great length being rendered necessary by the extensive dilution of the substance being measured (1 : 3000 to 1 : 1000), and found that the effect could also be observed when the air was treated with ozone *after* being sparked; from this and other evidence of less importance he concluded that an unstable modification of nitrogen, which can be oxidised by ozone but not by oxygen, is produced in the main discharge. As the Rayleigh active nitrogen does not react either with oxygen or with ozone we have made a further examination of Lowry's very interesting claims, but using a different, and, we believe, an entirely new, technique of measurement of the nitrogen peroxide.

Our method depends upon the fact that the spectral region wherever nitrogen peroxide absorbs most strongly is close to that at which a vacuum potassium photocell is most sensitive (namely, the blue-green), and we have found that when intensity of light transmitted (calculated from the photoelectric current) is plotted against concentration of absorbent gas, the Beer-Lambert law holds between 0·01 and 3·25 per cent NO_2, the range wherein we have worked. It is thus possible to effect practically instantaneous determinations of nitrogen peroxide, and by suitable choice of (*a*) length of gas column, and (*b*) accuracy of measurement of photoelectric current, the method can be made to give results much more exact than those obtainable by ordinary spectroscopic means; in our work, where concentrations of 1 : 3500 to 1 : 1000 have been encountered, we have used a column only 8 inches long but with a 6 ft. column, 1 part of NO_2 in 75,000 of air may easily be determined.

We have made an extended search, using both pure nitrogen and nitrogen-oxygen mixtures over a wide range of experimental conditions, for any oxidisable modification of nitrogen or for any nitrogen oxide which may react only with ozone and not with oxygen, but have obtained no evidence for any such substance, although we have confirmed the earlier findings as to the increase in NO_2 yields when the air is ozonised before or treated with ozone after it is sparked; this last effect may, however, be observed only when the time which elapses between the gas leaving the spark and entering the measuring tubes is very small.

The explanation of the results obtained by earlier investigators would, therefore, appear as follows. The primary product of the spark in air is nitric oxide, which can change to nitrogen peroxide either by the slow termolecular reaction with oxygen or by the rapid bimolecular reaction with ozone. We have calculated, from an application of Bodenstein's data (1919) upon the kinetics of the former reaction to the experimental data given by Lowry, that under his usual conditions the NO would be less than half oxidised before it reached the downstream end of his 64 ft. trunk, whereas with ozone present the oxidation would be complete even before the gas entered this tube.

This calculation has been entirely verified in experiments in which two absorption tubes have been used, one immediately below the discharge and the other some distance from it; the concentration of NO_2 measured in the first is much less, at high flow speeds, than in the second, whereas, as the gas velocity is gradually reduced the difference becomes progressively smaller and finally disappears, an effect which is paralleled by Lowry's observation that the effects of ozonising either before or after sparking are negligible at small flow speeds.

We would point out that Lowry several times suggests that the slow oxidation of nitric oxide by oxygen may account for his observations, but, possibly owing to there having been no accurate data available upon the kinetics of the reaction at the time of his investigations, rejects this explanation in favour of that already mentioned: hence, while we can confirm his experiments, we cannot, in the light of present knowledge, accept his theory.

A full account of these experiments will shortly be published.

E. J. B. WILLEY.
S. G. FOORD.

The Sir William Ramsay Laboratories of
Physical and Inorganic Chemistry,
University College, London,
Aug. 22.

Cytology of *Anchusa* and its Relation to the Taxonomy of the Genus.

Anchusa myosotidiflora was placed in the genus *Anchusa* by Lehmann [1] in 1818 after being originally described as *Myosotis macrophylla* by Marschall [2] in 1808. In 1851, C. Stevens [3] assigned it to the newly described genus *Brunnera*, calling it *Brunnera myosotidiflora*. This splitting of the genus, however, was not accepted until the almost simultaneous publications of Ivan M. Johnston [4] and O. Stapf [5] appeared, the species being regarded as members of *Anchusa* by M. Gürke [6] and others. Johnston concluded that *A. myosotidiflora* with its variety *grandiflora* and *A. neglecta*, because of their "peculiar nutlets, leafy and ranker habit, and different inflorescence", fully deserved the position given them by Stevens. He accordingly retained them in the genus *Brunnera* and by following the law of priority as *B. macrophylla*, *B. sibirica*, and *B. orientalis*.

Caryolopha sempervirens (L.) Fischer and Trautvetter[7] (1837), like *Brunnera*, was also referred in more recent works to the closely related genus, *Anchusa*, but on morphological grounds Johnston considered it also merited recognition as generically distinct from *Anchusa*.

A tabular comparison of Johnston's arrangement with that of Gurke, with a summary of my own cytological observations (Fig. 1), is given below.

Gurke's Classification.	2n Chromosome Number.	Chromosome Types Classified according to Position of Point of Attachment.			Chromosome Length in Microns.		Johnston's Classification.
		Sub-terminal.	Median.	Sub-median.	Shortest.	Longest.	
Anchusa Barrelieri	16	2	4	10	4 2	6 1	*Anchusa Barrelieri*
,, *ochroleuca* seedling	24	3	6	15	5 5	8 0	,, *ochroleuca* seedling
,, *italica* var. 'Pride of Dover'	32	4	6	22	4 7	8 5	,, *italica* var. 'Pride of Dover'
,, *officinalis*	16	2	6	8	5 9	8 5	,, *officinalis*
,, *hybrida*	16	2	6	8	5·2	7 8	,, *hybrida*
,, *sempervirens*	22	4	6	12	1 8	3·8	*Caryolopha sempervirens*
,, *myosotidiflora*	12	4	2	6	1·4	3 0	*Brunnera macrophylla*

It is apparent that Johnston's changes in classification are fully substantiated by the microscopical observations, for both *Brunnera* and *Caryolopha* differ markedly from each other and from *Anchusa* in size, type and number of chromosomes. Nevertheless, while recognising that collectively these differences justify the generic changes, there is to be seen a definite similarity between certain chromosomes of all three genera which may possibly indicate the moderately close relationship which Johnston assumes exists between them.

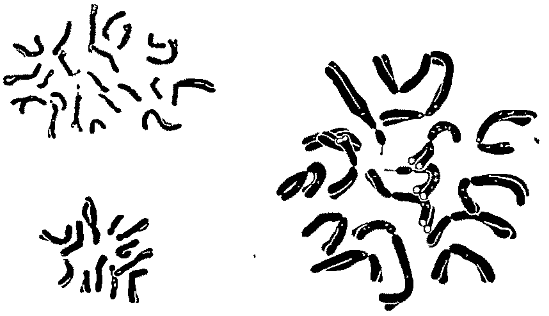

FIG 1.—Chromosomes of *Caryolopha sempervirens* (top left hand); *Brunnera macrophylla* (bottom left hand); *Anchusa officinalis* (right).

In a less abbreviated account to be published shortly, it is hoped to indicate more fully the value of cytology as a corroborant of herbarium methods in the classification of plants.

S. G. SMITH.

Department of Botany,
McGill University,
Montreal.

Thrips tabaci as a Vector of Plant Virus Disease.

IN NATURE of June 6, Dr. Kenneth Smith reports finding *Thrips tabaci* Lind. to be a vector of tomato spotted wilt in England. Since recent Australian work on the transmission of this disease has not yet been published, the following particulars may also be of interest:

The first record of successful insect transmission of tomato spotted wilt was made by Pittman,[1] who described three experiments with thrips; the insects used in the last of these experiments were identified by an entomologist as *Thrips tabaci*. Later, Samuel, Bald, and Pittman published a bulletin,[2] in which the main vector of the disease in South Australia was claimed to be the thrips *Frankliniella insularis* Franklin. In this bulletin a number of experiments with *Thrips tabaci* were recorded which proved negative, but the possibility that *Thrips tabaci* might act as a vector was not yet excluded. This was because transmission, even with *Frankliniella insularis*, was often so irregular that it was felt that some unknown factor influencing transmission had not been discovered. Another fact which indicated that *Frankliniella insularis* was not the only vector was that spotted wilt was a serious disease in Victoria, although *Frankliniella insularis* was extremely rare in Victoria.

In a bulletin now in the press, further work on transmission with *Frankliniella insularis* is described, in which it was found that when adult thrips were fed on a diseased plant and then transferred to healthy plants the disease was never transmitted. For successful transmission to occur, it proved to be essential that the thrips should have fed on the diseased plant in the *larval* stage. No analogous case with other insect vectors of virus diseases appears to have been described yet. (One of the writers, G. S., however, was much interested to find, on passing through Honolulu recently, that Dr. M. B. Linford, of the Hawaiian Pineapple Growers' Experiment Station, had discovered that *Thrips tabaci*, the insect vector of the yellow-spot disease of pineapple, was also unable to transmit the disease unless it had fed on a diseased plant during its larval stage.)

With this additional information of transmission, and also the fact that the incubation period of the virus in the thrips (*Frankliniella*) was found to be between five and seven days, the experiments with *Thrips tabaci* are being repeated. Already this species has been found to act as a vector of spotted wilt, as originally claimed by Pittman, and as now verified independently from England by Dr. Kenneth Smith. It is not yet known whether this, or possibly still another species of thrips, is the vector of the disease in Victoria. Several facts, however, suggest that in South Australia *Frankliniella insularis* is a more 'efficient' vector of the disease than *Thrips tabaci*.

Dr. Smith's observations on dahlia plants infected with spotted wilt are also interesting. In our forthcoming bulletin, besides thirty species of *Solanaceæ*, three species in the *Compositæ* and one each in the *Papaveraceæ* and *Tropæolaceæ* are proved to be hosts for the spotted wilt virus.

GEOFFREY SAMUEL.

Waite Agricultural Research Institute,
University of Adelaide.

J. G. BALD.

Council for Scientific and Industrial
Research of Australia,
July 24.

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[1] " Plantæ et Familia Asperif nuciferæ descripsit.' Berlin; 1818.
[2] " Fl. Taur.-Cauc.", 1, Leipzig; 1808.
[3] *Bull. Soc. Nat. Moscov.*, **24**, 1; 1851.
[4] Contrib. Gray Herb. of Harvard Univ., **73**; 1924.
[5] *Curtis's Bot Mag.*, **151**, Tab. 9110; 1925.
[6] In Engler and Prantl, " Die naturliche Pflanzenfamilien", **4**, Abt. 3a: 71-131. Leipzig, 1893
[7] *Ind. Sem. Hort. Petrop.*, **3**; 1837.

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[1] *Jour. Counc. Sci. and Ind. Res. Aust*, **1**, 74; 1927.
[2] *Counc. Sci. and Ind. Res. Aust. Bull*, 44; 1930.

Lines of Large Frequency Shift in the Raman Spectra of Crystals.

Prof. F. Rasetti[1] has described lines in the Raman spectrum of fluorite and calcite, which show a remarkably large shift of about 7000 cm⁻¹. Owing to the theoretical importance of this fact, which would indicate the co-operation of electronic transitions of considerable energy in the Raman spectra, I wish to point out that these lines can be explained as lines of the phosphorescence of gadolinium. It is a well-known fact that natural fluorite nearly always contains rare earths. These earths, when excited by ultra-violet light or cathode rays, show a phosphorescence having a spectrum of very sharp lines. The spectrum of fluorite was examined by G. Urbain.[2] The following table shows that the observed lines coincide with the lines of phosphorescence of gadolinium.

$\Delta\nu$ from Hg λ2537.	Observed lines. λ	Lines of gadolinium, after Urbain. λ
7256	3109	3108
7273	3110	3110
7285	3112	3113
7298	3113	3115

The agreement is as good as the limit of error in the exact measurement of the lines of phosphorescence will allow. In addition, Urbain observed other lines between 3118 A. and 3147 A. That these lines were not observed in the Raman spectrum is easily understood. These lines coincide partly with the strong lines of mercury in this region, and further, Urbain showed that the lines between 3147 A. and 3132 A. disappear when the amount of gadolinium in the fluorite becomes very small. Conversely we can conclude that the material examined by Prof. Rasetti contained only a very small quantity of gadolinium.

An analysis of the spectrum of calcite is not possible, since the spectrum of phosphorescence of gadolinium in calcite has not yet been examined. The known spectrum in calcium oxide shows also in the spectral region under consideration the main lines of gadolinium. Hence in the examination of materials which are likely to show a phosphorescence spectrum of sharp lines, the appearance of such lines, as well as the lines of the Raman spectrum, is, if they are excited with ultra-violet light, always possible.

It can also be seen from the above, that similar lines of large frequency shift are not recognisable in the examination of other materials, since they most probably contain no rare earths.

R. Tomaschek.

Physical Laboratory,
University of Marburg,
July 24.

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[1] Nature, April 25, 1931, p. 626

[2] *Ann. de chim*, 1909, and "Handb. d. Experimentalphysik", **23**, 484; 1928.

The Fine Structure of Spectral Lines of Light Scattered by Liquids.

Gross[1] has investigated by means of an echelon grating the fine structure of spectral lines scattered by liquids, and has found that in addition to the lines scattered without change of wave-length there appear new lines symmetrically situated relatively to the primary ones. The number of those new lines depends from the substance investigated, and the distance between them depends upon the angle formed by the incident and the dispersed rays.

Similar investigations were carried out by Vacher.[2] He used for that purpose a Fabry Perot interferometer. His observations, however, do not confirm Gross's results. Though he found that the primary line is widened by increasing the angle between the incident beam and the direction of observation, yet he states that this widening takes place only towards the long wave-length. Also, he did not observe the appearance of single lines.

The discordance between the results mentioned above induced me to undertake a similar investigation, using a different experimental arrangement. I put the vessel with the liquid investigated inside the mercury lamp, which had the form of a ring (the detailed description of the apparatus will be given in a paper which will be published in *Bull. de l'Acad. Pol.*). A current of 4½ amp. passed through the lamp burning at 110 v. The scattered light after passing through a monochromator fell on a Lummer-Gehrcke plate. I used in my experiments two different quartz plates of thicknesses of 3·92 mm. and 6·888 mm. and lengths of 13 cm. and 20 cm. respectively. In the case of benzene there does not appear in the scattered light any new line, though the components observed by Gross were of the same intensity as the primary component. Taking in consideration Gross's data, those lines should appear half-way between the neighbouring orders of the primary line. The spectra of the scattered light in both cases, benzene and white paper, differ only by the continuous background and by a slight widening of the lines which appears in the case of benzene. I obtained similar results with water.

The same experiments were undertaken with a different arrangement of apparatus; I irradiated the liquid at a definite angle (90°). In this case also the spectrum does not alter in any noteworthy way.

Since Vacher and I are not able to confirm the phenomenon observed by Gross by means of other interferometric apparatus (Fabry Perot interferometer and Lummer-Gehrcke plate), hence a more accurate investigation of that problem, and the explanation of the difficulties involved, would be desirable.

St. Rafalowski.

Physical Laboratory of the Society of
Sciences and Letters, Warsaw,
July 8.

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[1] Gross, Nature, **126**, 201, 400, 603; 1930.

[2] Vacher, *Phys. Ber.*, **12**, 1044; 1931 *C. R.*, **191**, 1121-1123; 1930.

Vitamin A and the Antimony Chloride Reaction.

For the determination of vitamin A by means of the reaction of Carr and Price, the blue colour of the mixture is estimated with the Lovibond tintometer. If analysed by the spectroscope, the blue mixture shows two absorption-bands at 572$\mu\mu$ and 610$\mu\mu$ respectively (Morton). The blue colour depends only on the intensity of the 610 band.

Recently Morton and Heilbron have announced that the strength of different vitamin A preparations corresponds better with the extinction of the mixture in the 572$\mu\mu$ region than in the 610$\mu\mu$ region.

We can confirm this by the following facts: By treating a vitamin A preparation from saponified cod liver oil or saponified extract of cow's liver with some drops of furan, methylfuran, pyrrol, indol, or skatol (all substances of related chemical structure) and then adding antimony chloride, the mixture turns purple instead of blue, and in the spectroscope the 610$\mu\mu$ band is no longer seen, while the 572$\mu\mu$ band remains unaltered. The physiological activity is unimpaired and the preparation (without antimony chloride) shows the 328$\mu\mu$ band just as the original substance did.

It is known that liver may contain indol-like substances and so it can be understood that in some vitamin A preparations the 572$\mu\mu$ band is the stronger and in others the 610$\mu\mu$ band is the stronger. In fact, we have obtained saponified vitamin A preparations in which the two bands were of equal strength and others in which either the 610$\mu\mu$ band or the 572$\mu\mu$ band was the more intense.

A. Emmerie.
M. v. Eekelen.
L. K. Wolff.

Laboratory of Hygiene,
University, Utrecht.

Effect of Light on the Surface Tension of Boys's Soap Solutions.

While investigating the phenomenon of the surface tension of different dilutions of Boys's soap solutions (2·5 per cent sodium oleate and 25 per cent glycerine in water) I found that, whenever the solution was exposed to light, there was an abrupt but small fall of surface tension of the solution; but when the solution was kept in a cool, dark room, this abrupt change was not noticed during the experiment, if all the other conditions remain the same.[1]

In 1924, Du Nouy[2] found that the surface tension of colloidal solutions is not constant, but decreases rapidly as a function of time, and concluded that this phenomenon is due to the adsorption of the molecules in suspension, in the surface layers, as a function of time.

I have found now, by two different methods, namely (1) the surface tension balance method[3] and (2) the weighing method,[4] that the decrease in surface tension is a function of the time for which the solution is exposed to light, and not a mere function of the time as found by Du Nouy. The dark time—that is, the time for which the soap solutions are kept in a cool, dark room—has almost no effect on the surface tension of soap solutions. A possible reason for this is a chemical action, not adsorption in the surface layers alone.

The detailed study of the investigation, with observations, curves, and discussion, will soon appear in the *Indian Journal of Physics*, Calcutta.

L. D. Mahajan.

Physics Laboratory, Mohindra College,
Patiala, India, July 20.

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[1] L. D. Mahajan, "The Surface Tension of Different Dilutions of Boys's Soap-Solution", *Phil. Mag.*, in press.

[2] Du Nouy, P. L., "Surface Tensions of Colloidal Solutions and Dimensions of certain Organic Molecules", *Phil. Mag.*, vol. 48, August 1924, p. 264.

[3] Warren, E. L., "Surface-tension Balance", *Phil. Mag.*, No. 27, August 1927.

[4] "Properties of Matter", by Poynting and Thomson, p. 161.

Inheritance of Melanism in Moths.

In 1926, Prof. J. W. Heslop Harrison and Dr. F. C. Garrett published an account of experiments in which the moth *Selenia bilunaria* was fed upon hawthorn foliage which had been artificially contaminated with salts of lead and manganese respectively. In the second generation of moths fed upon the treated material, melanic forms appeared; and the melanism afterwards was inherited on Mendelian lines. No melanics appeared in the control moths fed upon untreated foliage.

So important are these results as regards the origin of mutations that a repetition of the experiments was begun at the John Innes Horticultural Institution in 1927. Three families from three different localities have been reared, one for five and two for six inbred generations. After two generations fed upon untreated foliage had been raised, in order to ascertain that the material was genetically pure, portions of each family were fed upon foliage treated with lead and manganese respectively, a control portion being also retained on untreated foliage. In all, 1231 control, 1472 lead treated, and 283 manganese treated moths have been reared, and no signs of melanism have appeared in any individual. Analysis showed that the lead, at any rate, was present in the moths of the final generation reared.

A detailed account of the experiments is being prepared for publication; the results, being negative, lead to no immediate conclusions on the hypotheses that had been advanced to account for the results of Prof. Harrison and Dr. Garrett.

A. W. McKenny Hughes.

John Innes Horticultural Institution,
Sept. 12.

The Structure of the Spectrum Se III.

The analysis of the spectra Se IV and Se V has been reported by us in a previous paper.[1] The experimental data described there have led further to the identification of a system of energy-levels characteristic of the spectrum of doubly-ionised selenium. Combinations between the deepest terms $4s^2 4p^2$, ${}^3P$, ${}^1D$ and the terms $4s^2 4p5s$ ${}^3P$, ${}^1P$ have been established by comparison with the spectra of Ge I and As II (unpublished data by K. R. Rao). About two hundred lines belonging to the spectrum have entered into the scheme. The $4s^2 4p^2$ term-differences are ${}^3P_0 - {}^3P_1 = 1740$, ${}^3P_1 - {}^3P_2 = 2196$, ${}^3P_2 - {}^1D_2 = 9095$, the $4s^2 4p5s$ differences are ${}^3P_0 - {}^3P_1 = 504$, ${}^3P_1 - {}^3P_2 = 3610$, ${}^3P_2 - {}^1P_0 = 1265$, and $4s^2 4p^2$ ${}^3P_2 - 4s^2 4p5s$ ${}^3P_2 = \nu 126454$ ($\lambda = 790{\cdot}80$).

The above work was done partly at the Imperial College, London, and partly at the Physical Laboratory, Uppsala. A full report will be published later.

J. S. Badami.
K. R. Rao.

Physikalisch-Technische Reichsanstalt,
Berlin, Aug. 7.

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[1] *Proc. Roy. Soc.*, vol. 131, p. 154; 1931.

Group-Capt. Martin Flack.

In my obituary notice of the late Group-Capt. Martin Flack, I mentioned the fact that, "beginning research with Sir Arthur Keith, he discovered anatomically the sinu-auricular node". These words perhaps do not express fully enough the debt which Martin Flack owed to Sir Arthur, who had been searching for such a structure. He put Flack on to the examination of the heart of a mole, which first gave clear evidence of a structure of which he (Sir Arthur) had found some evidences in the human hearts sent to him for examination by Sir James Mackenzie. Flack completed the discovery by experimental evidence, in the case of hearts of living animals.

Leonard Hill.

Sept. 11.

Radioactivity and Earth Movements.

In a notice of my Glasgow lecture on this subject (Nature, Sept. 5, 1931, p. 419) occurs the passage: "Amongst other instructive conclusions are that 'we may regard the Pacific crust as being like that of the continents' (p. 570)". As I have already received several invitations to justify this alleged "conclusion", I wish to point out that what I actually wrote was: "we may therefore regard the Pacific crust as being like that of the continents, but with gabbro passing down into amphibolite in place of the sialic upper layer".

Arthur Holmes.

Durham, Sept. 12.

Research Items.

Hawaiian Temples.—In the course of a study of the archæology of Kauai Island, Hawaii (*Bull.* No. 80, Bernice P. Bishop Museum), Dr. Windell Clark Bennett describes the various types of *heiaus* (temples), of which there are traces, and discusses their uses and affinities. To-day only their foundations survive. Temple forms are influenced by two factors. Many old temples were remodelled by later chiefs; and the temple architect was a priest whose business it was to study the forms of old *heiaus* and design new ones, incorporating features which seemed to him the cause of the success of important *heiaus*. A great confusion of forms and features was the result. The principal types in both small and large *heiaus* are those (1) with open platforms, (2) walled enclosures, (3) terraced platforms; each of these in the group of larger *heiaus* having several subdivisions. In function the *heiaus* fall into five general classes: (1) The sacrificial *heiau*, called by various names, but chiefly *luakini* and *pookanaka*. (2) The agricultural *heiau*, for which one of the commonest names was *heiau hoouluulu*. Its purpose was to induce rain, increase the crops, and fulfil any other purpose useful to agriculture. (3) Fishing shrines, *hoa*, located along the shore and used in sacrificing to the fish god in order to increase the catch of fish. (4) The *pohaka o kane* or family *heiau*, for private prayer or worship. (5) Miscellaneous *heiaus*, including a great variety of *heiaus* built by lesser chiefs and priests for such purposes as circumcision, aid in child-birth, impelling love, paying debts, surf riding, hula dancing, and tapa making. To-day the purpose of the *heiaus* is little known and the information given is likely to be faulty. There seems to be no connexion between the functional and descriptive classifications.

Malaria in South Africa.—An important survey of the distribution and conditions of spread and of control of malaria in the Transvaal and Natal has been carried out by Prof. N. H. Swellengrebel ("Report on Investigation into Malaria in the Union of South Africa, 1930–31". Union of S. Africa: Dep. Pub. Health, Pretoria, 1931). Of some twenty species of anopheline mosquitoes met with in these two countries, only two, *A. costalis* and *A. funestus*, are of practical importance as vectors of malaria, because they alone enter into such close contact with man that they become infected; this fact much simplifies anti-mosquito, and particularly anti-larval, measures. Interesting details are given of the distribution of various species of anopheline larvæ that may occur in the collections of water met with on an average farm. The prophylactic use of quinine and screening from mosquitoes are found definitely to reduce the incidence of malaria, judged by the 'spleen rate'. Thus the spleen rate among children was 88 per cent in unscreened farms and 44 per cent in screened ones, even though these measures were far from perfect. Recommendations are made for the control of malaria, and include the formation of an administrative control unit and a research field station, instruction of school teachers and of future farmers' wives in the principles of hygiene and anti-malarial measures, promotion of the sale of quinine by the Government, and a system of medical examination of recruited labour before acceptance, so that malaria carriers may be detected and excluded.

Starch Digestion in Silkworms.—It is widely believed that the nutrition of herbivorous insects depends chiefly upon the carbohydrates, starch especially, of their food substances; and in regard to the silkworm it has even been recommended that the nutritive values of mulberry leaves might be determined by the iodine reactions of the leaves. Osamu Shinoda shows that in one race of silkworm ("Hasegawa-Shimpaku") starch is not digested at all (*Annot. Zool. Japon.*, vol. 13, p. 117; 1931). Since the sugar content of the leaves is too low to sustain the life of the larva, whence does it synthesise the carbohydrates? Apparently from proteins, in the presence of desamidase, which is shown to exist in the blood of the fifth instar larvæ experimented with. Another significant discovery was that the wall of the hind-gut was impermeable to glucose, and this leads the author to suggest that the symbiont hypothesis of hind-intestinal organisms in various xylophagous insects (for example, the protozoa of termites, or bacteria of lamellicorn beetle larvæ) requires many more confirmatory experiments.

The Permeability of Protoplasm to Water.—The rate of contraction of the protoplast in a cylindrical plant cell, such as the filament of *Spirogyra* provides during the process of plasmolysis, proceeds so regularly and symmetrically that the volume alterations of the protoplast with time can readily be measured. The velocities thus obtained must either be determined by the rate at which the external solution is penetrating the cell wall, or by the rate at which the solvent, water, is leaving the protoplast. In *Die Naturwissenschaften*, July 24, 1931, Bruno Huber shows that good grounds exist for regarding the velocity of such volume changes as a measure of the permeability of the protoplasm to water. When such measurements are extended over a wide range of biological material, it is evident that the living protoplast has a characteristic water permeability, very different in different objects, in different species, or even in different tissues of the same plant. In a study of the cells of the stem hypodermis of *Majanthemum bifolium*, it appeared that the permeability of the protoplast for water was 10,000 times as high as for cane sugar, 600 times as for potassium nitrate, and 120-140 times as for urea. These data supply interesting quantitative evidence for the 'semi-permeability' of protoplasm in which, as Lillie expressed it (*Amer. Jour. of Physiol.*, 45, p. 406; 1918), "a high degree of semi-permeability . . . appears to require a high degree of impermeability to water".

Genetics of Japanese Morning Glory.—The genetics of the Japanese Morning Glory, *Pharbitis Nil*, has been studied entirely in Japan, during the last twenty years. The species shows much variation in flower-colour and pattern. In a paper by Yoshitaka Imai (*Jour. of Genetics*, vol. 24, No. 2) twenty-one genes affecting flower-colour have been studied. There are three different types of white, as well as purple, magenta, duskish tinged, speckled, rayed, flecked, etc. Flecked and duskish are two mutable genes. The former shows much variation and may give rise to self-coloured bud-sports. Normal plants derived by seed from the normal part of a mosaic flecked plant are in part homozygous normal and in part heterozygous for flecked. Some 'fringed' flowers also arise, which are found to be periclinal chimæras. Duskish gives about one per cent of mutations to the normal blue, and also certain variegated types which vary widely.

Carboniferous Bellerophons.—A memoir by Dr. J. Weir on the "British and Belgian Carboniferous Bellerophontidæ" (*Trans. Roy. Soc.*, Edinburgh, 56, 1931, pp. 767-861, pls. i.-ix.) completes the history of this group of Palæozoic gasteropods in the British area. The forms from the Ordovician and Silurian have already been described by Cowper Reed, and those from the Devonian by G. F. Whidborne in monographs published by the Palæontographical Society. Dr. Weir recognises 78 species and varieties of Bellerophontids in the Carboniferous belonging to 7 genera: *Bellerophon, Waagenella, Bucaniopsis, Patellostium, Tropidocyclus, Zonidiscus*, and *Euphemus*.

Quaternary Ice Margins (North Sea).—Prof. J. K. Charlesworth has published and described a valuable map of north-west Europe, showing the successive positions of the Quaternary ice-margins in the region of the North Sea (*Proc. Roy. Irish Acad.*, **40**, B (4), 1931, pp. 67-83). It is concluded that the Elster and Saale glaciations of Germany and Holland correspond to the older drifts of the British Isles. At the period of the Saale glaciation the ice-sheets were united and their margin over the North Sea cusp-shaped. The Newer Drift of the British Isles is equivalent to the Brandenburg stage of the Continent (or possibly to the Warthe stage). At this time the British ice was separate from the Norwegian ice and formed a piedmont mass over the western part of the North Sea. The Highland glaciation is of the same age as the Finiglacial stage of Fennoscandia; both were local in their distribution and bordered by the late-glacial sea. The new reconstruction, the first to be attempted by a British geologist, corrects certain errors in two of a series of maps recently published by Antevs to show the extent and distribution of the Quaternary ice-sheets in different parts of the world (*Bull. Geol. Soc. Am.*, **40**, 1930, pp. 631-720).

Curvature of Island and Mountain Arcs.—In Nature for Nov. 15, 1930 (vol. 126, p. 787), an account is given of Dr. N. Kumagai's investigation of the form of the Japan islands arc. Prof. T. Terada has recently continued the subject, taking other insular arcs and several mountain ranges (*Earthq. Res. Inst. Bull.*, vol. 9, pp. 144-150; 1931). The island arcs belong to four groups, those of the Pacific Ocean, the West Indies, the Atlantic and Indian Oceans. The results are plotted by taking the latitude of the middle point of the arc as abscissa and the radius of curvature of the arc as ordinate. The diagram is divided into three regions by two straight lines drawn from the origin. The Pacific and West Indian groups lie in the middle region, a result that is of some interest, as the West Indies are usually cited as belonging morphologically to the same type as the Pacific islands. The Atlantic and Mediterranean groups lie in the sector of smallest radius of curvature, and the Indian Ocean group in that of largest radius. In the middle section, and to some extent in the others also, the radius of curvature increases with the latitude. A second diagram shows the corresponding relations for mountain-ranges, and it is worthy of notice that the European mountain arcs fall in the same zone as the Atlantic and Mediterranean island arcs, while the Asiatic mountain-ranges lie, like the Pacific islands arcs, in the middle zone.

Electrification of Coal Dust.—When, in ventilating a coal mine, air containing small quantities of coal dust in suspension is drawn or forced through metal ducts, it is found that the whirling action of the air on the dust is capable of electrifying the dust, and that the electric charges generated are communicated to the metal ducts. If these ducts are highly insulated, they may be raised in electrical potential sufficiently to cause sparks to pass from the ducts to surrounding objects. A research carried out by Messrs. S. C. Blacktin and H. Robinson, of the Safety in Mines Research Board, and issued as Paper No. 71 (London: H.M. Stationery Office, 6*d*.), shows that in order to get such sparks as would be sufficient to cause an explosion of firedamp in a mine, the insulation of the metal ducts has to be so good that under actual mining conditions it would only exceptionally be reached, and the chance of an explosion being produced by this cause is correspondingly small.

Generalised Thermodynamics.—Many attempts to derive the second law of thermodynamics from statistical theories have been made, but particular interest is attached to that given by Prof. G. N. Lewis in the July issue of the *Journal of the American Chemical Society*. The method differs considerably from those of classical thermodynamics and of statistical mechanics, and from a single postulate it is shown that the laws of thermodynamics and the laws of fluctuations are derivable as a generalised thermodynamics. The partition of a quantity x between two (or more) independent systems is made to depend on what are defined as specific probabilities, the ratio of which, for any two partitions, is postulated as dependent solely on the nature of the two systems and on their respective contents. The definition of temperature, entropy and its relation to fluctuations, and thence the general equations of thermodynamics, follow mathematically. Prof. Lewis considers that his postulate constitutes the first really valid statement of the second law of thermodynamics, and his deductions are certainly very interesting and rigorous.

Prediction of Isotopes.—The *Journal of the American Chemical Society* for August contains two papers dealing with the above subject. In the first, by H. L. Johnston, an arrangement which is a kind of periodic table is used, the atoms being arranged in order of isotopic mass numbers. The atoms are first arranged in four main types: the $4N$ type, with atomic weights exactly divisible by four, and regarded as composed of N alpha-particles; the $4N+1$ type, containing one free proton; and the $4N+2$ and $4N+3$ types, containing two and three free protons. A further classification is carried out, based on the number of 'free' electrons in respective nuclei, the numbers at the heads of columns representing nuclear electrons in excess of $2N$, which may be arbitrarily taken as nuclear electrons outside α-particles. Atoms experimentally observed and reported are shown, and possible but hitherto undiscovered atoms are indicated. The latter include Sr^{84}, Zr^{88}, Pd^{104}, Cd^{108}, Te^{120}, A^{38}, Ca^{42}, etc. Aston has directed attention to an isobaric triplet of mass 96, and the table predicts triplets of masses 77 and 124. Certain regularities in the table are emphasised as possibly having significance with respect to structural relationships within the nuclei. The second paper, by H. C. Urey, uses the plot of numbers of nuclear protons and electrons as co-ordinates, as proposed by Barton. The known nuclei lie on this diagram between two lines of slopes 2 and 1·61, there being well-defined clusters, each possessing an approximate centre of symmetry. The pattern from Li^6 to A^{36} is taken to indicate that all possible nuclei in this region are known, or unknown ones very rare. Between A^{36} and Cu^{63} there is a low density of points and irregularity, which seem to indicate unknown nuclei. A parallelogram pattern for these higher nuclei indicates many unknown nuclei. The structure of the nucleus is then considered on the lines of the hypothesis that it consists of helium nuclei, internal binding electrons, external protons, and external electrons, and it is shown that the isotopic isobars Io^{230} and UY may be expected.

Science and Curative Medicine.

IN the fifth Stephen Paget Memorial Lecture before the Research Defence Society (*Quart. Jour. Research Defence Soc.* summer issue), Dr. H. H. Dale gave some examples of the effect of research on curative medicine. After referring to the founder of the Society, in memory of whom the lecture was instituted, Dr. Dale pointed out the remarkable change which had come over therapeutics in the last thirty years. Not only have new drugs been introduced after experimental trial in the laboratory, but also the investigation of old drugs, found to be of use empirically, has resulted in explanations being obtained for their actions, so that they can be prescribed with confidence that they will be of value, rather than with the pessimism which feels that at any rate they will do no harm. Only passing reference need be made to insulin, salvarsan, ipecacuanha and emetine, as their therapeutic efficacy is so well known: but it might be pointed out that the experimental investigation of emetine led to the differentiation of the different dysenteries, for only one of which emetine is a remedy, and finally to the development of a method of cultivating the amœbæ *in vitro*, so that new substances likely to be of value in amœbic dysentery can now be tested first in the test-tube, without the use of experimental animals other than the amœbæ themselves.

Many active remedies are mixtures of different chemical compounds, which it is often impossible to separate by chemical means: even when prepared synthetically in the laboratory, it is not always possible to obtain them in the pure state, free from toxic or inactive by-products: their potency can only be determined by tests on animals or tissues obtained from them. Among these may be mentioned immune sera, the extract of the posterior lobe of the pituitary gland, insulin, salvarsan. Until the potency of pituitary (posterior lobe) extract was controlled under the Therapeutic Substances Act, 1925, one extract might be eighty times stronger than the weakest of a series. Nowadays all are standardised in terms of the International Unit, which is the same amount of activity, whatever preparation is used. Recently a particular make of foreign insulin sold in Great Britain for a short time was imperfectly standardised by animal tests: reports were received that patients relapsed into diabetes because the batch used was too weak, or suffered from dangerous symptoms because another batch was too strong. Animal tests indicated that the batches might be 40 per cent weaker or 60 per cent stronger than the indications on the labels. The controlling authority under the Therapeutic Substances Act had power to deal with this situation, and no more of such inadequately standardised insulin has been distributed. Insulin would never have come into practical use without control of its activity by regular tests on animals: if such tests were now abandoned, it would lose the greater part of its value in the treatment of diabetes.

In concluding his lecture, Dr. Dale referred to the work of the National Institute for Medical Research in preparing international and British standards for remedies requiring biological test and in developing suitable methods of assay; as well as to the researches being carried out in virus diseases.

Activity Coefficients and the Debye-Hückel Equation.

DISCREPANCIES between experimental results and calculations from the Debye-Hückel equation are known to exist even at high dilution with salts of higher valency, as well as for univalent types in non-aqueous solvents. Gronwall, La Mer, and Sandved have assumed that the incomplete mathematical solution of the Poisson-Boltzmann equation as given by Debye and Hückel might explain part at least of the discrepancy. They deduce, as a further approximation, the equation for the activity coefficient of a salt of symmetrical valency type:

$$\log f = \frac{-\epsilon^2 z^2}{kTDa} \cdot \tfrac{1}{2} \cdot \frac{x}{1+x} + \sum_{m=1}^{\infty} \left(\frac{\epsilon^2 z^2}{kTDa}\right)^{2m+1} \left[\tfrac{1}{2} X_{2m+1}(x) - 2m\, Y_{2m+1}(x)\right]$$

in which ϵ, z, k, T, D have the usual significance in the Debye-Hückel theory; $x =$ 'a' k, where 'a' is the distance of closest approach of the ions; and $X(x)$, $Y(x)$ are functions of x defined and tabulated through the fifth approximation, that is $m = 2$.

For values of $a/z^2 > 1{\cdot}5$ A., only the first term of this expression, corresponding to the Debye-Hückel approximation, is usually required, but for lower values, corresponding to 'a' < 6 A. for a bi-bivalent salt, the contribution of higher terms cannot be neglected. In low dielectric solvents the higher terms become important, and may even predominate over the first approximation even for 1, 1 valent types. The general solution should yield positive and physically reasonable values for 'a' which are constant over a legitimate concentration range.

La Mer and Parks, in the June number of the *Journal of the American Chemical Society*, describe experiments with cells involving the process $Cd + PbSO_4 = Pb + CdSO_4$ (using cadmium and lead amalgams), which were in good agreement with the theory for the region 0·0006 to 0·01 molal, and yielding positive constant (3·6 A.) values of 'a' which are physically plausible. The Debye-Hückel approximation gave impossible values of 'a'. If cadmium sulphate is dissociated incompletely in the classical sense, this influence on the activity coefficient is too small to be detected below 0·01 molal. It is also shown that 'a' is practically independent of temperature, so that hydration is probably not included in it.

Scatchard, in the same journal, points out that it is incorrect to calculate the heat of dilution from the interionic force formula by differentiation at constant volume, since the experimental data refer to constant pressure. The difference between the two heat quantities is small and can be determined, that between the two dielectric constants is probably also very small, but that between the temperature coefficients at constant pressure and constant volume is generally more important. The calculations are, therefore, made for constant pressure, which involves the addition of a term dependent on the thermal expansion of the solution. The difference is said to amount to about the error of measurement of heat of dilution in very dilute solutions. In the calculation the dielectric constant is assumed independent of concentration, but the extended calculation of Gronwall, La Mer, and Sandved referred to above is applied instead of the simple limiting law of Debye and Hückel. Even in the use of the limiting law, however, neglect of thermal expansion is shown to lead to considerable error.

Archæology and Surveying in Southern Rhodesia.

WE have at times had occasion to refer to difficulties placed in the way of archæological and ethnological research owing to vexatious regulations imposed by the governments of the countries in which research is to be prosecuted. It is not often that the other side of the picture is presented, and that an accredited expedition is known to have abused the privileges that have been granted. Our attention has been directed to a particularly flagrant case. The official report of the Debates of the Legislative Assembly of Southern Rhodesia for May 7 records a reference to the case of Dr. Frobenius, who, it will be remembered, conducted an expedition in Rhodesia in 1929 and communicated some of the results of his investigations at Zimbabwe and elsewhere to the South African meeting of the British Association in that year. Dr. Frobenius, it is stated, was in receipt of substantial assistance from the Government of Southern Rhodesia. A money grant of £92 : 4 : 0, representing half the costs, was supplemented by an equivalent share borne by the railways, and, in addition, a native commissioner was granted six weeks leave on full pay to assist him.

Notwithstanding the fact that, in return, Dr. Frobenius entered into an agreement to share any finds equally with the Government and to submit any specially valuable find to arbitration, the whole of the relics found were removed from the country without the knowledge of the Government. When this was condoned on the condition that they were divided up at Cape Town, they were removed to Germany. Since then Dr. Frobenius has returned such objects as he considers the share of the Government, and has refused either to return or to submit to arbitration the only gold object stated by him to have been found within the Colony. The Colonial Secretary, in making a statement on the matter, was good enough to contrast the action of Miss Caton-Thompson, on behalf of the British Association, in returning all her finds to the Colony.

According to the official report of the debates in the Legislative Assembly of Southern Rhodesia, in the debate on the estimates the deletion was moved of the item "Geodetic and Secondary Triangulation, £5000." In defending the appropriation the Minister of Agriculture and Lands pointed out not only that every self-respecting colony undertakes work of this kind as early as possible in its history, but also that had Southern Rhodesia started it earlier a great deal of money would have been saved. It would appear that much of the present cost of the Geological Survey is due to the fact that, before the Geological Department can pursue its legitimate work of mapping the geological formations, much preliminary work has to be done, which is made necessary by the fact that there is no Ordnance Survey to which reference can be made. Indeed, it was stated by another member that the surveyors who are engaged in the work of triangulation often have to refer to the Geological Survey for information. The Minister also referred to the position in the Union of South Africa. In the Boer war it was found that the maps of the country were utterly defective and a reproach. Immediately after the Union a triangulation of the whole country was begun, and the expenditure now stands at £20,000 a year. The result is that, as the Director states, the triangulation of the Union, which is just about completed, is as fine as any in the British Empire. The motion to delete the appropriation was withdrawn.

In the same debate reference was made to expenditure on afforestation, in which Southern Rhodesia is also pursuing a forward policy. Indeed, throughout the debates it is encouraging to note that the members of the Legislature are fully alive to the advantages of the application of science to the development of the colony, even if not immediately remunerative.

Exhibition of British Optical Instruments.

THE Loan Exhibition of British Optical Instruments which was opened at the Science Museum, South Kensington, on Aug. 28, will remain on view until the end of October, and will provide the public with an opportunity to see collected together in a comparatively small space representative exhibits contributed by most of the important optical firms in Great Britain.

Binoculars are very adequately represented by the exhibits of Messrs. Ross and Messrs. Barr and Stroud, among those of the former being a three power prism binocular telescope with objective aperture of 60 mm. Telescopes are exhibited by Messrs. Ross and Messrs. W. Ottway and Co., the latter firm showing also a selection of stainless steel mirrors. Photographic objectives designed for special purposes, such as aerial photography, the projection and taking of cinema pictures, etc., have received considerable attention by British manufacturers in recent years, and these are included in the lenses shown by Messrs. Ross and Messrs. Taylor, Taylor and Hobson. A portable cinematograph, taking standard size films, is notable amongst Messrs. Ross' exhibits.

Among the surveying instruments is the Tavistock theodolite, reading to one second of arc, which is made by Messrs. Cooke, Troughton and Simms, who are also exhibiting a 45° prismatic astrolabe. This instrument has been designed for the accurate determination of latitude and longitude on shore, and has been used with marked success by the Hydrographic Service of the Admiralty. Messrs. E. R. Watts and Son are showing a selection of 'constant' bubbles, the air-bells of which remain the same length over a wide range of temperature, a vertical magnetic force variometer, and various surveying instruments. A selection of 'Heath' sextants is shown by Messrs. W. F. Stanley and Co.

The collection of microscopes includes a new binocular instrument made by Charles Perry, according to the design of Prof. D. M. S. Watson, of University College, London, and a new model Vickers projection microscope. The latter, which is of very robust design, taking objects up to 50 lb. in weight, can be used for opaque or transparent objects at magnifications of from 3 to 5000 diameters, and is fitted up for demonstration. Other firms exhibiting microscopes are Messrs. J. Swift and Sons, Messrs. C. Baker, and Messrs. W. Watson and Sons. The last-named firm is exhibiting also a selenium densitometer, designed by the British Photographic Research Association, for determination of the density of photographic negatives.

An aerial camera, of a type which has been used all over the world, is exhibited by the Williamson Manufacturing Co. This takes 100 photographs (9 in. × 7 in.) with one filling. Topographical stereoscopes designed for use in examination of aerial photographs for surveying purposes are shown by Messrs. Barr and Stroud.

A small model Hilger interferometer for the correction of prisms and lenses is fitted up to show the optical imperfection of a piece of glass, and a strain viewer by the same makers is arranged to show strain in a glass tumbler. In addition to a spectrographic outfit for metallurgical analysis, Messrs. Adam Hilger are exhibiting an outfit for spectrophotometry in the ultra-violet region of the spectrum. Messrs. Bellingham and Stanley also are showing a spectro-photometry outfit. This apparatus assumes a special interest just now in connexion with the spectral test employed by Dr. Bendien in his experiments on cancer diagnosis. This consists of a spectrograph with quartz optical elements, and a photometer of the sector type driven by an electric motor; the photometer design is based partly on the suggestions recently made by H. J. McNicholas in the Bureau of Standards *Journal of Research*, vol. 1, pp. 942-949. Absorption measurements are obtained by taking a number of exposures, each with a different opening of the variable sector. On the resulting photograph, positions are found in each spectrum where the amount of light passing through the tube of solution is equal to that passed by the variable sector, and from the data obtained an accurate absorption curve can be obtained. Polarimeters for use in the visible and ultra-violet are shown by both these makers.

A rangefinder by Messrs. Barr and Stroud, specially adapted for short ranges in the Museum, is fitted up for demonstration. The internal construction of a rangefinder and various optical parts used in the construction are also shown.

Price catalogues of the instruments in the exhibition are available to the public.

The exhibition is on view during the normal opening hours of the Museum, namely, Mondays, Tuesdays, Wednesdays, Fridays, 10 A.M. to 6 P.M.; Thursdays and Saturdays, 10 A.M. to 10 P.M.; Sundays, 2.30 P.M. to 6 P.M.

Evolutionary Tendencies in the Jaws and Teeth.

DURING the recent International Orthodontic Congress in London, Prof. Elliot Smith delivered an address on "Evolutionary Tendencies in the Jaws and Teeth". He pointed out that, in the human child, there is a delay of four years after the milk teeth have erupted before the permanent teeth commence to appear, and a further ten to fifteen years are required to complete its dental equipment. Up to the seventh year, that is, during the pause between milk and permanent teeth, the child is growing a very large brain, and, again, for a further period of fifteen years or so, when his dental affairs are relatively sluggish, he is learning how to put his complicated cerebral equipment to its fullest biological uses. During this period he develops a chin, because the growth of the tooth-bearing part is restrained by the long delay in the eruption of his teeth. The delay in tooth and jaw development is undoubtedly due to the growth of the brain and the subsequent development of its full functions, which disturbs the orderly process of uniform growth of the jaws and eruption of teeth.

In the apes, the process of eruption of the second teeth follows more closely on that of the first teeth; the second permanent molars erupt before the deciduous molars are replaced by the premolars. Dr. Degerøl, of Copenhagen, has recently pointed out that, in Neanderthal man, the simian type of sequence was still retained in the eruption of his teeth. There are reasons for inferring that the defective chin development of Neanderthal man may be associated with this fact—that the precocious cutting of his teeth permitted the tooth-bearing part of the jaw to keep pace more nearly with the growth of the rest of the jaw and preclude the development of a chin.

In the evolution of man from his simian ancestors the two fundamental structural advances were the great growth of the brain and the changes in the facial region culminating in the development of a chin. To the consequences of these evolutionary changes must be ascribed the origin of the problems of orthodontia. There is no just reason for the belief that the reduction or absence of the third molar is a sign of the early disappearance of this tooth in the human species, or that dental troubles, such as crowding and displacement of teeth, are due to evolutionary changes now active.

University and Educational Intelligence.

CAMBRIDGE.—At St. John's College the following research exhibitions have been awarded: for biochemistry, M. C. Franklin, Canterbury Agricultural College; for experimental physics, R. H. Sloane, Queen's University, Belfast.

THE City and Guilds of London Institute gives prominence in its report for 1930 to the work of the South London Technical Art School established at Kennington in 1879 for training persons engaged in the art industries of the locality, which were chiefly modelling from terra cotta, and for the study of architectural decoration. The school occupies a unique and useful place and has trained the majority of the leading sculptors and some of the foremost painters in Great Britain. The Engineering College was attended by 522 students, a larger number than in any of the four preceding years, and the number of first-year diploma and undergraduate students and of special and post-graduate students was larger than in any year since before the War. The number of candidates examined at the Institute's technological examinations in Great Britain and Ireland and overseas (chiefly in India and Ceylon and New Zealand) increased, respectively, to 14,721 (more than in any year since the War) and 1608.

SOME trends in recent scientific research in America are reflected in statistics of the doctorates conferred in the sciences in American universities. These have been tabulated year by year since 1919 by the National Research Council, the annual bulletin of which on the subject constitutes a useful index to the relevant theses. The total number of these doctorates has increased every year, rising from 336 in 1921 to 1055 in 1930. Of the subjects of the 1055 theses on which science doctorates were conferred last year, about one-third are, as usual, in the field of chemistry. Next comes zoology with 100. Psychology has dropped from 112 to 92 and physics from 101 to 89. All previous records were broken in botany (81), mathematics (74), geology (63—previous record 45), engineering (49), physiology (46), geography (17), whilst the following universities conferred more science doctorate than they have ever done before: Wisconsin (86), Cornell (80), Michigan (55), Ohio State (50), Massachusetts Institute of Technology (29), Pittsburg (15), Virginia (12), Indiana (11), Kansas (11).

Birthdays and Research Centres.

Aug. 26, 1860.—Sir Thomas Ranken Lyle, F.R.S., formerly professor of natural philosophy in the University of Melbourne.

During the last ten years, in addition to being associated in many public utilities, both industrial and educational, I have, in conjunction with my private assistant, Mr. Z. A. Merfield, been carrying on researches aiming at the improvement of diffraction gratings and microscopic test-rulings. The late Mr. Grayson's ruling machines, which I purchased from his executors, have in many respects been reconstructed and improved.

We have developed a type of speculum metal with a high reflecting power which is untarnishable, and we can prepare and polish the ruling diamond so as to have any desired operating faces. Thus we are able to produce gratings by which the major portion of the incident light is diffracted into any desired spectrum.

We have supplied rulings to different research institutes, on speculum for optical work and on glass for X-ray investigations. We have also succeeded in producing microscopic rulings for ultra-violet investigations with rulings at rates up to 250,000 an inch.

The work is being continued; at present, on further improvement of speculum and on more accurate temperature control of the ruling chamber.

Sept. 23, 1850.—Prof. Richard Hertwig, foreign member of the Linnean Society of London and formerly professor of comparative anatomy and zoology in the University of Munich.

Zurückblickend auf die sechsig Jahre meiner zoologischen Thätigkeit, empfinde ich es als ein grosses Glück, dass in diesen Zeitraum der gewaltige Aufschwung fiel, den die Biologie dem Wirken Darwins verdankt. Dieser Aufschwung kam zunächst der Morphologie zu Gute, der vergleichenden Anatomie und Entwicklungsgeschichte. In den letzten Jahrzehnten folgte die experimentelle Zoologie, die exacte Erblichkeits- und Variabilitätsforschung und die vergleichende Physiologie.

Mir will es sogar scheinen, als ob durch die grossen Erfolge der experimentellen Zoologie die morphologischen Probleme allzusehr in den Hintergrund gedrängt würden. Lange Zeit mit experimentellen Untersuchungen beschäftigt, habe ich mich neuerdings wieder der Morphologie der Radiolarien zugewandt und mich überzeugt, wie viel Interessantes hier noch zu entdecken ist. Die Morphologie bildet die Basis, auf der die Physiologie weiter baut. Wir müssen trachten, diese Basis ständig zu verbreiten und zu sichern. Damit werden wir auch der Palaeontologie und Thiergeographie gute Dienste leisten.

Sept. 23, 1850.—Prof. W. Mitchinson Hicks, F.R.S., emeritus professor of physics in the University of Sheffield.

I should like to publish a new edition of my "Analysis of Spectra", which is now out of print; but the advances in real observational knowledge and in that of spectral relationships since its appearance in 1922 are so enormous that it would be hopeless at my age to attempt it. I am anxious, however, to put into form for publication a connected account of the fundamental quantitative relations in spectra contained in that book and of new data in support.

Sept. 24, 1874.—Prof. Alex. Findlay, professor of chemistry in the University of Aberdeen.

The fact that Pasteur's method of resolving racemic compounds by crystallisation from solution has found application in only a small number of cases, provoked the investigations in which I have been engaged in recent years. What connexion, if any, exists between the constitution of a racemic compound and its stability relative to that of the active antipodes, and what are the factors which influence the temperature at which the relative stability of racemic and active forms undergoes change? Answers to these questions have been sought by a study of freezing point and solubility curves.

I have also been much interested in the pædagogy of chemistry, and in my leisure time I am collecting materials for a history of chemical teaching in Aberdeen.

Sept. 24, 1865.—Prof. C. F. Jenkin, formerly professor of engineering science in the University of Oxford.

I am chiefly interested in investigations on the fatigue of metals and building materials; and in earth pressures.

Sept. 26, 1881.—Mr. P. P. Laidlaw, F.R.S., pathologist to the Medical Research Council.

I am at present engaged on the improvement of dog distemper anti-serum and the separation and purification of the most active constituent of whole serum, so that a therapeutic product of high potency can be secured at will. It is hoped that the knowledge gained from this study may be of assistance in the production and improvement of anti-sera for other virus diseases.

The outstanding problem for the research worker in virus diseases is believed to be luxuriant cultivation of viruses, apart from living cells, and it is hoped that many workers will endeavour to solve this problem.

Societies and Academies.

London.

Institute of Metals, Sept. 14 (Annual Autumn Meeting, Zurich).—**H. Waterhouse** and **R. Willows**: The effects of cold-rolling and of heat-treatment on some lead alloys. The hardness numbers of the cast alloys ranged from 5 to 18 Brinell. Cold-rolling hardened the soft alloys and softened the hard alloys, the hardness immediately after cold-rolling lying in all cases between 8 and 11 Brinell. Most of the alloys, especially those containing cadmium and antimony, were re-hardened to approximately the 'as cast' hardness by suitable heat-treatment, quenching and ageing. Certain alloys age-hardened after air-cooling or even more restrained cooling from the heat-treatment temperature. The age-hardness persists for several months at least, but is destroyed by severe cold-working and self-annealing.—**H. Sutton** and **L. F. Le Brocq**: The protection of magnesium alloys against corrosion. Of the methods of protection examined the most promising appeared to be that of chemical treatment of the surface followed by the application of lanolin or a suitable enamel.—**D. G. Jones**, **L. B. Pfeil**, and **W. T. Griffiths**: Nickel-copper alloys of high elastic limit. The elastic limit is low in substantially pure nickel-copper alloys in the fully annealed and in the cold-drawn conditions, but high elastic limits are developed in all compositions as a result of low temperature heat-treatment following cold-working. High elastic limits may also be produced in nickel-copper alloys containing small amounts of such elements as silicon, which render the alloys susceptible to heat-treatment.—**D. Hanson** and **I. G. Slater**: Unsoundness in aluminium sand-castings. (1) Pin-holes: their causes and prevention. To eliminate pin-holes treatment with nitrogen or with chlorine is sometimes successful, but cannot always be relied upon to produce castings perfectly free from pin-holes; titanium tetrachloride is effective with 'Y'-alloy, but was found to be less certain with other alloys, although the grain-refinement which it produces may make the pin-holes very small without reducing the total volume of the cavities. The most generally successful method is treatment with a mixture of equal parts of nitrogen and chlorine, by means of which all the alloys examined could be made practically sound by a treatment of twenty minutes' duration at 700° C.—(2) The effects of using metal previously subjected to corrosive conditions. The extent and amount of unsoundness produced depends upon the type and time of exposure, and also upon the particular alloy examined. The suggestion is made that the deterioration is the result of electrolytic action on corrosion, involving the liberation of hydrogen in the nascent state which is absorbed by the metal. On re-melting and casting, the hydrogen is evolved in the molecular condition and produces pin-holes.—**William Hume-Rothery**: The macro-etching of aluminium-silicon alloys. The macrostructure of aluminium-silicon alloys can be revealed satisfactorily by means of a solution of cupric chloride containing 150-160 gm. per litre. Etching is carried out by immersing the specimen several times in the copper chloride solution, the deposit of copper being removed between each immersion. A final brightening can be obtained by treatment with a dilute solution of chromic acid.—**J. E. Newson** and **A. Wragg**: Note on the failure of a high-strength brass. The reeling process for straightening, after extrusion, in the case of a brass with a high yield-point, is responsible for residual stresses of such an order that failure due to internal cracking may result during storage or on subsequent machining.

PARIS.

Academy of Sciences, July 27.—**C. Camichel**, **C. Crescent**, and **L. Escande**: Contribution to the study of intermittent springs with underground gallery. Experimental study of the causes of variable flow.—**J. Pasquier**: The equations $s=f(x, y, z, p, q)$, integrable by the method of Darboux.—**Edouard Callandreau**: The conjugated points of de Fontviolant's equation of elasticity.—**Alfred Rosenblatt**: The stability of laminar movements of viscous incompressible liquids. —**Henri Mineur**: A new method for the study of galactic rotation.—**Pierre Guintini**: The movement of rotation of the *B*-type star ensemble.—**P. Biquard**: The absorption of ultra-sound waves by water.—**Paul Bizos** and **Tarlé**: The unification of all forms of string instruments.—**R. Guyot**: The reflection of very short electromagnetic waves. Pierret oscillators furnish a means of obtaining short electromagnetic waves, 12-20 cm. in length. The reflection of these short waves by water and by saline solutions has been studied. Results are given for water and for fourteen salt solutions, containing up to 13 per cent of common salt.—**Léon Bloch**, **Eugène Bloch**, and **Pierre Lacroute**: Multiplets in the spark spectrum of bromine (Br II).—**C. Marie** and **N. Thon**: The measurement of the stresses of electrolytic deposits of metals.—**Charles Liagre**: The theory of the lead accumulator. The experiments described lead to the conclusion that the classical equation PbO_2+Pb+ dilute sulphuric acid in excess$\rightleftharpoons 2PbSO_4+$dilute sulphuric acid is a true expression of the facts.—**R. Lespieau**, **M. Bourguel**, and **R. L. Wakeman**: The Raman effect in chemistry. The sensibility of organic spectrum analysis. Analysis by the Raman spectrum, improved by the use of the Chalonge and Lambert microphotometer, detects a very small quantity of an ethylenic hydrocarbon in the presence of cyclo-hydrocarbons, and can determine the proportion of the former to about 1·3 per cent.—**M. Prettre**: The ignition of mixtures of acetaldehyde and air. These mixtures show a double ignition point similar to the air-hydrocarbon mixtures previously described. The lower point can be suppressed by the addition of an antidetonant such as lead ethyl.—**Charles Dufraisse** and **Marius Badoche**: Researches on the dissociable organic oxides. The hydrocarbon produced by the removal of a phenyl group from rubrene. The compound obtained by the prolonged action of the Grignard reagent on iso-oxyrubrene, although a phenyl group has been removed, still retains the essential characters of rubrene.—**Paul Fallot**: The geology of the neighbourhood of Xauen (Spanish Rif).—**Jean Risbec**: A parasite of the spring caterpillar of the cotton plant (*Earias huegli*).—**Georges Bourguignon**: The relations of vestibular chronaxy with emotivity, in the normal state, in pseudo-Mongolism and in dementia præcox.—**E. Brumpt**: Pruritis and dermatitis produced in bathers by the cercariæ of fresh-water molluscs.—**A. Blanchetière**: The action of pepsin on the solutions of monamino-acids, isolated or mixed.—**Georges Blanc** and **J. Caminopétros**: Experimental researches on the sensibility of domestic animals, carriers of *Rhipicephalus sanguineus*, to the virus of exanthematic fever. Domestic animals (dog, rabbit, rat, pig, sheep, pigeon), normal carriers of *R. sanguineus*, are not sensible to the virus of exanthematic fever. The fact that the virus of this fever is transmitted by *R. sanguineus* to its descendants proves that exanthematic fever in the Mediterranean region is an infection of the tick of the dog, without any domestic animal acting as a reservoir of the virus.—**Marcel Labbé**, **Maurice Villaret**, **L. Justin-Besançon**, **Mlle. D. Kohler**, **Mme. Schiff-Wertheimer**, and **P. Soulié**: Preliminary researches on certain protrusions of the eyeball, especially Basedowian exophthalmia.

LENINGRAD.

Academy of Sciences, *Comptes Rendus*, 1931, No. 3. —**A. Tsvetkov**: On the fundamental psycho-physical law. A formula is offered to express the relation between the intensity of the stimulus and the number of the excited nerve cells.—**J. Orlov**: The remains of a primitive representative of Pinnipedia from the neogene deposits in western Siberia. The remains have been found in fresh-water neogene deposits near Pavlodar. The animal is described under the name *Semantor macrurus* g. et sp. n., and regarded as belonging to a new family Semantoridæ, which differs more from the three known families of Pinnipedia than these families differ between themselves.—**K. K. Flerov**: (1) A review of the elks (*Alces* Gray) of the Old World. Three subspecies of *Alces alces* L. are distinguished, namely, *A. alces alces* L. distributed from western Europe as far east as the Yenisei river and the Altai mountains; *A. alces pfizenmayeri* Zukov. (with *jakutensis* Millais and *bedfordiae* Lyd. as synonyms) occurring east of the Yenisei; and *A. alces* subsp. from the Ussuri region.—(2) On the generic characters in the family Tragulidæ (Mammalia, Artidactyla). Three genera of living Tragulidæ are distinguished, namely, *Moschiola*, *Hyemoschus*, and *Tragulus*.—**G. Nadson** and **E. Stern**: The combined action of metals and of X-rays on yeasts. Oligodynamic action of metals on yeasts is altered if the metals act simultaneously with X-rays. In this case the oligodynamic effect of different metals shows an inverse correlation with their atomic weight. —**E. Stern**: The combined action of metals and X-rays on luminous bacteria. Experiments with *Photobacterium phosphorescens* confirmed the results obtained with yeasts (see above).

Official Publications Received.

British.

Journal of the Indian Institute of Science. Vol. 14A, Part 2: The Photochemical Oxidation of Organic Hydrocarbons. Part 2: Toluene, and the Oxidation of Benzaldehyde. By C. J. Kothari and H. E. Watson Pp. 11-30. (Bangalore.) 1.4 rupees.

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape, (and the Karoo Garden, Whitehill, near Matjesfontein), for the Year ending 31st December 1930. Pp. 30. (Kirstenbosch.)

Transactions and Proceedings of the New Zealand Institute. Vol. 62, Part 1, March. Pp. 66. (Wellington.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 416, August. Pp. 983-1044+xx. (London: E. and F. N. Spon, Ltd.) 10*s* 6*d*.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1369 (Ae. 496—T. 3062): Further Experiments on the Flow around a Circular Cylinder. By A. Fage and V. M. Falkner. Pp. 13+10 plates. 1*s*. net. No. 1371 (Ae. 498—T. 3054): Drag Tests on a Large Model in a Small Tunnel. By F. B. Bradfield and W. G. A. Perring. Pp. 11+10 plates. 9*d*. net. No. 1385 (M. 70—T. 2974 and a): Mode of Deformation of a Single Crystal of Silver By Dr. H. J. Gough and H. L. Cox. Pp. 13+8 plates. 1*s*. net. (London: H.M. Stationery Office.)

Foreign.

Department of Agriculture, Straits Settlements and Federated Malay States. Scientific Series, No. 5: The Bionomics of some Malayan Rhynchota (Hemiptera-Heteroptera.) By N. C. E. Miller. Pp. ii+142. (Kuala Lumpur.)

The Bulletin of the Central Meteorological Observatory of Japan. Vol. 4, No. 1: Note on the Meteorology of the Sun. By Rikiti Sekiguti. Pp. ii+88. Vol. 4, No. 2: The Climate of Japan. By T. Okada. Pp. vi+89-416+10+35 plates. (Tôkyô.)

Publications of the Astronomical Observatory of the Warsaw University. Vol. 6. Pp. iii+60. (Warsaw.)

The Carnegie Foundation for the Advancement of Teaching. Twenty-fifth Annual Report of the President and of the Treasurer. Pp. vii+206. (New York City.) Free.

Records of Oceanographic Works in Japan. Compiled by the Committee on Pacific Oceanography of the National Research Council of Japan. Vol. 3, No. 2. Pp. ii+35-62+11 plates. (Tokyo: National Research Council of Japan.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 310: On the Diffraction of Proton Wave. By Yoshikatsu Sugiura. Pp. 29-40. 20 sen. No. 311: The Solarization of Fluorite, and the Law of Lumino-Transformation. By Satoyasu Iimori and Eiichi Iwase. Pp. 41-67+5 plates. 45 sen. Nos. 312-315: Physical Investigations of Conflagrations in Tokyo, by Torahiko Terada and Tyokuro Utigasaki; Propagation of Combustion along the Surface of Inflammable Liquid, Part 1, by Tosirô Kinbara; Rupture Phenomena of Liquid Drops, by Toshimasa Tsutsui; Effects of Carbon and Iron in Blue Powder on Sherardizing (Abridgment), by Masawo Kuroda. Pp. 69-126+8 plates. 95 sen. (Tokyo: Iwanami Shoten.)

Catalogues.

Floras (and Kindred Subjects) of Europe, Asia, Africa, America and Australia. (Catalogue No. 188) Pp. 16. (London: Dulau and Co., Ltd.)

Price List of Microscopical Rock Sections and Geological Accessories. Pp. 12. (London: Gregory, Bottley and Co.)

Standard Meteorological Instruments. (List M.2.) Pp. 140. (London: Negretti and Zambra.)

A Catalogue of Book Bargains. (No. 530). Pp. 16. (London: William Glaisher, Ltd.)

Diary of Societies.

TUESDAY, September 22.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—Mrs. Norman Lowe: A Rambler in Siam.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.

FRIDAY, September 25.

Electroplaters' and Depositors' Technical Society (in Rehearsal Room of the Royal Albert Hall), at 3 30.—Dr. R. S Hutton: The Rise and Early Development of Electroplating (Address).—At 7.30.—D. J. Macnaughtan: Electrodeposition and the Engineer (Address).

CENTENARY.

September 19 to 25.

Faraday Celebrations.

Saturday, Sept. 19 (at Royal Institution).—Reception.

Monday, Sept. 21, at 11.30 A.M. (at Royal Institution).—Informal Meeting.
At 3.—Reception.
At 8 P.M. (at Queen's Hall).—Commemorative Meeting. Speeches by Representatives of Institutions in various parts of the world.

Tuesday, Sept. 22, at 10.30 A.M. (at Kingsway Hall)—Conference.
At 8 30 P.M. (at Royal Institution).—Conversazione.
At 8.30 P.M. (at Institution of Electrical Engineers).—Conversazione.

Wednesday, Sept. 23, at 4.30 (at Royal Albert Hall).—Faraday Exhibition.

Thursday, Sept. 24, at 3 (at National Physical Laboratory)—Garden Party.

Friday, Sept. 25, at 7.45 (at Dorchester Hotel)—Entertainment by H.M. Government.

CONGRESSES.

September 1 to 19.

International Illumination Congress. (For Programme see Nature, Aug. 29.)

September 13 to 18.

Institute of Metals. (For Programme see Nature, Sept. 5.)

September 13 to 19.

International Medical Educational Congress (with special reference to Balneology) (at Carlsbad).

September 16 to 24.

International Geographical Union (at Paris).

September 18 to 20.

National Smoke Abatement Society. (For Programme see Nature, Sept. 12.)

September 18 to 21.

Association of Special Libraries and Information Bureaux (at Lady Margaret Hall, Oxford). (For Progamme see Nature, Sept. 12.)

September 20 to 27.

Institut International d'Anthropologie (at Paris).—Sections: Morphological Anthropology and Study of Races; Human Palæontology and Archæology; Eugenics and Heredity; Psychosociology and Criminology; Ethnography, Folklore, and Human Geography.

September 23 to 25.

Institution of Mining Engineers (at Manchester).

September 23 to 26.

International Climatological Commission (at Innsbruck).

September 23 to 30.

British Association for the Advancement of Science (Centenary Meeting).

Wednesday, Sept. 23, at 3 (in the Royal Albert Hall).—Installation of President.
At 9 P.M. (in Central Hall).—Genl. Smuts: The Scientific World-Picture of To-day (Presidential Address).

Thursday, Sept. 24, at 10 A.M.—Sir J. J. Thomson: The Growth in Opportunities for Education and Research in Physics in the past Fifty Years (Presidential Address to Section A)
Brig.-Genl. Sir Harold Hartley: Michael Faraday and the Theory of Electrolytic Conduction (Presidential Address to Section B).
Prof. J. W. Gregory: Presidential Address to Section C.
Prof. E. B. Poulton: A Hundred Years of Evolution (Presidential Address to Section D)
Prof. A. R. Radcliffe-Brown: Presidential Address to Section H.
Sir Charles Grant Robertson: Educational Development; 1831–1931: A Centenary Retrospect and a Forecast (Presidential Address to Section L).
At 2.—Sir Arthur Smith Woodward: Geology as a Subject for Local Societies (Presidential Address to Conference of Delegates of Corresponding Societies).
At 9 P.M.—Prof. W. A. Bone: The Photographic Analysis of Explosion Flames (Evening Discourse, in Royal Geographical Society's Hall).
Sir P. Chalmers Mitchell. Zoos and National Parks (Evening Discourse, in Royal College of Music).

Friday, Sept. 25, at 10 A.M.—Prof. E. Cannan: The Changed Outlook in regard to Population, 1831–1931 (Presidential Address to Section F)
Sir John Russell: The Changing Outlook in Agriculture (Presidential Address to Section M).
At 10.15 A M.—Sir Halford J. Mackinder: The Human Habitat (Presidential Address to Section E).
At 5.—Sir Alfred Ewing: Presidential Address to Section G and Bramwell Trust Lecture.

Saturday, Sept. 26, at 9 P.M.—Sir Arthur Keith: The Construction of Man's Family Tree (Evening Discourse, in Royal Geographical Society's Hall).
Sir Oliver Lodge: A Retrospect of Wireless Communication (Evening Discourse, in Royal College of Music).

Monday, Sept. 28, at 10 A.M.—Dr. H. H. Dale: The Biological Nature of Filtrable Viruses (Presidential Address to Section I).
Dr. C. S. Myers: The Nature of Mind (Presidential Address to Section J)
Prof. T. G. Hill: The Advancement of Botany (Presidential Address to Section K).
At 3.30.—Dr. A. Macrae: Guidance in the Choice of an Occupation (Public Lecture, at London School of Economics).

Tuesday, Sept 29, at 8.30 P.M.—Dr G. Thilenius: Some Biological Viewpoints in Ethnology (Huxley Memorial Lecture of the Royal Anthropological Institute).
At 9 P.M—Sir James Jeans: Beyond the Milky Way (Evening Discourse, in Central Hall).
Dr S. Kemp: Oceanography in the Antarctic (Evening Discourse, in Royal Geographical Society's Hall).

September 24 to 27.

Swiss Society of Natural Sciences (at La Chaux-de-Fonds and Le Locle).
Prof. A. Piccard: Ascent into the Upper Atmosphere in a Sealed Car attached to a Balloon (Lecture).
Dr. C. Perret: Film on the Life of Bees.
Prof. P. Arbenz: The Geological History of South Africa and Its Camp Sites (Lecture).
Prof. Pérez: Rhizocephalods Parasitic on Hermit Crabs (Lecture).

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SATURDAY, SEPTEMBER 26, 1931.

CONTENTS.

PAGE
Science and Humanity 505
Problems of the Mineral Industry. By Dr. E. F. Armstrong, F.R.S. 508
A Chinese Alchemist. By Prof. John Read . . . 509
The New Crystallography. By Prof. W. L. Bragg, O.B.E., F.R.S. 511
Science in the Rabbit Industry 512
Short Reviews 513
Science in the City of London. By Engr.-Capt. Edgar C. Smith, O.B.E., R.N. 515
Modern Apparatus for the Reproduction of Speech and Music. By Dr. N. W. McLachlan . . . 517
News and Views 520
Letters to the Editor :
  The Angular Momentum of Light.—Sir C. V. Raman, F.R.S. 545
  The Penetration of Light through Successive Layers of Tissue Paper.—Dr. W. R. G. Atkins, O.B.E., F.R.S. 545
  Analysis of Complicated Band Spectra with the Aid of Magnetic Rotation Spectra.—Prof. R. W. Wood, For.Mem.R.S., and G. H. Dieke . 545
  Structure of the Raman Band of Water.—Stanislaw Rafałowski ; Dr. G. Bolla 546
  Photoelectrons and Negative Ions.—Prof. E. M. Wellish 547
  Photosensitised Decomposition of Ozone by Bromine.—J. W. T. Spinks 548
  Pottery with Flint Implements of Upper Palæolithic Facies from Swanscombe, Kent.—J. P. T. Burchell 548
Research Items 549
Astronomical Topics 550
The Preservation of Food 551
The Idu (Japan) Earthquake of Nov. 26, 1930 . . 552
The National Radio Exhibition 553
Birthdays and Research Centres 553
Societies and Academies 554
Official Publications Received 556
Diary of Societies 556
SUPPLEMENT.
  The Scientific World-Picture of To-day. By General the Right Hon. J. C. Smuts, P.C., C.H., F.R.S., President of the British Association . 521
  Summaries of Addresses of Presidents of Sections 530

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Science and Humanity.

TO look back over the century's record of the achievements of the British Association for the Advancement of Science is to be reminded once again of the disparity between the achievements of science and its actual control or direction of public affairs. A century which has witnessed the growth of the meeting of 350 enthusiasts at York in 1831, organised by Harcourt, Brewster and others, " to give a stronger impulse and a more systematic direction to scientific enquiry ; and to promote the intercourse of those who cultivate science in different parts of the British Empire " into a powerful Association that the Empire is now proud to honour in its capital for the first time, has seen indeed an immense advance in the respect with which men of science are held by the nation. The disparagement or opposition which the early efforts of the Association encountered, sometimes in unexpected quarters as from Carlyle, have long since passed away, but the brilliant achievements in pure and applied science during the last century have availed scarcely at all to increase the power of science to direct or influence national policy in matters which involve questions of science. While almost all the major problems of administration involve the assessment of scientific factors, lack of appreciation of science remains characteristic of our administrators. Many of Thomas Huxley's persuasive addresses on science, education, and politics remain as pertinent to-day as when they were uttered half a century or more ago.

This situation is one so fraught with danger to civilisation that on this ground alone inquiry into its causes is urgent. Essentially we are faced with a gap between knowledge and power ; a contrast between the comparative freedom with which scientific knowledge and development influence industrial development, and their almost negligible influence in the control of national and international policies which are largely responsible for the development or stagnation of industry and society.

One of the commonest views as to the cause of this situation is that the intense specialisation demanded in scientific work renders the man of science incompetent to undertake administrative work or assess the value of facts outside the narrow sphere of his specialised work. Fundamentally this view is probably an unconscious assertion of the distinction between knowledge and method or use. There is little in our educational system to enable those who receive no scientific training to distinguish science from the mere knowledge of a mass of undigested facts. Knowledge, as a matter of experience, as Sir Arthur Quiller-Couch has said, cannot even be counted upon to educate. The science graduate is no exception to the general tendency of our universities to neglect to teach the use of knowledge—or in other words to relate knowledge and power—and to devote to competitive examinations the energy that were better spent in the production of graduates whose trained judgment as matured by experience we could trust to choose the better and reject the worse.

The mere fact that the growth of knowledge has made selection both more imperative and more difficult lends no support to the plea that we should call a halt in our quest of knowledge, that scientific research might well take a ten years' holiday and our energies be devoted to the utilisation or correlation of knowledge that is already ours. Merely to consider how much mankind might have lost had some such truce to discovery been declared at any time in the last fifty years is to realise the futility and impracticability of that plea. Nature does not lightly reveal her secrets to those who miss their opportunities, and we might still be without the knowledge of radium, of insulin, vitamins, broadcasting, and the motion picture—to mention only recent contributions of science to the relief of suffering or to the amenities of life. To interrupt the quest for knowledge might rob mankind for a generation or more of some vital clue to the control of such a scourge as cancer or to the real causes of the present unemployment and industrial depression.

What is required is not less research but more wisely and widely directed research. Huxley's words in 1854, on the science of society, "a higher division of science which considers living beings as aggregates—which deals with the relation of living beings one to another, the science which observes men, whose deductions lead to our happiness or our misery—and whose verifications often come too late", are strangely echoed in Prof. McDougall's recent plea for the direction of our most powerful intellects from the physical sciences into researches on the biological, the human, and the social sciences; and thus to build the social sciences, especially the science of economics, on the basis provided by anthropological research.

It is admittedly a fundamental defect of our present university training that while teaching the appreciation of facts it frequently fails to impart scientific method, and largely in consequence of this its graduates are sometimes quite unable to assess values, especially human values. The suggestion that the technical expert tends to ignore the human element in a situation and looks exclusively at the functional results of his work, may, in consequence of his imperfect training, be true of the newly graduated, but in the opinion of the Committee of the British Science Guild on the Position of the Technical Expert in the Public Services and Industry, it is completely contradicted in experience. Under industrial conditions, the scientific worker rapidly and readily learns to assess the human factors involved in his projects, and acquires experience in co-operation, compromise and accommodation which early fit him for administrative duties. Abundant evidence could be furnished to show that in spite of defects in their academic training, many scientific workers when afforded the opportunity are in no way inferior in administrative capacity to their fellows who have graduated in arts or classics.

Unfortunately, this defect in the present system of training for the appreciation of scientific values inevitably tends to obscure both the human value of the study of science and what is equally important, the defective teaching of general science to those pursuing a career in arts, law medicine, commerce, or industry generally. On the first point it is pardonable to recall once more Huxley's emphatic conviction that for the attainment of real culture an exclusively scientific education is at least as effective as an exclusively literary education. The science student at least acquires some elementary knowledge of scientific method, of some habits of accurate observation and the rudiments of deductive reasoning. These are the habits and methods which are essential not only to the administrator but also to all who by skilful selection arrive at their own judgments whether on questions of art, science, history, or life. The emphasis on discovery and on verification implicit in all true teaching of science is an invaluable corrective to the bias towards authority which it is so difficult to avoid in the teaching of literary subjects. That alone would justify the claim that a knowledge of science and of scientific method is essential if education is to confer real balance and the power to assess human and other values.

Largely because of our unscientific teaching of science, the human value of science is only slowly being recognised, and biologists are still reiterating the pleading of Huxley two generations ago. To science and to scientific workers more than to any other factor is due the immense improvement in the conditions of work in industry and the elaboration of methods which adapt the machine to man instead of viewing, as the early Victorians did, the operatives as mere cogs in the industrial machine. Beyond this, as Prof. A. V. Hill pointed out in his Henry Sidgwick memorial lecture, we are now glimpsing in psychology the experimental application of biology to problems of national and international conduct, racial relations, including the administration of the backward races, the evolution of co-operation in place of competition, upon the solution of which the fate of civilisation largely turns. Nor have we yet utilised the human values which lie latent in the history of science itself. Scientific workers themselves are apt to neglect unduly the inspiration and teaching which a knowledge of the growth and development of their own science can often give.

It is probable that we here come close to one of the causes of the defective teaching of science to those pursuing other careers. We are still far indeed from Huxley's ideal that

> no boy or girl should leave school without possessing a grasp of the general character of science and without having been disciplined, more or less, in the methods of all sciences, so that they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem or by being able at once to solve it; but by being familiar with the general current of scientific thought and by being able to apply the methods of science in the proper way when they have acquainted themselves with the conditions of the special problem ".

The rapidity with which scientific discoveries in the intervening seventy-two years have transformed the conditions of life make that ideal an objective essential for the security of civilisation. Had scientific workers themselves realised more fully the human value of scientific history, especially biography, much more might have been done to secure a wider and more effective teaching of science. The records of science are full of episodes of courage and endurance, patience, heroism, and resource as stirring as any culled from chronicles of war, politics, or religion. Without the spirit of adventure even in his laboratory the scientific worker would make little progress, and it is among the merits of science that it equips mankind for its migration across uncharted seas of adventure, and assists man to master his surroundings and not merely adapt himself to them.

The neglect of history by scientific workers is, however, completely overshadowed by the neglect of science by history, to which attention was directed at the recent International Congress of the History of Science and Technology. Pointing out that the very success of the application of scientific method and discovery has deflected attention from the process itself, Dr. Singer urged the value of watching its application under other conditions in the past for a full understanding of the process. More than this, it was eloquently urged by Prof. A. V. Hill that if science is to deal with human greatness, with things which have given man control of himself and of his surroundings and have freed him from superstition, ignorance, ill-health, and incompetence in the face of natural forces, the great figures of science and their discoveries deserve a prominent place in all history books.

The service which history can render to science may indeed prove decisive. While, as already suggested, scientific workers themselves might make far more effective use of the opportunities which biography affords them of bringing home to the general community the human aspects of science and its effect on and expression in personality, to the professional historian largely must be left the task of correlating scientific advances in different fields and the main stream of human progress. Only when this task is attempted and the history of science becomes an integral part in the training and discipline of general historical study can science assume her just position in education. It will then no longer be possible for administration to remain exclusively in the hands of those who have no first-hand knowledge of science or any independent capacity to sort the issues when scientific questions are involved in an important administrative decision. We shall have travelled a long distance towards the fulfilment of Huxley's ideal when the extensive science discipline advocated by Sir David Prain finds its place in the arts faculties of our universities and training colleges.

There is perhaps no greater service that the British Association can render to society at its centenary celebrations than by its attention to the human values of science. In looking back over a century of honourable progress, the Association is entitled to point out the high achievements of many of those with whose names it has been associated, the inspiration which their spirit of adventure, of service and of devotion, can give to society, and the part which science has played in shaping the social and intellectual environment in which we live. In the impressive programme of the meetings there is ample evidence of the attention which science is giving to the improvement of conditions of work, and to the application of scientific methods to problems of industrial management and distribution, as well as to the government of native races. Problems of population and of education are to be discussed from the scientific point of view, including the value of such new methods as the cinematograph film both in general and in industrial education, and the application of eugenics in education.

The Association provides scientific workers with an unrivalled opportunity for presenting a constructive programme indicating the contribution which the teaching of science, and especially of scientific method and achievement, may make to education. By emphasising the positive side of science, the inspiration which man derives from its achievements in the conquest of Nature, the assistance which scientific method and scientific knowledge confer in handling not only industrial problems but also social, economic, and administrative problems generally, rather than the defects of our present methods of education with their tendency to encourage premature specialisation, the pursuit of knowledge rather than method and to discourage the development of personality and independence of thought, scientific workers will do much to prepare the way for a century of even greater advances in science. If this is undertaken, seeking, as Colet wrote to More, " not for victory in argument but for truth ", and attempting to set in order the facts of experience, it may well happen that under the leadership of science there may be ushered in a truly scientific age in which personality finds its full play, science and art and literature make their fitting contribution to general culture, and the application of scientific methods enables man to pioneer into yet wider realms in search of truth and mastery over Nature.

When scientific achievements in the conquest of Nature have received their full meed of acknowledgment, it is the spirit of science that is all-important to mankind. The accumulation of knowledge signifies little. The science of one age, as Dr. Singer wisely says, becomes the nonsense of the next, but the spirit of science leads man forward continually to fresh conquests over his changing environment. From the labours of scientific workers as of others may we hope some day to understand better what is involved in the toilsome path which humanity still has to tread towards the goal of civilisation—in Seebohm's phrase the art of living together in civilised society —and to finding that, as in More's " Utopia ", a fearless faith in the laws of Nature consorts well with a profound faith in man's noblest ideals.

Problems of the Mineral Industry.

Minerals in Modern Industry. By Dr. Walter H. Voskuil. Pp. ix + 350. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 18*s.* 6*d.* net.

THE industrial revolution which began in England spread to the western countries of the Continent and developed because of favourable conditions of mineral resources. These natural conditions were found to be reproduced on a larger scale on the other side of the North Atlantic and the new industries became transplanted there also. Three centres—northern England, the Franco-German district bordering the Rhine valley, and the north-eastern United States—became the world's workshops: they embrace more than ninety per cent of the world's iron and steel-making capacity. Once established, the inertia of invested capital helped to maintain production. Other types of industries, notably the chemical, found it convenient to locate close to the steel centre. The increasing density of population enhances the local market for manufactured products. Raw materials, including accessory minerals, flow to these three centres from all over the globe.

The demand for minerals becomes ever greater, producers have been supplying a market which each year exceeded the year preceding in its demands. The needs of the War and the post-War expansion period were met by expansion of production and of capacity to produce to such a degree that, first with a return to normality and now to a condition far below normal, heroic measures must be attempted to find outlets for the products of the mines and even to save them financially.

The urge to consume, the use of every form of persuasion and advertisement, have been directed towards trying to keep in motion as much and as many as possible of the material goods that have been produced. One of the effects of this campaign has been to increase the costs of distribution in greater and greater proportion so that often they exceed those of manufacturing, not only absorbing all the profits but also imposing a greater deadweight of oncost when production is slack. The salesman has become more important than the technician.

The remedy, to fit production to the needs of the market, implies control of output in minerals as in other products, but the problem is simpler to suggest than to solve.

The question of control of production leads directly into the broader problem of the conservation of mineral resources. Minerals are wasting assets, and although, taking the world as a whole, there is no need to be alarmed at the depletion of natural stores, yet the acceleration of production during the last twenty years is sufficient to indicate the wisdom of taking stock. The living generation may always be expected to take all it needs, and deliberate curtailment of any particular mineral is only brought about by raising the price to a point when some alternative is favoured. There is a duty, however, to eliminate needless waste and to initiate research into economy of use.

Work to this end is going on with every mineral; more efficient methods of mining, of extraction, of utilisation, of recovery and re-use, are brought forward every day. In coal alone the progress is enormous: electric energy is produced to-day with half the weight of coal per unit required ten years ago and it will be halved again. It is safe to forecast that the same effect could be gained with half the coal at present burnt in England if it were used in the most up-to-date apparatus. Every coal strike, every increase in price, give new impetus to such a movement.

Gold and tin are the chief minerals of which the prospect of a declining output is admitted. The former is the foundation of a monetary system which, judging by to-day's chaos, has failed and will perhaps be replaced. Tin is mainly used for containers in contact with foods, but it is certain that the march of research and invention will find substitutes for this, either aluminium or possibly even cellulose acetate or lacquered containers. Indeed, we are only at the beginning of the potential discoveries in connexion with the addition of small quantities of so-called rare elements to metal alloys, whilst we shall not be content very much longer to make structural steelwork of a metal which rusts so quickly as to require regular painting. Research will prove a certain palliative for possible mineral shortage.

The critical minerals are the energy resources—coal, oil, natural gas: these at least must not be wasted. A close control on their use is imposed, however, by each fractional increase in price, and a period like the present when wasteful competition is causing them to be sold at entirely uneconomic prices is not likely to last. Water power, energy from the sea and from the sun, are all available when real economy is necessary.

No one nation contains a full variety of the essential minerals. Those missing can be obtained by the vigilance of governments or of manufacturing interests in securing control of concessions in other lands, but whilst insuring the domestic position, no nation can deprive its neighbour of needed minerals without inviting trouble. The War was fought above the coal and iron mines of France, Belgium, and Lorraine; the unequal geographical and political control of mineral resources forms a background of menace to the maintenance of peace.

Such are the problems envisaged by Dr. Vosguil, his book containing an exposition of the facts relating to the chief minerals: it will well repay careful reading throughout by all connected, in whatever way, with them.

E. F. ARMSTRONG.

A Chinese Alchemist.

The Travels of an Alchemist: the Journey of the Taoist Ch'ang-Ch'un from China to the Hindukush at the Summons of Chingiz Khan. Recorded by his Disciple, Li Chih-Ch'ang. Translated with an Introduction by Arthur Waley. (The Broadway Travellers.) Pp. xi + 166. (London: George Routledge and Sons, Ltd., 1931.) 10*s.* 6*d.* net.

MR. WALEY provides an English translation of the "Hsi Yu Chi", made directly from the Chinese text. In a valuable introduction of 40 pages he deals with Mongol history and philology, and illuminates the history of medieval Taoism with the light of the Taoist Canon, which has become freely available to European scholars since its re-publication in 1923–25. He points out that the new Taoism, created by Chang Tao-ling in the second century A.D., rendered a great service by preserving texts and doctrines of philosophy, astrology, alchemy, hygiene, etc., which Confucianism rejected as heterodox. He sums up the connexion between Taoism and alchemy in the following words:

> "In one branch of study the Taoists were unique. To them alone is due the vast body of alchemical literature, which makes the Chinese sources more important than even the Mohammedan to the historian of this strange subject. The Chinese had inherited from the remote past the belief that certain substances such as jade, pearl, mother-of-pearl, cinnabar, were life-giving, and that if absorbed into the body they would prevent the gradual deteriorations of old age. As they exist in nature, however, these substances, it was thought, are always 'impure'. Only when made artificially can they be safely and efficaciously ingested. In early China gold was not highly valued. When through contact with the gold-prizing nomads of the north-west the Chinese, in the three or four centuries before the Christian era, began to accept gold as their highest standard of value, the ideas previously attached to other

'life-giving' and consequently valuable substances became associated also with gold. Thus arose various distinct forms of alchemy: (1) the attempt to produce a liquid gold that could be drunk and so produce longevity; (2) the so-called 'Gold-cinnabar' alchemy. To the recipes for making artificial cinnabar and thus producing an elixir of life was arbitrarily added the further clause that 'when the cinnabar is made, gold will easily follow'. We thus see the new life-giving substance gold tagged on to the beliefs connected with the older substance, cinnabar. (3) An attempt, parallel to that of the earliest Western alchemy, to produce gold from baser metals such as lead."

These ideas are of particular interest to students of the origins of alchemy, who, during recent years, have devoted increasing attention to the nature and scope of Chinese alchemy.* According to Mr. Waley, an alchemy of gold existed in China so far back as the first century B.C. In extant alchemical treatises of the fourth century A.D., Pao P'u Tzu discriminates between the three kinds of alchemy quoted above. In the tenth century exoteric alchemy (*wai tan*) merged into esoteric (*nei tan*), the 'souls' or 'essences' of mercury, sulphur, lead, etc., bearing to the common metals the same relationship as the Taoist, adept, or perfected man, bears to common mortals. A further evolution had been reached at the end of the eleventh century, the transcendental metals having become identified with various parts of the human body. Thus,

> "alchemy comes to mean in China not an experimentation with chemicals, blowpipes, furnace and the like (though these survive in the popular alchemy of itinerant quacks), but a system of mental and physical re-education. It was in this sense that Ch'ang-ch'un, whose travels are here recorded, was an alchemist, and it is a mysticism of this kind that is expounded in his 'Straight Guide to the Mighty Elixir'."

The reader who takes up this book in the expectation of gathering at first hand the views of the adept Ch'ang-Ch'un upon orthodox alchemy will thus be disappointed: the narrative contains little of alchemical interest. There is ample compensation, however, in the light it throws upon the character of the 'Master', and in the picturesque glimpses it affords of varied Eastern races, manners, and customs, in the early thirteenth century. "Leaving the crowded Chinese plains, we see the Mongol nomads with their waggons and flocks, their fur-trimmed coats and strange head-dresses, then the turbaned Moslem ploughman, the cosmopolitan crowds of Samarkand and the wild tribesmen of Afghanistan."

The translator points out that the "Hsi Yu Chi" is true to type in the highly impersonal treatment of its theme. Notwithstanding this, we are able to build up from it an intimate picture of the 'Master', Ch'ang-Ch'un. In Sun Hsi's preface, written in 1228, we read that "he sat with the rigidity of a corpse, stood with the stiffness of a tree, moved swift as lightning and walked like a whirlwind"—further, that (in words which remind us of the celebrated Macpherson) "he was by no means an ordinary person". The Recluse of the Western Brook continues: "conversation with him showed me that his learning was tremendous; there seemed to be no book he had not read". In spite of his age, when Chingiz Khan's call for the long double journey came to him at Lai-chou from far-off Afghanistan,

> "here was the Master setting out to cover thousands of miles of most difficult country, through regions never mapped, across deserts unwatered by rain or dew, in which, though he was received everywhere with the utmost honour, it was inevitable that he should suffer considerable hardship and fatigue. Yet whenever opportunity arose he was ready to loiter on the way, enjoy the beauties of the scenery in the most natural and leisurely manner, write a poem, talk or laugh."

Ch'ang-Ch'un arrived at Samarkand early in December 1221, and wintered there. When he reached Chingiz's camp, between the Hindukush and Kabul, in the following May, "Chingiz was delighted, begged him to be seated and ordered food to be served. Then he asked him: 'Adept, what Medicine of Long Life have you brought me from afar?' The Master replied: 'I have means of protecting life, but no elixir that will prolong it.' The Emperor was pleased with his candour, and had two tents for the Master and his disciples set up to the east of his own." The central incident of the narrative thus has a bearing upon the alchemical doctrine of the elixir of life. "A temporary compound of the Four Elements," says Ch'ang'-Ch'un in another place, "the body at last must suffer decay. The soul, composed of one spiritual essence, is free to move wherever it will."

More direct than the alchemical references are those to astronomy and astrology. At Talas, near the modern Aulie-ata, notice was taken of "a number of great mounds, set like the stars in the Polar Constellation". At Samarkand, the Master held a conversation with an astronomer about a recent eclipse of the sun.

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* Reference may be made here to Mr. Waley's "Notes on Chinese Alchemy" (supplementary to O. S. Johnson's "A Study of Chinese Alchemy") in the *Bulletin* of the School of Oriental Studies, London Institution, vol. 6, part 1, 1930.

"The man said: 'Here the eclipse was at its full at the hour of the Dragon, when it covered three-fifths of the sun.' 'We were by the Kerulen River,' said the Master; 'the eclipse was total towards mid-day. But when we came south-west to the Chin Shan, the people there said that at the hour of the Snake it reached its greatest extent, covering seven-tenths. Thus in three places it was seen in three different ways. K'ung Ying-ta [574–648 A.D.], in his commentary on the *Springs and Autumns*, says that when the moon comes between us and the sun there is an eclipse of the sun. In the present case only those who were in a direct line with the sun and moon experienced a total eclipse. By those away from this line the eclipse is seen differently, the gradual change becoming considerable at a distance of a thousand *li*. It is just as though one covered a candle with a fan. In the direct shadow of the fan there is no light, but the further one moves to the side the greater the light becomes.'"

Mr. Waley explains that the Chinese believed that every point on earth was influenced by a corresponding point in the heavens. Thus, on a certain day the Controller Wang Chi appealed to the Master to avert the danger threatening the district of Pekin through the impinging of the planet Mars upon the constellation Wei. The Master hurriedly arranged a service, and upon the second night "the planet was now several mansions away . . . so swiftly had the Master's magic taken effect. . . . A large number of Taoists came from distant places with offerings of chrysanthemum-flowers. He made for them a poem in lines of unequal length, to the tune *Yü Shêng Hên Huan Ch'ih*."

Many incidents are related which bring out traits in the Master's character. The governor of Samarkand gave a banquet in his honour. "Noticing that the Master drank very little, he begged to be allowed to press a hundred pounds of grapes and make him some new wine. But the Master answered: 'I do not need wine. But let me have the hundred pounds of grapes; they will enable me to entertain my visitors.'" Upon another occasion, stories were related of mischievous mountain spirits which had cut off the back hair and departed with the choicest provisions of the narrators. "The Master made no comment on these stories."

Among his varied accomplishments, the Master was skilled at rain-making and poetry. During the great drought of 1227, the authorities offered up prayers in vain.

"The Taoist congregations in the City came one day and begged the Master to perform the rain-bringing service. . . . The Master said quietly: 'I was just thinking of celebrating such a service. That you, sirs, should have come with the same suggestion is an example of what is called "spontaneous identity of ideas". There remains nothing for it but that you . . . should devote all your energy to the arrangements.' . . . And sure enough as the time for the service arrived, rain fell all day, and by next day a foot of it had fallen."

Upon occasion, the Master applied his poems with great effect.

"One day there was a dispute and the Master was asked which side he took. He remained silent, and thus settled the question in accordance with the spirit of Tao. Presently he gave them the following hymn:

Sweep, sweep, sweep!
Sweep clear the heart till there is nothing left.
He with a heart that is clean-swept is called a 'good man'.
A 'good man' is all that is meant by 'holy *hsien*' or '*Fo*'.

The disputants retired discomfited."

The narrative abounds in pleasant reading of this kind, and at the end our old Chinese alchemist leaves us to exclaim with bully Bottom: "I desire your more acquaintance, good Master!"

JOHN READ.

The New Crystallography.

Strukturbericht, 1913–1928. Von P. P. Ewald und C. Hermann. *Zeitschrift für Kristallographie, Kristallgeometrie, Kristallphysik, Kristallchemie*, Ergänzungsband. Pp. iv + 818. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 47 gold marks.

THE publication in book form of the reviews which have been appearing for several years in the *Zeitschrift für Krystallographie* will be warmly welcomed by those interested in the structure of crystals. The book contains a survey of all work in this field from 1913, when the first analyses by X-ray methods were made, to the end of 1928. The older crystallography was mainly concerned with the external form and physical properties of crystals; its achievements are recorded in the five volumes of Groth's "Chemische Krystallographie". The present volume makes a first step towards fulfilling the same function in the new field as Groth's monumental work in the old, and we owe a great debt to the authors for the immense amount of labour which must have been put into its compilation. Their task has been no easy one. Not only is the output of papers increasingly great every year, but also it is often difficult to sort the wheat from the chaff, and estimate from an author's account the reliance to be placed on his conclusions.

The new crystallography probes more deeply, and attempts to give the arrangement of atoms in the structures. The centre of interest has shifted, and the external crystalline form, which has for long been the chief preoccupation of crystallography as a means of classification and examination, is now to be reckoned as a secondary and relatively unimportant manifestation of the underlying structure, dependent on elusive factors, and telling little about the crystal. The less ambitious aim of the investigations into crystalline form gave a precision and completeness to the results, and Groth was able to condense the data into a single account for each crystal. The new field is only partially explored; early results are continually being modified and new crystals investigated. Hence the authors of the "Strukturbericht" have both classified, when possible, and also given summaries of all the individual papers in a form which is very convenient to consult.

The crystals are divided into the classes of elements and inorganic compounds, alloys, and organic compounds, and each class is subdivided into groups of types. For example, the elements are classified under the types *A*1 (face-centred cubic lattice), *A*2 (body-centred cubic lattice), *A*3 (hexagonal closest packing), and so forth. Compounds with formula *AB* belong to *B* types, those with formula AB_2 to *C* types. The descriptions of the types are very clear, and figures are numerous and cleverly drawn so as to give an appearance of perspective. A separate diagram shows the way in which each atom is surrounded by neighbours. After the description of the type, a detailed list of crystals belonging to it is given, with tables of parameters and interatomic distances. Then, at the end of the descriptions of types in each group, all relevant papers are briefly reviewed, the writers' conclusions being summarised and in some cases a critical paragraph added.

The description of the salient physical features of each structure is a model of completeness and conciseness, and is often a great improvement on the account in the original papers. The value of all the information in the "Raumgruppentabelle", which lists the purely geometrical properties of symmetry of each structure, is not so apparent. To take an example, the structure of indium is based on a tetragonal space-lattice. A list of 35 space groups is given, of each of which the indium lattice may be regarded as a special case, and the corresponding atomic symmetry, "Hauptinseln" and "Minimum Inselsymmetrie" are faithfully recorded for each group. Not only is it doubtful whether such data have a physical significance or correspond to any property of the constituent atoms, but also, in the unlikely contingency that these symmetry properties are required, they can be readily seen from a glance at the structure.

The division into types is convenient in the case of the simple inorganic compounds and alloys, where many compounds containing different elements crystallise in a similar way. It is not so well suited to the organic compounds. Here one is dealing with a variety of structures in which the elements are the same, and there are practically as many types as compounds. Possibly a different method of classifying these structures will finally be adopted.

An excellent feature of the book is its indexing. There are four indexes, for authors, names of compounds, formulæ, and types; it is easy to find any information one requires. The whole book is very successfully planned. The authors must be congratulated, both for their courage in tackling such a heroic task and for their skill in devising a scheme which is so sound and so easily extended to embrace new knowledge, and on which future reviews will no doubt be modelled.

W. L. BRAGG.

Science in the Rabbit Industry.

The Scientific Aspects of Rabbit Breeding. By James N. Pickard and F. A. E. Crew. Pp. ix + 122 + 12 plates (Idle, Bradford; and London: Watmoughs, Ltd., 1931.) 6*s.* 6*d.*

THIS little book affords welcome evidence of an increasing inclination on the part of the animal breeder to turn to science for guidance. For its publishers are also the publishers of the principal weekly paper dealing with the rabbit industry and fancy, and they must have scented an opening for such a work. Indeed, it is fully time that such a work appeared, for the cult of the rabbit has undergone profound changes since the War. Twenty years ago the only breeders of rabbits who mattered were the fanciers, and it was almost entirely for them that the literature catered. As compared with to-day, relatively few varieties were standardised, the object of breeding being solely for show purposes. Rabbit keeping was a hobby, and though from time to time enthusiasts would suggest the possibility of industrial exploitation, yet the author of "The Book of the Rabbit", writing in 1889, stated that "as against all theories to the contrary, the stern fact remains that a

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modern instance of profitable rabbit farming is unknown".

It was only with the War that the rabbit began to come into its own. Thousands then realised that it was easy to keep and not too disagreeable to eat. Even so, the advent of peace, bearing cheap beef and mutton, might have led to renewed stagnation in the rabbit world had not another circumstance reacted in its favour. The general raising of the standard of life led to a greatly increased demand for inexpensive furs such as the rabbit alone could supply. Fortunately also, the rabbit had 'sported' several attractive new colours during the earlier part of the century, and these were available when the fur boom started. With good skins fetching up to 10*s*. apiece, and even more, rabbit farming at once became a profitable industry. Though, like other industries, it has suffered recently from the prevailing depression, there are sound reasons for expecting it to flourish once more when the general outlook brightens.

In the first place, it is clear that 'wild' furs must become progressively less able to cope with the world demand, with the consequent advantage to the pelt of the rabbit. Secondly, the new 'sports' in colour and texture of fur which have appeared during the past few years have added enormously to the variety of *natural* rabbit furs. In earlier days the choice was very limited, and rabbit pelts were generally dyed to render them more attractive. This naturally affected their durability, so that rabbit fur got a bad name, which it has not yet lived down. This prejudice must eventually pass away, for the natural fur, pelted at the right time and properly treated, lacks nothing in durability.

At present one of the obstacles to the spread of the new types of fur is the difficulty of producing a uniform article in sufficient quantities, and it is here that the breeder is beginning to make use of modern genetical knowledge. These new types are largely the result of recombinations through crossing, and in the hands of the ordinary breeder throw many unwanted forms, with consequent loss. This, of course, could be avoided if the breeder were to work in the light of what is already known about the genetics of the rabbit, and it is with the idea of assisting him that the present little book has been brought out.

No more competent guides could have been selected either from the point of view of scientific attainment or of practical experience. They have produced between them an excellent little treatise which covers the whole ground of the physiology, nutrition, genetics, and general management of the animal. The genetical part, as might be expected, is fully entered into, and an analysis in terms of genetical factors is given for all the principal breeds. At the same time, the breeder is initiated into the modern manner of recombining characters, and of the steps necessary to form them into fixed breeds with the least expenditure of time and energy.

The chapters on nutrition and management are eminently practical, and, though mainly devised for the industry, the book should prove of great service to all who make use of the rabbit for scientific purposes. It concludes with a serviceable bibliography.

Short Reviews.

(1) *Outlines of Physical Geology.* Prepared from the Third Edition of Part I. of Pirsson and Schuchert's "Textbook of Geology" by Prof. Chester R. Longwell. Pp. vi + 376. 1930. 15*s*. net.
(2) *Outlines of Historical Geology.* By Prof. Charles Schuchert. Second edition, rewritten. Pp. v + 348. 1931. 15*s*. net.
(New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.)

(1) THE first of these "Pirsson-Schuchert Geologies" is a shorter form of the 1929 revision of Pirsson's "Physical Geology" (NATURE, Oct. 4, 1930, p. 531) made by members of the Yale Department of Geology under the editorship of Prof. Longwell. The chapters dealing with the interior of the earth, ore deposits, and land forms have been omitted from this abridgment, and all the remaining chapters, except Chap. i., have been shortened. The book is authoritative and beautifully illustrated and can be confidently recommended to elementary students of geology and physical geography. The prospective buyer, however, would be well advised to pay the extra 3*s*. 6*d*. and acquire the more complete revision of 1929.

(2) Prof. Schuchert's "Outlines" is in its origin an abridgment of his much longer "Historical Geology" of 1924 (NATURE, Sept. 13, 1924, p. 376), but in its present dress it constitutes practically a new book. It gives an admirable summary of "the archives of life's adventures". The continuity of the historical story is now less broken into by sections dealing with plants and animals, as the latter have been brought together to form two of the introductory chapters. More stress has been laid on evolution as the keynote of geological chronology and correlation. Considerably more attention has also been given to palæogeography, and the maps for which Prof. Schuchert is justly famous have been redrawn in accordance with the additional data now available. The book is more richly adorned with splendid illustrations than any other comparable work. Both students and teachers and also the ordinary reader who may be looking for a coherent account of the principles of earth history

will be amply rewarded by Prof. Schuchert's competent management of his vast subject.

We are informed by the publishers that the two works are now available as a single volume entitled "Foundations of Geology", price 25*s*. net.

Climatology. By A. Austin Miller. (Methuen's Advanced Geographies.) Pp. x + 304. (London: Methuen and Co., Ltd., 1931.) 12*s*. 6*d*. net.

THIS is an excellent book, well produced and well illustrated, and should be of great value to geographers both for reading and reference. After three introductory chapters on the scope of climatology, the elements, and the factors of climate, the major part of the book is descriptive. The author first sets out the modern ideas on the classification of climates, especially those of Köppen, and then arranges his material according to the major climatic provinces—equatorial, tropical, tropical monsoon, etc., ending with two chapters on desert and mountain climates. This logical arrangement is probably the best for teaching purposes, though it breaks up the unity of the continents. The various climatic types and subtypes receive clear treatment, illustrated by charts and diagrams, and completed by paragraphs on the associated vegetation and cultivation; and each chapter is followed by a short bibliography and by two pages giving averages of temperature and rainfall for a number of typical stations. The book ends with an interesting chapter on changes of climate, and a very good index.

The author's physical explanations are sometimes obscure: thus, a cooling breeze surely cannot promote radiation, as stated on p. 13, though it does promote conduction; and the explanation of the vertical decrease of temperature on p. 37 is very muddled. The diagram on p. 184 is also difficult to understand; the fact that the "highest mean monthly maximum on record" (whatever that is) at Cambridge in January is just higher than the "lowest mean monthly minimum on record" in July is not evidence that "the coldest July was actually colder than the warmest January", a statement which is, in fact, incorrect. These are small blemishes, however, and the book as a whole shows that the author has read with understanding as well as widely.

Commonwealth Bureau of Census and Statistics, Canberra. Official Year Book of the Commonwealth of Australia. No. 23, 1930. Prepared under instructions from the Minister of State for Home Affairs by Chas. H. Wickens. Editor: John Stonham. Pp. xxxii + 806. (Melbourne: H. J. Green, 1931.) 5*s*.

THE issue of this year book for 1930 is considerably smaller than for recent years, and yet a comparison with last year's volume suggests that nothing of real importance has been omitted. As usual, the book contains full statistics of every aspect of Australian activity, and, in many cases, the figures for recent years which enable comparisons to be made.

It has been the custom for the Year Book to contain at least one specially contributed article. This practice is continued with an article by Prof. Radcliffe Brown on the former numbers and distribution of the Australian aborigines. In making his estimates, for which data naturally vary in different parts, Prof. Brown has divided each State into districts which so far as possible are those recognised by the natives. The final figures give 251,000 as the lowest, and 300,000 as the highest, figure for the original population of Australia. This is equal to 12 per square mile for the continent as a whole with as many as 38 per square mile in South Australia and as few as 6·7 per square mile in Queensland. Prof. Brown admits that much of the evidence on which these figures are based, especially in regard to Queensland, New South Wales, and Tasmania, is not wholly satisfactory.

The Journal of the Institute of Metals. Vol. 44. Edited by G. Shaw Scott. Pp. xii + 880 + 56 plates. (London: Institute of Metals, 1930.) 31*s*. 6*d*. net.

THIS volume is the last of the present series. In future, the papers read before the Institute of Metals will appear, as before, in half-yearly volumes, but the abstracts will form a third volume, published annually. The papers read at the Southampton meeting include several on aluminium alloys, including an illuminating discussion of the methods of refining the grain size of aluminium by the use of volatile chlorides or of chlorine-bearing vapours. It appears that the entry of water vapour from products of combustion into aluminium and its alloys may be particularly harmful. An interesting monograph on the origin and development of rolled gold contains information which will be new to most readers, on a material in familiar use. Further work has been done on the atmospheric corrosion of copper, and a basic sulphate is shown to be the principal constituent of the product in ordinary atmospheres, largely replaced by the basic chloride in marine situations. Prof. Tammann has contributed a paper on the determination of crystallite orientation in metals, which will be found useful as a summary of numerous papers by that author which have appeared elsewhere. The plates are, as usual, excellently produced.

Exercices de mécanique. Par H. Beghin and Prof. G. Julia. Tome 1, Fascicule 2. Pp. iv + 337-577. (Paris: Gauthier-Villars et Cie, 1931.) 60 francs.

THIS part of the work, by M. Beghin and Prof. Julia of the Faculty of Science of the University of Paris, contains six chapters dealing with fundamental laws, general theorems, work and power, virtual work, impulsive motion, and Lagrange's equations as applied to this type of motion. Each chapter contains a short theoretical introduction and a collection of illustrative examples worked out in detail. These are usually of a fairly advanced type, and frequently deal with interesting physical or engineering problems. The book should be useful to the teacher in search of problems or to the student working alone from text-books.

Science in the City of London.

By Engr.-Capt. Edgar C. Smith, O.B.E., R.N.

To the student of the history of science and technology London offers a field of inquiry of wide and unfailing interest. From Westminster Abbey to the docks, from Highgate to Clapham, all routes lead to some spot with scientific associations. Ever since the Romans came, bringing with them their measuring, surveying, and surgical instruments, London has owed something to scientific inquiry, and the construction of her gates and fortifications, her historic Bridge, and her great Tower were only rendered possible through the discoveries of the ancient world. But great as is our debt to Greece and Rome, it is within modern times that science has invaded every side of human activity, and many of the most important discoveries, many of the most notable inventions, and many of the most striking applications of science have been made in London. Thus it is that from one boundary of London to the other her streets and lanes, her institutions, hospitals, and workshops, her cathedrals and churches, the river and its bridges, her parks and gardens, all have some tale to tell relating to the increase of natural knowledge.

Obvious as are the many applications of science to practical affairs to-day, and numerous as are the records of men of science who have lived and worked in London, the annals of science in the City of London still remain fragmentary and scattered. The intrinsic interest in the story was well shown by Mr. H. G. Wayling in his articles on "The Romance of Science in Bygone London", published in *Science Progress* in January and April this year, and also in Dr. Charles Singer's address on "The First Century of Science in England", given during the recent International Congress of the History of Science and Technology. The subject, too, is happily claiming the attention of the British Association, which this year for the first time is meeting in London.

"The general attitude to Nature", said Dr. Singer, "which we nowadays call scientific was opened, as far as England was concerned, by the appearance of certain works of Giordano Bruno." These works were surreptitiously printed in London in 1584, probably in the Charterhouse. Fourteen years before that, however, Henry Billingsley, Sheriff of London in 1584 and Lord Mayor in 1596, had published the first English translation of Euclid. With "a very fruitfull Præface" by Dee, Billingsley's book was printed by John Daye, dwelling over Aldersgate beneath Saint Martins. Billingsley became a knight and a member of parliament, and died in 1606. If to him we are indebted for the earliest English translation of the "Elements of Geometry", to his famous contemporary Sir Thomas Gresham we owe the establishment of Gresham College and the founding of the earliest chairs of geometry and astronomy in the country. Some science had been taught at Oxford and Cambridge long before then, but the foundation of Gresham College was one of the most important steps taken in connexion with the educational facilities of London, and with its history the story of modern science in London rightly begins.

Gresham was born about 1519 and died in 1579. The son of a Lord Mayor, he was a servant of the State as well as a great merchant, and, during the reigns of Edward VI., Mary, and Elizabeth, acted as a sort of financial ambassador. In 1566 he founded the Royal Exchange, and, perhaps influenced by the establishment in Paris by Francis I. of the Collège Royale, now the Collège de France, he left his fine mansion in Bishopsgate to the London Corporation and the Mercers' Company for a college and endowed chairs in physic, geometry, astronomy, music, law, rhetoric, and divinity. His widow dying in 1596, the bequest then became available and the first lecturers were appointed. Briggs was chosen first professor of geometry and Brerewood first professor of astronomy. To them succeeded in turn Edmund Gunter, the inventor of Gunter's chain; Henry Gellibrand, who completed Brigg's "Trigonometria Britannica"; John Greaves, the first man in modern times to measure the Pyramids; Samuel Foster, the author of "The Use of the Quadrant"; Rooke, declared to be "the greatest man in England for profound learning"; Walter Pope, a contributor to the first volume of the *Philosophical Transactions*; and Barrow, Wren, and Hooke. Some of these, it will be recalled, were among the founders of the Royal Society, which from its foundation in 1660 until 1710, except for a few years after the Great Fire, met in Gresham College.

In the seventeenth century, London was also the home of Thomas Harriot, the algebraist and the first Englishman to observe sunspots; Walter Warner, Thomas Allen, Nathaniel Torporley, who is said to have acted as amanuensis to Vieta, and Dr. Wilkins, who "deserves more than any man to be esteemed the founder of the Royal Society". Many of these scientific worthies were buried in the City churches, although to-day, owing to the destruction by the Great Fire and to other causes, one may look in vain for memorials of them. Billingsley was buried in St. Katherine Coleman, Fenchurch Street; Brerewood and Hooke, like Gresham himself, in St. Helen's, Bishopsgate, "the Westminster Abbey of the City"; Gunter, Foster, and Gellibrand in St. Peter the Poor in Broad Street; Torporley in St. Alphage in London Wall; Rooke in St. Mary Outwich, Bishopsgate; Pope in St. Giles', Cripplegate; Harriot in St. Christopher le Stocks, a church which had to make way for the Bank of England; Greaves in St. Benet's, and Wilkins in St. Lawrence Jewry, of which he was one time rector. Of other old mathematicians, Thomas Digges was buried in St Mary Aldermanbury; and Collins, "the attorney-general for the mathematics", in St. James', Garlick Hill. Wren, of course, lies in St. Paul's; and Barrow in Westminster Abbey.

Bishopsgate, besides being the street in which Gresham College was situated, is the centre of a district abounding in scientific interest. In Winchester Street hard by, at his father's house, Halley, as a boy of nineteen, began his astronomical observations; in Austin Friars, Aubert had the first of his three observatories; and at the offices of the Magnetic Company, in Old Broad Street, in 1856, the electricians, Whitehouse and Bright, showed Morse that signals could be sent at the rate of 272 a minute through 2000 miles of wire laid to and fro between London and Manchester. Latimer Clark had shown Airy and Faraday the same experiment at Lothbury in the City three years before. In Bishopsgate also stands the little church of St. Ethelburga, which has recently been enriched with three beautiful windows erected to the memory of Henry Hudson, who with his crew took Holy Communion in the church on April 19, 1607, the day before he set sail in the *Hopewell*, Frobisher's old ship. Then, too, Birchin Lane and Finch Lane, at the back of the Royal Exchange, remind us of the work of Newcomen and Watt. For a year, Watt worked in Finch Lane learning to make sextants, all the time going in fear of the press gang. Farther to the east, the Tower, the Mint, and Trinity House all have links with modern science; with one or the other have been connected Sir Jonas Moore, Flamsteed; Drummond, the inventor of the lime-light; Forsyth, the inventor of the fuse; Newton; Graham the chemist; Sir John Herschel; Roberts-Austen, who was responsible for the quality of no less than £150,000,000 of gold coins; the engineers Barlow and Douglas; and Faraday, Tyndall, and Rayleigh. The City, too, was the home of the early clock makers, map makers, and instrument makers, and some of these were associated with the old Mathematical Society of Spitalfields, of which Major P. A. MacMahon gave some particulars in his presidential address to Section A of the British Association in 1901.

This old scientific society came to an end in 1845, but long before then the centre of London science had shifted westward. Just as the history of science in London in the seventeenth century is bound up principally with the district to the east of St. Paul's, so its history in the eighteenth century brings us to the west of St. Paul's and to Fleet Street and the Strand. St. Paul's itself, as Mr. Wayling has pointed out, Christ's Hospital, the Charterhouse, Child's Coffee House in St. Paul's Churchyard, the London Coffee House in Ludgate Hill, the Mitre Tavern in Fleet Street, and the Crown and Anchor in the Strand, all have some scientific associations, as also have the Temple and Somerset House.

Fleet Street abounds in both literary and scientific associations, and to-day the Newcomen Society frequently meets in Prince Henry's Room in a house which was familiar to Newton and his fellows who came to Crane Court in Fleet Street for the meetings of the Royal Society. On Sept. 8, 1710, Newton as president had summoned the council of the Society for the purpose of informing them that the house of the late Dr. Brown in Crane Court was to be sold, " and being in the middle of the Town, and out of noise, might be a proper place to be purchased by the Society for their Meetings ". The outcome of this suggestion was the purchase for £1450 of Dr. Brown's house and the next; and on Nov. 8, 1710, the Society held its first meeting in its own home, and Gresham College, much to its detriment, saw the Society no more. During the seventy years the Society met at Crane Court it had ten different presidents, among whom were Sir Hans Sloane, Martin Folkes, Sir John Pringle, and Sir Joseph Banks, the last of whom was just beginning his long period of office, when in 1780 the Society, through George III., was granted the use of apartments in Somerset House. Newton's last appearance in Crane Court was when he presided over a meeting on March 2, 1727, eighteen days before he died. To the period the Society was housed in Crane Court belong the labours of Halley, Bradley, and Hadley; the foundation of the Copley Medal and its award to Gray, Desaguliers, Bradley, Harrison, Canton, Franklin, Dollond, Smeaton, Cavendish, Priestley, and Cook; the promotion by the Society of the practice of inoculation; the controversy over lightning conductors, and the furtherance of expeditions to observe the transits of Venus of 1761 and 1769.

In those days several members lived quite close to Crane Court. James Ferguson, elected F.R.S. in 1763, a very remarkable self-taught man, had his home in Bolt Court, where Johnson lived, and he died there in 1776. From Ferguson's books Herschel gained his first knowledge of astronomy. Crane Court and Bolt Court are on the north side of Fleet Street. On the other side was Water Lane, now Whitefriars Street. Tompion, the famous watchmaker, had a shop at the sign of the Dial and Three Crowns at the corner of Water Lane. Here George Graham worked for Tompion, married his niece, and succeeded to his business, which, however, he moved across Water Lane to the Dial and One Crown. Graham's house was a workshop, a laboratory, and an observatory combined. He and Tompion to-day rest in the same grave in the nave of Westminster Abbey. Another famous Fleet Street instrument maker was Pinchbeck, and another, Troughton, who died at No. 138. Just below Whitefriars Street is Salisbury Court, leading to St. Bride's Church and Dorset Street. Salisbury Court once contained the " workhouse " of Captain Thomas Savery, " the most prolific inventor of his day ", and there in 1702 his steam pumps could be seen.

In St. Bride's Church is the monument to Dr. Wells, bearing representations of the Rumford Medal of the Royal Society, which was awarded him for his excellent memoir on dew. The church also recalls the names of Wren and of the chemist Delaval, who described the damage done to it by lightning in 1764. He also wrote an account of the damage to St. Paul's by lightning in 1772. About forty years after this, at No. 53 Dorset Street, lived Mr. Tatum, in whose house the City Philosophical Society met on Wednesday evenings.

After his trip to the continent with Davy, Faraday became a member of this Society and it was in this house he served his apprenticeship as a lecturer.

Such are a few of the scientific associations of Fleet Street and its neighbourhood. Were it possible to continue the story, the survey would take us into Chancery Lane and Gunpowder Alley and to the Middle Temple, where William Ball, the first treasurer, was buried, and Garden Court, the first home of the Geological Society, and thence back into the Strand and its surroundings, and so still farther westward. For the history of science in both the City of London and greater London during the nineteenth century, the birth and growth of our great scientific and technical societies and institutions, their work and influence, as well as university education, the volume on "London and the Advancement of Science", published by the British Association, should be consulted.

Altogether apart from the records of any organisation, however, there is much of an intimate and personal character awaiting the student of science in London. In the lives of men of science, as in the lives of others, are to be found those incidents, anecdotes, and observations which are the breath of biography and by which we are able in some degree to reconstruct the past. With a knowledge of the past, London becomes a place of memories, and in imagination we can join the company of Raleigh and the Earl of Northumberland and his 'three magi' in the Tower, or visit the lecture rooms of Hauksbee and Desaguliers or stand beside Voltaire at the grave of Newton. In fancy we can endeavour to break through the strange seclusion in which Cavendish lived and worked in his house on Clapham Common, watch Davy in the laboratory overcome with delight as he sees the first globules of metallic potassium form, assist Frank Buckland in his efforts to find the coffin of John Hunter in the crypt of St. Martin's-in-the-Fields, or travel across London with Kekulé on the evening he first saw the atoms linked.

This story is best told in Kekulé's own words. It takes us back to 1855, when Kekulé, at the age of twenty-six, was assistant to Stenhouse at St. Bartholomew's Hospital. Living in Clapham, he was returning home from a visit to Hugo Müller at Islington. "One fine summer evening", he says, "I was returning by the last omnibus, 'outside' as usual, through the deserted streets of the metropolis, which are at other times so full of life. I fell into a reverie, and lo, the atoms were gambolling before my eyes! Whenever, hitherto, these diminutive beings had appeared to me, they had always been in motion, but up to that time I had never been able to discern the nature of their motion. Now, however, I saw how frequently two smaller atoms united to form a pair; how a larger one embraced the smaller ones; how still larger ones kept hold of three or even four of the smaller; whilst the whole kept whirling in a giddy dance. I saw how the larger ones formed a chain dragging the smaller ones after them, but only at the ends of the chain. I saw what our Past Master, Kopp, my highly honoured teacher and friend, has depicted with such charm in his 'Molekularwelt'; but I saw it long before him. The cry of the conductor, 'Clapham Road', awakened me from my dreaming; but I spent a part of the night in putting on paper at least sketches of these dream forms. This was the origin of the Structurtheorie."

Modern Apparatus for the Reproduction of Speech and Music.

By Dr. N. W. McLachlan.

Sounds can be divided broadly into two classes: (*a*) transients, with which one is mainly concerned in speech, and to a lesser extent in music; (*b*) continuous sounds, which pertain chiefly to instrumental music and singing. Since a transient can be represented by an infinite frequency spectrum, the ideal apparatus should be capable of reproducing the entire range from zero to infinity. Fortunately for designers, the sensitivity of the ear is limited to the range 25-20,000 cycles (according to the individual). The widest range adequately covered by a single reproducer is from 50 to 7000 cycles, but this can be extended to 12,000 cycles by an additional reproducer. The range covered by the ordinary domestic loud speaker of the moving coil variety is roughly from 40 to 5000 cycles.

The energy of speech and music is conveyed by the frequency band below 500 cycles, whilst the interpretational and intelligibility characteristics reside in the range above this. Attenuation of the lower register is accompanied by a lack of body; for example, a pedal organ sounds like a harmonium. Attenuation of the upper register makes speech woolly, unnatural, and difficult to understand, music loses character and brilliance, whilst transients are travestied to a new type of sound; for example, the *rustle* of paper has never been heard over the microphone! The faithful reproduction of paper rustling and coin jingling involves frequencies greater than 10,000 cycles.

It is impossible to deal here with all forms of reproducing apparatus, but two representative types have been chosen, in both of which the driving mechanism is a circular coil immersed in a strong radial magnetic field. In the first or hornless type, the reproducing mechanism is a conical paper diaphragm 10-15 cm. in radius, to which the coil is rigidly attached (Fig. 1). The coil is constrained to move axially by a centering device, whilst the diaphragm is supported at its periphery by an annulus of leather, rubber, or other material. This arrangement is associated with some form of baffle to prevent interference between the pressure waves on each side of the diaphragm, since they are of opposite sign. The interference increases with the wave-length and is, therefore, greatest at low frequencies. To prevent appreciable reduction in output at, say, 100 cycles, the distance from centre to centre round the baffle should be half the wave-length, which makes the baffle about six feet round or square. In commercial apparatus for domestic purposes these dimensions are not realised. It is customary to use a cabinet which often introduces resonance effects. For talking pictures, however, a baffle is generally used.

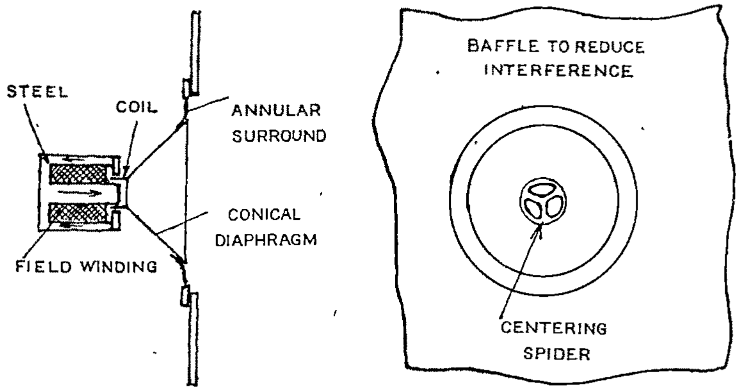

FIG. 1.

In the second type of reproducer, the diaphragm is within the coil and is used in conjunction with a horn, the cross-section of which increases exponentially (Fig. 2). The low frequency cut-off of the horn depends upon the rate of expansion and upon the length. A long horn permits a gradual expansion, whilst the diameter at the open end can then be greater than a quarter of the wave-length of the lowest frequency to be adequately reproduced. These conditions are concomitant with small reflection within the horn, whilst at the mouth the reflection is only serious for those frequencies below the cut-off point. For adequate reproduction below 100 cycles per second, an axial length of 15-25 ft. is required.

The coil and diaphragm (Fig. 2) is attached to a flexible annulus, the outer edge being securely clamped to the electromagnet. The natural frequency of the system on open circuit *in vacuo* is 400 cycles per second. The diaphragm is shaped to give rigidity, so that it moves substantially as a whole over a wide frequency band. The obstruction *H*, apart from reducing the throat area and thereby increasing the air particle velocity, acts as a phase equaliser. The clearance between the diaphragm and *H* gradually increases with the radius. Thus, during vibration the velocity of the air particles most remote from the horn aperture is increased, so that up to quite high frequencies the pressure from all parts of the diaphragm arrives in the main column in substantially the same phase.

In the early days of broadcasting it was thought that the ideal diaphragm (10-15 cm. radius) ought to move as a whole. Some years ago I showed that, owing to interference, the power output above 1000 cycles decreases so rapidly that a rigid structure would be of no value for modern moving-coil loud speakers using a baffle. After the 'moving coil' made its début, it was believed in certain quarters that the diaphragm moved as a whole over a wide frequency range. When the apex or the coil is tapped, a complex sound corresponding to the natural frequencies of the diaphragm is heard, whilst during operation the output above 1000 cycles usually exceeds that at lower frequencies. Such effects preclude the possibility of rigidity throughout the acoustic register.

I have shown recently that the action of a moving coil loud speaker depends upon resonances throughout the frequency range. The lower register is due to resonance of the annular support, acting as an auxiliary diaphragm, or to resonance of the diaphragm as a whole on the support or on the centering device of the coil. The upper register is due to the centre moving symmetrical modes of the diaphragm. If the low frequency resonances are eliminated, the upper register is overpowering and the reproduction lacks body. Owing to transmission loss in the diaphragm and to interference in the surrounding space, there is an upper frequency cut-off and considerable attenuation occurs above 5000 cycles.

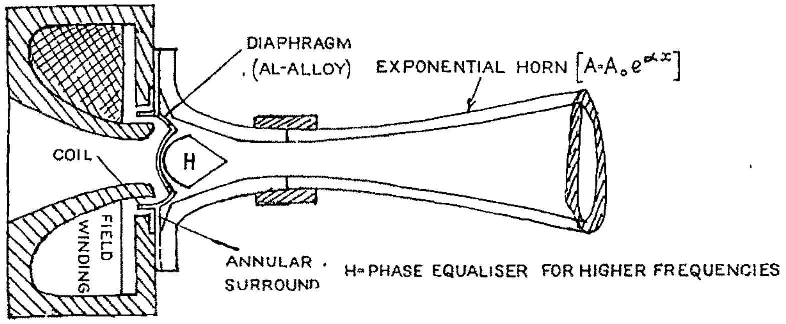
DIAPHRAGM (AL-ALLOY)
EXPONENTIAL HORN [A=A₀e^αx]
COIL
H
FIELD WINDING
ANNULAR SURROUND
H=PHASE EQUALISER FOR HIGHER FREQUENCIES

FIG. 2.

The reaction on the driving coil consists of two components in quadrature: (*a*) resistive due to the radiation of sound and transmission loss; (*b*) reactive due to the mass of the diaphragm including the accession to inertia caused by divergence of sound waves from the diaphragm as source. The mass reactance is a considerable proportion of the total mechanical impedance and reduces the amplitude of vibration considerably unless it is offset by elasticity of the diaphragm structure.

As in the case of a heat engine, the efficiency of an electrical-mechanical-acoustical apparatus can be stated in several ways. For the present we shall take the ratio η = acoustic output/electrical input. The value of η depends upon the magnitude of the resonances and the strength of the magnetic field. For a hornless type driven by a coil 2·5 cm. radius, 0·95 cm. long, and a radial field strength of $1 \cdot 3 \times 10^5$ lines per sq. cm., an efficiency of 10 per cent or more can be obtained over a certain frequency range.[*] By using a stronger field the efficiency can be increased. Where a permanent magnet is used, as in apparatus for domestic use, the efficiency is more likely to lie between 2 and 4 per cent.

When a horn is used, the radius of the diaphragm is usually about 2·5 cm. As in the preceding case, the reaction on the coil can be divided into resistive and reactive components. By means of the horn, however, the resistive component can be made relatively larger than in the hornless type of reproducer.

The horn acts as a coupling device which enables the high-pressure low-volume energy in the immediate vicinity of the diaphragm (the coupling chamber) to be transformed gradually and efficiently into low-pressure energy ultimately supplied to a large volume of air. This is very different from the large diaphragm type, where no attempt at impedance matching is made. The resistive load being relatively higher than in the hornless reproducer, means that the efficiency is correspondingly larger, whilst resonances are more heavily damped. Efficiencies of 30 per cent over a wide range can be obtained with a horn 15-25 ft. in axial length. Consequently, these instruments are invaluable for public address and entertainment purposes where an acoustic output of several watts is required.

With the same input, the reproduction of broadcasting by aid of a well-designed horn apparatus[†] is louder and better than that from a large diaphragm apparatus using a baffle. Although the lower register is more powerful in the latter case, the resonances are more marked and more sustained,[‡] whilst the upper frequencies are weaker. Moreover, the reproduction of transients is better with the horn type.

The operation of loud speakers for public address and entertainment purposes where the acoustic output runs into watts, requires a power installation. From a supply engineer's point of view the power is negligible, but in comparison with that required for domestic receivers it is large. In speech and music, peak values ten or more times the mean value occur in transients. To avoid distortion, it is essential that on the average the output valves are not worked to their limit. This necessitates applied voltages of from 500 to 1000.

In receivers for domestic purposes, it is seldom that the voltage applied to the valves exceeds 220. This combined with reproducers of low efficiency often means that in an attempt to get adequate volume, the output or power valve is worked beyond its normal capacity. On loud passages considerable distortion ensues, due to the creation of alien frequencies arising from operation beyond the linear limits of the valve characteristics. For undistorted output the general loudness level must be fairly low. Although this meets with approval in many households, it must be realised that with music it is desirable to have a reasonable loudness level, to simulate conditions in the concert hall or studio. The effect of loudness level is related to the physiological properties of the ear. If we listen close to a band in the park, the fundamental tones of all the instruments, from the bass drum upwards, are in evidence. But when we walk slowly away from the band, the pitch of the lower-toned instruments appears to alter, and ultimately the music sounds thin. This is due to the insensitivity of the ear to low frequencies. Beyond a certain distance from the band the air pressure due to the fundamental frequencies is below the audible limit for the human ear.

Applying this effect to indoor listening, it is clear that if the overture to the "Mastersingers" is reproduced at a level readily drowned by conversation, the musical balance is lost and the orchestra would be just as effective if it consisted of a flute and a few violins. Going to the opposite extreme, most of us have experienced the 'giant' voice of the announcer when the receiver is set to reproduce at a loud level for orchestral work. The voice is then projected at many times its normal loudness and air pressure distortion occurs. By virtue of the aural characteristics, the low tones appear unduly loud, thereby masking the naturalness of the voice. Sometimes this is due to diaphragm or other resonances, but undistorted reproduction at a much greater level than the original always accentuates the lower register. In this respect a violin reproduced very loudly might pass for a 'cello, and a flute for the diapason of a pedal organ.

As a general rule, there are one or more positions of a loud speaker which will give the best results in the average room. Here, as in the design of such instruments, one is often faced with 'Hobson's choice'. Thus reproduction is marred by resonances due to cabinets in which not only the loud speaker but also the whole receiving equipment is housed. The acoustic output is lavished mainly on the carpet, thereby causing attenuation of the upper frequencies and an inferior distribution of sound. When the time comes for a really high standard of reproduction in the home, the acoustic properties of rooms—amongst other things—will have to be taken into serious consideration.

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[*] This estimate is independent of the power valve and transformer.

[†] It is assumed that the horn structure is substantially dead.

[‡] Damping is greater, due to the restive load imposed by the horn. The magnetic field also assists.

News and Views.

A PUBLIC and official celebration of the British Association centenary took place at Liverpool Cathedral on Sunday, Sept. 20, with the main object of paying tribute to the special associations which Liverpool can claim with the original formation of the Association. A special liturgy of thanksgiving for the works of great natural philosophers of all races and nations throughout the ages was read by Prof. J. L. Myres, one of the general secretaries of the Association, and responded to by the Dean and choir and the congregation. Special emphasis was placed on the public avowal of the debt of churchmen to science and an open recognition of common tasks and common aspirations. This great change in the relations between science and religion since the days of Darwin and Huxley was manifest in the Cathedral addresses of General Smuts and Sir Oliver Lodge and in the special sermon preached by the Bishop of Birmingham. Dr. Barnes remarked that the centenary coincides with the most magnificent period of scientific discovery in the history of humanity. Against this we have literature and art of which, according to Dr. Barnes, little will survive, ethical weakness testified by war, and religious decay. A hundred years ago, geological conceptions began to assail contemporary religious theory. As an antidote arose the Oxford movement. Such opposition still persists, but there are friends of science within the Church. Scientific workers are, like Darwin in the face of the antagonism of Wilberforce, then Bishop of Oxford, going steadily on, and are helping clergy to gain a richer certainty of God's existence and glory. The task before us, since the great advance in biological, physical, and all other sciences, is to make a satisfactory synthesis of man's religious aspirations and the conclusions of modern science.

SUFFICIENT interest has been aroused in the celebration of the centenary of the British Association for the general reader, as well as the student of the history of science, to desire a detailed and connected account of the events which have led up to the present commemoration. The need is admirably met by the issue of a second edition of Mr. Howarth's "The British Association for the Advancement of Science", originally published in 1922. Among the new features is a chapter on Down House—the home of Darwin—presented to the Association by Mr. Buckston Browne. The book contains excellent portraits of many of the Association's most distinguished members, taken at those periods of their lives when scientific discovery and achievement had produced a serenity of bearing, a pleasure to behold. In the first instance, the book was made possible through the generosity of the late Sir Charles Parsons, and its creditable compilation is the outcome of the labours of the secretary of the Association. The Association traverses all the domains of the realms of science, and treks to all the dominions of our Empire. Previously to this year it has regarded a visit to London in the nature of carrying coals to Newcastle; but now it has come and set the City ablaze. The British Association is a monument to the genius of our nation, and Mr. Howarth's book provides a brilliant floodlight to illuminate and advertise the fact. Copies are being presented to members of Association attending the London meeting.

MEMBERS of the British Association are also receiving a copy of "London and the Advancement of Science", a volume of some three hundred pages, compiled by ten contributors, each authoritative in his particular theme. As a preliminary classification of its contents, one might say that the scientific soul of London is revealed in such chapters as those on the learned societies, Government and scientific research, the development of medicine, and the history of education in London; while the more material aspect of the metropolis is dealt with in the sections on the Royal Observatory at Greenwich, Kew Gardens, the John Innes Institution, and the museums of London. There is also an introductory survey and a brief history of the London makers of scientific instruments. Among the authors' names are those of Sir Frank Heath, Sir Frank Dyson, Sir Daniel Hall, and Dr. F. A. Bather. Nothing so worthy of this phase of London life has ever before been attempted or achieved. There is a surfeit of good things for instructor and the instructed. In our youth we were told that the streets of London were paved with gold; we have only to turn to a random page of this book to discover treasures that historians of science, in their maturer years, might accept as precious metal. When Sir Humphry and Lady Davy, after a long stay abroad, arrived home, they mutually agreed that, although the Continent is a nice place to visit, London is the best place to live in. The more one becomes acquainted with the scientific history of London, the more one feels in spiritual contact with its glorious past, and in living union with its quickening present.

THE Faraday Commemorative Meeting, organised by the Royal Institution and the Institution of Electrical Engineers, was held at the Queen's Hall on Sept. 21. Representatives of forty-two countries attended this brilliant and dignified opening of the centenary celebrations in honour of the father of modern physics. In spite of the present crisis, the Prime Minister, the Right Hon. J. Ramsay MacDonald, honoured the meeting by his presence, and paid a warm tribute, in his opening address, to Faraday, the man who lived for his scientific convictions. The prominent speakers who followed laid stress on some particular points of Faraday's discoveries connected with their own special researches.

THE Duc de Broglie, well known for his investigations on X-ray spectra, contrasted the variety of Faraday's experiments with the unity of his purpose —a deeper knowledge of the laws of Nature. The Marchese Marconi explained how wireless and its

(*Continued on p.* 541.)

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The Scientific World-Picture of To-day.

By General the Right Hon. J. C. SMUTS, P.C., C.H., F.R.S., President of the British Association.

PRESIDENTIAL ADDRESS DELIVERED IN LONDON ON SEPT. 23, 1931.

THIS centenary meeting of the British Association is a milestone which enables us to look back upon a hundred years of scientific progress such as has no parallel in history. It brings us to a point in the advance from which we can confidently look forward to fundamental solutions and discoveries in the near future which may transform the entire field of science. In this second and greater renaissance of the human spirit, this Association and its members have borne a foremost part, to which it would be impossible for me to do justice. I shall therefore not attempt to review the achievements of this century of science, but shall content myself with the simpler undertaking of giving a generalised composite impression of the present situation in science.

I am going to ask the question : What sort of world-picture is science leading to ? Is science tending towards a definite scientific outlook on the universe, and how does it differ from the traditional outlook of commonsense ?

The question is not without its interest. For our world-view is closely connected with our sense of ultimate values, our reading of the riddle of the universe, and of the meaning of life and of human destiny. Our scientific world-picture will draw its material from all the sciences. Among these, physical science will—in view of its revolutionary discoveries in recent years—be a most important source. But no less important will be the contribution of the biological sciences, with their clear revelation of organic structure and function as well as of organic evolution. Last, not least, the social and mental sciences will not only supply valuable material, but also especially methods of interpretation, insights into meanings and values, without which the perspectives of our world-picture would be hopelessly wrong.

Can we from some reunion or symposium of these sciences obtain a world-picture or synoptic view of the universe, based on observation and calculation, which are the instruments of science, but reaching beyond the particular phenomena which are its immediate field to a conception of the universe as a whole ?

That was how science began—in the attempt to find some simple substances or elements to which the complex world of phenomena could in the last analysis be reduced. The century over which we now look back, with its wonderful advance in the methods and technique of exact observation, has been a period of specialisation or decentralisation. Have we now reached a point where science can again become universal in its ultimate outlook ? Has a scientific world-picture become possible ?

Of course there can be no final picture at any one stage of culture. The canvas is as large as the universe, and the moving finger of humanity itself will fill it in from age to age. All the advances of knowledge, all the new insights gained from those advances, will from time to time be blended into that picture. To the deeper insight of every era of our human advance there has been some such world-picture, however vague and faulty. It has been continually changing with the changing knowledge and beliefs of man. Thus, there was the world of magic and animism, which was followed by that of the early Nature gods. There was the geocentric world, which still survives in the world of commonsense. There is the machine or mechanistic world-view dominant since the time of Galileo and Newton, and now, since the coming of Einstein, being replaced by the mathematician's conception of the universe as a symbolic structure of which no mechanical model is possible. All these world-views have in turn obtained currency according as some well-defined aspect of our advancing knowledge has from time to time been dominant. My object is to focus attention on the sort of world-picture which results from the advances of physical, biological, and mental science during the period covered roughly by the activities of our Association.

Science arose from our ordinary experience and commonsense outlook. The world of commonsense is a world of matter, of material stuff, of real separate things and their properties which act on each other and cause changes in each other. To the various things observable by the senses were added the imperceptible things—space and time, invisible forces, life, and the soul. Even these were not enough, and the supernatural was added to the natural world. The original inventory was continually being enlarged, and thus a complex empirical world-view arose, full of latent contradictions, but with a solid basis of actual experience and facts behind it.

Speaking generally, we may say that this is substantially still the commonsense view of the world and the background of our common practical beliefs. How has science dealt with this commonsense empirical world-view? The fundamental procedure of science has been to rely on sense observation and experiment, and to base theory on fact. Thus the vast body of exact science arose, and all entities were discarded which were either inconsistent with observed facts or unnecessary for their strict interpretation. The atomic view of matter was established. Ether was given a status in the physical order which is now again being questioned in the light of the conception of space-time. New entities like energy emerged; old entities like forces disappeared; the principle of the uniformity of Nature was established; the laws of motion, of conservation, and of electromagnetism were formulated; and on their basis a closed mechanistic order of Nature was constructed, forming a rigid deterministic scheme. Into this scheme it has been difficult, if not impossible, to fit entities like life and mind; and the scientific attitude has on the whole been to put them to a suspense account and to await developments. As to the supernatural, science is or has been agnostic, if not frankly sceptical.

Such, in very general terms, was the scientific outlook of the nineteenth century, which has not yet completely passed away. It will be noticed that much of the fundamental outlook of commonsense has thus survived, though clarified and purified by a closer accord with facts. This scientific view retained unimpaired, and indeed stressed with a new emphasis, the things of commonsense, matter, time, and space, as well as all material or physical entities which are capable of observation or experimental verification. Nineteenth-century science is, in fact, a system of purified, glorified commonsense. Its deterministic theory certainly gave a shock to the common man's instinctive belief in free will; in most other respects it conformed to the outlook of commonsense. It is true that its practical inventions have produced the most astounding changes in our material civilisation, but neither in its methods nor in its world-outlook was there anything really revolutionary.

Underneath this placid surface the seeds of the future were germinating. With the coming of the twentieth century fundamental changes began to set in. The new point of departure was reached when physical science ceased to confine its attention to the things that are observed It dug down to a deeper level, and below the things that appear to the senses it found, or invented, at the base of the world, so-called scientific entities, not capable of direct observation, but which are necessary to account for the facts of observation. Thus, below molecules and atoms still more ultimate entities appeared; radiations, electrons, and protons emerged as elements which underlie and form our world of matter. Matter itself, the time-honoured mother of all, practically disappeared into electrical energy.

"The cloud-capp'd towers, the gorgeous palaces,
The solemn temples, the great globe itself,"

yea, all the material forms of earth and sky and sea, were dissolved and spirited away into the blue of energy. Outstanding among the men who brought about this transformation are two of my predecessors in this chair: Sir J. J. Thomson and Lord Rutherford. Like Prospero, like Shakespeare himself, they must be reckoned among the magicians.

Great as was this advance, it does not stand alone. Away in the last century, Clerk Maxwell, following up Faraday's theories and experiments, had formulated his celebrated equations of the electromagnetic field, which applied to light no less than to electromagnetism, and the exploration of this fruitful subject led Minkowski to the amazing discovery in 1908 that time and space were not separate things, but constituent elements in the deeper synthesis of space-time. Thus time is as much of the essence of things as space; it enters from the first into their existence as an integral element. Time is not something extra and superadded to things in their behaviour, but is integral and basic to their constitution. The stuff of the world is thus envisaged as events instead of material things.

This physical concept or insight of space-time is our first revolutionary innovation, our first complete break with the old world of commonsense. Already it has proved an instrument of amazing power in the newer physics. In the hands of an Einstein it has led, beyond Euclid and Newton, to the recasting of the law and the concept of gravitation, and to the new relativity conception of the basic structure of the world. The transformation of the concept of space, owing to the injection into it of time, has destroyed the old passive homogeneous notion of space and has substituted a flexible, variable continuum, the curvatures and unevenness of which constitute to our senses what we call a material world. The new concept has made it possible to construe matter, mass, and energy as but definite measurable conditions of curvature in the structure of space-time. Assuming that electromagnetism will eventually follow the fate of gravitation, we may say that space-time will then appear as the scientific concept for the only physical reality in the universe, and that matter and energy in all their forms will have disappeared as independent entities, and will have become mere configurations of this space-time. This will probably involve an amplified concept of space-time. Einstein has recently indicated that for further advance a modification in our space-time concept will become necessary, and that the additional element of direction will have to be incorporated into it. Whatever change may become necessary in our space-time concept, there can be no doubt about the immense possibilities it has opened up.

I pass on to an even more revolutionary recent advance of physics. The space-time world, however novel, however shattering to commonsense, is not in conflict with reason. Indeed, the space-time world is largely a discovery of the mathematical reason, and is an entirely rational world. It is a world where reason, as it were, dissolves the refractoriness of the old material substance and smoothes it out into forms of space-time. Science, which began with empirical brute facts, seems to be heading for the reign of pure reason. But wait a bit; another fundamental discovery of our age has apparently taken us beyond the bounds of rationality, and is thus even more revolutionary than that of space-time. I refer to the quantum theory, Max Planck's discovery at the end of the nineteenth century, according to which energy is granular, consisting of discrete grains or quanta. The world in space-time is a continuum; the quantum action is a negation of continuity. Thus arises the contradiction, not only of commonsense, but apparently also of reason itself. The quantum appears to behave like a particle, but a particle out of space or time. As Sir Arthur Eddington graphically puts it: a quantum of light is large enough to fill the lens of a hundred-inch telescope, but it is also small enough to enter an atom. It may spread like a circular wave through the universe, but when it hits its mark this cosmic wave instantaneously contracts to a point where it strikes with its full and undivided force.

Space-time, therefore, does not seem to exist for the quantum, at least not in its lower multiples. Nay, more: the very hitting of its mark presents another strange puzzle, which seems to defy the principles of causation and of the uniformity of Nature, and to take us into the realm of chance and probability. The significant thing is that this strange quantum character of the universe is not the result of theory, but is an experimental fact well attested from several departments of physics. In spite of the strange Puck-like behaviour of the quantum, we should not lightly conclude, with some prominent physicists, that the universe has a skeleton in its cupboard in the shape of an irrational or chaotic factor. Our macroscopic concepts may not fit this ultra-microscopic world of the quantum. Our best hopes for the future are founded on the working out of a new system of concepts and laws suited to this new world that has swum into the ken of science. The rapid development of wave mechanics in the last four years seems to have brought us within sight of this ideal, and we are beginning to discern a new kind of order in the microscopic elements of the world, very different from any type of law hitherto imagined in science, but none the less a rational order capable of mathematical formulation.

We may summarise these remarks by saying that the vastly improved technique of research has led to physical discoveries in recent years which have at last completely shattered the traditional commonsense view of the material world. A new space-time world has emerged which is essentially immaterial, and in which the old-time matter, and even the scientific mass, gravitation, and energy stand for no independent entities, but can best be construed as configurations of space-time; and the discovery of the quantic properties of this world points to still more radical transformations which loom on the horizon of science. The complete recasting of many of our categories of experience and thought may ultimately be involved.

From the brilliant discoveries of physical science we pass on to the advances in biological science which, although far less revolutionary, have been scarcely less important for our world-outlook. The most important biological discovery of the last century was the great fact of organic evolution; and for this fact the space-time concept has at last come to provide the necessary physical basis. It is unnecessary for my purpose to canvass the claims and discuss the views represented by the great names of Lamarck, Darwin, and Mendel, beyond saying that they represent a progressive advance in biological discovery, the end of which has by no means been reached yet. Whatever doubts and differences of opinion there may be about the methods, the mechanism, or the causes, there is no doubt about the reality of organic evolution, which is one of the most firmly established results in the whole range of science. Palæontology, embryology, comparative anatomy, taxonomy, and geographical distribution all combine to give the most convincing testimony that, throughout the history of this earth, life has advanced genetically from at most a few simple primitive forms to ever more numerous and highly specialised forms. Under the double influence of the internal genetic and the external environmental factors, life has subtly adapted itself to the ever-changing situations on this planet. In the process of this evolution not only new structures and organs, but also new functions and powers have successively appeared, culminating in the master key of mind and in the crowning achievement of human personality. To have hammered the great truth of organic evolution into the consciousness of mankind is the undying achievement of Charles Darwin, by the side of which his discovery of natural selection as the method of evolution is of secondary importance.

The acceptance of the theory of evolution has brought about a far-reaching change in our outlook on the universe and our sense of values. The story of creation, so intimately associated with the groundwork of most religions, has thus come to be rewritten. The unity and interconnexions of life in all its manifold forms have been clearly recognised, and man himself has had to come down from his privileged position among the angels and take his proper place in the universe as part of the order of Nature. Thus Darwin completes the revolution begun by Copernicus.

Space-time finds its natural completion in organic evolution. For in organic evolution the time aspect of the world finds its most authentic expression. The world truly becomes process, where nothing ever remains the same or is a duplicate of anything else, but a growing, gathering, creative stream of unique events rolls forever forward.

While we recognise this intimate connexion between the conceptions of space-time and organic evolution, we should be careful not to identify the time of evolution with that of space-time. There is a very real difference between them. Biological time has direction, passes from the past to the future, and is therefore historical. It corresponds to the 'before' and 'after' of our conscious experience. Physical time as an aspect of space-time is neutral as regards direction. It is space-like, and may be plus or minus, but does not distinguish between past or future. It may move in either direction, backwards or forwards, while biological time, like the time of experience, knows only a forward flow. Hence cosmic evolution, as we see it in astronomy and physics, is mostly in an opposite direction to that of organic evolution. While biological time on the whole shows a forward movement towards ever higher organisation and rising qualities throughout the geological ages, the process of the physical world is mostly in the opposite direction *—towards disorganisation, disintegration of more complex structures, and dissipation of energy. The second law of thermodynamics thus marks the direction of physical time. While the smaller world of life seems on the whole to be on the up-grade, the larger physical universe is on the down-grade. One may say that in the universe we witness a majority movement downward, and a minority movement upward. The energy which is being dissipated by the decay of physical structure is being partly taken up and organised into life structures—at any rate on this planet. Life and mind thus appear as products of the cosmic decline, and arise like the phœnix from the ashes of a universe radiating itself away. In them Nature seems to have discovered a secret which enables her to irradiate with imperishable glory the decay to which she seems physically doomed.

Another striking point arises here. Organic evolution describes the specific process of what we call life, perhaps the most mysterious phenomenon of this mysterious universe. When we ask what is the nature of life we are curiously reminded of the behaviour of the quantum referred to. I do not for a moment wish to say that the quantum is the physical basis of life, but I do say that in the quantum the physical world offers an analogy to life which is at least suggestive. The quantum follows the all-or-nothing law and behaves as an indivisible whole : so does life. A part of a quantum is not something less than a quantum ; it is nothing or sheer nonentity : the same holds true of life.

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* No doubt there are exceptions to this broad generalisation. In astronomy stars and solar systems and galaxies are probably still being formed, while in physics syntheses of elements may possibly still be going on. In the same way we find in organic evolution minor phases of regression, degeneration, and parasitism.

The quantum is perhaps most easily symbolised as a wave or combination of waves, which can only exist as a complete periodicity, and the very concept of which negatives its existence as partial or truncated. In other words, it is a specific configuration and can only exist as such: the same holds true of life. The quantum does not fall completely within the deterministic causal scheme: the same seems true of life.

Significant, also, is the fact that quantum phenomena underlie secondary qualities such as colour and the like, which the older science in its mechanistic scheme ignored, but which are specially associated with life and consciousness. Life is not an entity, physical or other. It is a type of organisation; it is a specific principle of central or self organisation. If that organisation is interfered with we are left, not with bits of life, but with death. The nature of living things is determined, not by the nature of their parts, but by the nature or principle of their organisation. In short, the quantum and life seem to have this in common, that they both behave as wholes.

I have before now endeavoured to explore the concept of life in the light of the more general concept of the whole. A whole is not a sum of parts, or constituted by its parts. Its nature lies in its constitution more than in its parts. The part in the whole is no longer the same as the part in isolation. The interesting point is that while this concept of the whole applies to life, it is according to the recent physics no less applicable to the ultimate physical units. Thus the electron within an atom is no longer a distinct electron. There may be separate electrons, but when they cease to be separate they also cease to be. The eight electrons which circulate in an oxygen atom are merged in a whole in such a way that they have lost their separate identity; and this loss of individuality has to be taken into account in calculations as to the physical behaviour of the atom. The physicist, in fact, finds himself unable to look upon the entity which is one-eighth of eight electrons as the same thing as a single electron. At the very foundation, therefore, of physics, the principle or category of the whole applies no less than in the advanced structure of life, although not in the same degree. In the ultimate analysis of the world, both at the physical and the biological level, the part or unit element somehow becomes shadowy and incoherent, and the very basis of mechanism is undermined. It would almost seem as if the world in its very essence is holistic, and as if the notion of individual parts is a practical makeshift without final validity in the nature of things.

The general trend of the recent advances in physics has thus been towards the recognition of the fundamental organic character of the material world. Physics and biology are beginning to look not so utterly unlike each other. Hitherto the great gulf in Nature has lain between the material and the vital, between inorganic matter and life. This gulf is now in process of being bridged. The new physics, in dissolving the material world of common sense and discovering the finer structure of physical Nature, has at the same time disclosed certain fundamental features which it has in common with the organic world. Stuff-like entities have disappeared and have been replaced by space-time configurations, the very nature of which depends on their principle of organisation. This principle, which I have ventured to call holism, appears to be at botton identical with that which pervades the organic structures of the world of life. The quantum and space-time have brought physics closer to biology. As I have pointed out, the quantum anticipates some of the fundamental characters of life, while space-time forms the physical basis for organic evolution. Physics and biology are thus recognised as respectively simpler and more advanced forms of the same fundamental pattern in world-structure.

The older mechanistic conception of Nature, the picture of Nature as consisting of fixed material particles, mechanically interacting with each other—already rudely shaken by the relativity theory—is now being modified by the quantum physics. The attack on mechanism, thus coming from physical science itself, is therefore all the more deadly. Even in physics, organisation is becoming more important than the somewhat nebulous entities which enter into matter. Interaction is more and more recognised to be not so much mechanical as organic or holistic, the whole in some respects dominating not only the functioning but also the very existence of the entities forming it. The emergence of this organic view of Nature from the domain of physics itself is thus a matter of first-rate importance, and must have very far-reaching repercussions for our eventual world-view.

The nature of the organic whole is, however, much more clearly recognised in its proper sphere of biology, and especially in the rapidly advancing science of physiology. Here, too, the correct view has been much obscured by the invasion of mechanistic ideas from the physics of the nineteenth century. A crude materialism all but swamped biology for more than a generation. At the Belfast meeting of the British Association in 1874, a famous predecessor of mine gave unrestrained expression to this materialistic creed. All that is passing, if not already past. It must be admitted that up to a point mechanism has been useful as a first approximation and fruitful as a convention for research purposes. But if even in physics it has lost its savour, *a fortiori* has it become out of place in biology. The partial truth of mechanism is always subtended by the deeper truth of organicity or holism. So far from biology being forced into a physical mould, the position will in future be reversed. Physics will look to biology and even to psychology for hints, clues, and suggestions. In biology and psychology it will see principles at work in their full maturity which can only be faintly and fitfully recognised in physics. In this way the exchanges of physics, biology, and psychology will become fruitful for the science of the future, and lay the basis for a new scientific monism.

A living individual is a physiological whole, in which the parts or organs are but differentiations of this whole for purposes of greater efficiency, and remain in organic continuity throughout. They are parts *of* the individual, and not independent or self-contained units which *compose* the individual. It is only this conception of the individual as a dynamic organic whole which will make intelligible the extraordinary unity which characterises the multiplicity of functions in an organism, the mobile, ever-changing balance and interdependence of the numerous regulatory processes in it, as well as the operation of all the mechanisms by which organic evolution is brought about. This conception applies not only to individuals, but also to organic societies, such as a beehive or an ants' nest, and even to social organisations on the human level.

As the concept of space-time destroys the purely spatial character of things, so the concept of the organic whole must also be extended beyond the spatial limits of the organism so as to include its interaction with its environment. The stimuli and responses which render them mutually interdependent constitute them one whole which thus transcends purely spatial aspects. It is this overflow of organic wholes beyond their apparent spatial limits which binds all Nature together and prevents it from being a mere assemblage of separate interacting units.

It is time, however, that we pass on to the world of mind. From matter, as now transformed by space-time and the quantum, we pass step by step through organic nature to conscious mind. Gone is the time when Descartes could divide the world into only two substances: extended substance or matter, and thinking substance or mind. There is a whole world of gradations between these two limits. On Descartes' false dichotomy the separate provinces of modern science and philosophy were demarcated. But it is as dead as the epicycles of Ptolemy, and ultimately the Cartesian frontiers between physics and philosophy must largely disappear, and philosophy once more become metaphysic in the original sense. In the meantime, under its harmful influence, the paths of matter and mind, of science and philosophy, were made to diverge farther and farther, so that only the revolution now taking place in thought could bring them together again. I believe, however, their reunion is coming fast. We have seen matter and life indefinitely approaching each other in the ultimate constituents of the world. We have seen that matter is fundamentally a configuration or organisation of space-time; and we have seen that life is a principle of organisation whereby the space-time patterns are arranged into organic unities. The next step is to show that mind is an even more potent embodiment of the organising whole-making principle, and that this embodiment has found expression in a rising series, which begins practically on the lowest levels of life, and rises ultimately to the conscious mind which alone Descartes had in view in his classification. I have no time to follow up the matter here beyond making a few remarks.

Mind is admittedly an active, conative, organising principle. It is for ever busy constructing new patterns of things, thoughts, or principles out of the material of its experience. Mind, even more than life, is a principle of whole-making. It differentiates, discriminates, and selects from its vague experience, and fashions and correlates the resulting features into more or less stable, enduring wholes. Beginning as mere blind tropisms, reflexes, and conditioned reflexes, mind in organic Nature has advanced step by step in its creative march until in man it has become Nature's supreme organ of understanding, endeavour, and control—not merely a subjective human organ, but Nature's own power of self-illumination and self-mastery: "The eye with which the universe beholds itself and knows itself divine".

The free creativeness of mind is possible because, as we have seen, the world ultimately consists, not of material stuff, but of patterns, of organisation, the evolution of which involves no absolute creation of an alien world of material from nothing. The purely structural character of reality thus helps to render possible and intelligible the free creativeness of life and mind, and accounts for the unlimited wealth of fresh patterns which mind freely creates on the basis of the existing physical patterns.

The highest reach of this creative process is seen in the realm of values, which is the product of the human mind. Great as is the physical universe which confronts us as a given fact, no less great is our reading and evaluation of it in the world of values, as seen in language, literature, culture, civilisation, society and the State, law, architecture, art, science, morals, and religion. Without this revelation of inner meaning and significance the external physical universe would be but an immense empty shell or crumpled surface. The brute fact here receives its meaning, and a new world arises which gives to Nature whatever significance it has. As against the physical configurations of Nature we see here the ideal patterns or wholes freely created by the human spirit as a home and an environment for itself.

Among the human values thus created science ranks with art and religion. In its selfless pursuit of truth, in its vision of order and beauty, it partakes of the quality of both. More and more it is beginning to make a profound æsthetic and religious appeal to thinking people. Indeed, it may fairly be said that science is perhaps the clearest revelation of God to our age. Science is at last coming into its own as one of the supreme goods of the human race.

While religion, art, and science are still separate values, they may not always remain such. Indeed, one of the greatest tasks before the human race will be to link up science with ethical values, and thus to remove grave dangers threatening our future. A serious lag has already developed between our rapid scientific advance and our stationary ethical development, a lag which has already found expression in the greatest tragedy of history. Science must itself help to close this dangerous gap in our advance which threatens the disruption of our civilisation and the decay of our species. Its final and perhaps most difficult task may be found just here. Science may be destined to become the most effective drive towards ethical values, and in that way to render its most priceless human service. In saying this I am going beyond the scope of science as at present understood, but the conception of science itself is bound to be affected by its eventual integration with the other great values.

I have now finished my rapid and necessarily superficial survey of the more prominent recent tendencies in science, and I proceed to summarise the results and draw my conclusions, in so far as they bear on our world-picture.

In the first place we have seen that in the ultimate physical analysis, science reaches a microscopic world of scientific entities, very different in character and behaviour from the macroscopic world of matter, space, and time. The world of atoms, electrons, protons, radiations, and quanta does not seem to be in space-time or to conform to natural law in the ordinary sense. The behaviour of these entities cannot be understood without the most abstruse mathematics or, apparently, without resort to epistemological considerations. We seem to have passed beyond the definitely physical world into a twilight where prophysics and metaphysics meet, where space-time does not exist, and where strictly causal law in the old sense does not apply. From this uncertain nebulous underworld there seems to crystallise out, or literally to materialise, the macroscopic world which is the proper sphere of sensuous observation and of natural laws. The pre-material entities or units condense and cohere into constellations, which increase in size and structure until they reach the macroscopic stage of observation. As the macroscopic entities emerge, their space-time field and appropriate natural laws (mostly of a statistical character) emerge *pari passu*. We seem to pass from one level to another in the evolution of the universe, with different units, different behaviours, and calling for different concepts and laws. Similarly, we rise to new levels as later on we pass from the physical to the biological level, and again from the latter to the level of conscious mind But—and this is the significant fact—all these levels are genetically related and form an evolutionary series ; and underlying the differences of the successive levels, there remains a fundamental unity of plan or organisation which binds them together as members of a genetic series, as a growing, evolving, creative universe.

In the second place, let us see how common sense deals with this macroscopic world. On this stage common sense recognises three levels of matter, life, and mind as together composing the world. But it places them so far apart, and makes them so inherently different from each other, that relations between them appear unintelligible, if not impossible. The common-sense notions of matter, life, and mind make any relations between them, as well as the world which they form, an insoluble puzzle. The older science therefore attempted to reduce life substantially to terms of matter, and to put a question mark behind mind ; and the result was a predominantly materialistic view of the world. The space-time relativity concept of the world has overcome the difficulty by destroying the old concept of matter, and reducing it from a self-subsistent entity to a configuration of space-time—in other words, to a special organisation of the basic world-structure. If matter is essentially immaterial structure or organisation, it cannot fundamentally be so different from organism or life, which is best envisaged as a principle of organisation ; or from mind, which is an active organiser.

Matter, life, and mind thus translate roughly into organisation, organism, organiser. The all-or-none law of the quantum, which also applies to life and mind, is another indication that matter, life, and mind may be but different stages or levels of the same activity in the world which I have associated with the pervading feature of whole-making. Materialism has thus gone by the board, and the unintelligible trinity of common sense (matter, life, mind) has been reinterpreted and transformed and put on the way to a new monism.

In the third place, the iron determination of the older science, so contrary to direct human experience, so destructive of the free activity of life and mind, as well as subversive of the moral responsibility of the individual, has also been materially recast. It was due to the Newtonian causal scheme which, as I have indicated, has been profoundly shaken by recent developments. Relativity reduces substance to configuration or patterns, while quantum physics gives definite indications of indeterminism in Nature. In any case, life through the ages shows clearly a creative advance to ever more complex organisation, and ever higher qualities, while mind is responsible for the creation of a whole realm of values. We are thus justified in stressing, along with natural necessity, an increasing measure of freedom and creativeness in the world, sufficient at least to account for organic evolution and for the appearance of moral law and endeavour

This liberation of life and spirit from the iron rule of necessity is one of the greatest gains from the recent scientific advances. Nature is not a closed physical circle, but has left the door open to the emergence of life and mind and the development of human personality. It has, in its open flexible physical patterns, laid the foundation and established the environment for the coming of life and mind. The view, to which Huxley once gave such eloquent and poignant expression, of a dualism implanted in the heart of Nature, of a deadly struggle between cosmic law and moral law, is no longer justified by the subsequent advances of science.

In the fourth place, however, another dualism of a wider reach has appeared, which makes the universe itself appear to be a house divided against itself. For while the stream of physical tendency throughout the universe is on the whole downward, toward disintegration and dissipation, the organic movement, on this planet at least, is upward, and life structures are on the whole becoming more complex throughout the course of organic evolution. From the viewpoint of physics, life and mind are thus singular and exceptional phenomena, not in line with the movement of the universe as a whole. Recent astronomical theory has come to strengthen this view of life as an exceptional feature off the main track of the universe. For the origin of our planetary system is attributed to an unusual accident, and planets such as ours with a favourable environment for life are taken to be rare in the universe. Perhaps we may even say that at the present epoch there is no other globe where life is at the level manifested on the earth. Our origin is thus accidental, our position is exceptional, and our fate is sealed, with the inevitable running down of the solar system. Life and mind, instead of being the natural flowering of the universe, are thus reduced to a very casual and inferior status in the cosmic order. A new meaning and a far deeper poignancy are given to Shakespeare's immortal lines :

> " We are such stuff
> As dreams are made of ; and our little life
> Is rounded with a sleep."

According to astronomy, life is indeed a lonely and pathetic thing in this physical universe—a transient and embarrassed phantom in an alien, if not hostile, universe.

Such are some of the depressing speculations of recent astronomical theory. But in some respects they have already been discounted in the foregoing. For even if life be merely a terrestrial phenomenon, it is by no means in an alien environment if, as we have seen reason to think, this is an essentially organic universe. In its organic aspects the universe is on the way to life and mind, even if the goal has been actually reached at only one insignificant point in the universe. The potencies of the universe are fundamentally of the same order as its actualities. The universe might say, in the words of Rabbi Ben Ezra :

> " All I could never be
> All man ignored in me,
> This I was worth to God."

Then again, the very possibility of perception, of knowledge and science, depends on an intimate relation between mind and the physical universe. Only thus can the concepts of mind come to be a measure for the facts of the universe, and the laws of Nature come to be revealed and interpreted by Nature's own organ of the human mind. Besides science we have other forms of this inner relation between the mind and the universe, such as poetry, music, art, and religion. The human spirit is not a pathetic wandering phantom of the universe, but is at home, and meets with spiritual hospitality and response everywhere. Our deepest thoughts and emotions and endeavours are but responses to stimuli which come to us, not from an alien, but from an essentially friendly and kindred universe. So far from the cosmic status of life and mind being degraded by the newer astronomy and physics, I would suggest an alternative interpretation of the facts, more in accord with the trend of evolutionary science. We have seen a macroscopic universe born or revealed to consciousness out of a prior microscopic order of a very different character. Are we not, in the emergence of life and mind, witnessing the birth or revelation of a new world out of the macroscopic physical universe ? I suggest that at the present cosmic epoch we are the spectators of what is perhaps the grandest event in the immeasurable history of our universe, and that we must interpret the present phase of the universe as a mother and child universe, still joined together by a placenta which science, in its divorce from the other great values, has hitherto failed to unravel.

Piecing together these clues and conclusions, we arrive at a world-picture fuller of mystery than ever. In a way it is closer to common sense and kinder to human nature than was the science of the nineteenth century. Materialism has practically disappeared, and the despotic rule of necessity has been greatly relaxed. In ever-varying degree the universe is organic and holistic through and through. Not only organic concepts, but also, and even more so, psychological viewpoints are becoming necessary to elucidate the facts of science ; and while the purely human concepts, such as emotion and value, purpose and will, do not apply in the natural sciences, they retain their unimpaired force in the human sciences. The ancient spiritual goods and heirlooms of our race need not be ruthlessly scrapped. The great values and ideals retain their unfading glory and derive new interest and force from a cosmic setting.

In other respects it is a strange new universe, impalpable, immaterial, consisting not of material or stuff, but of organisation, of patterns or wholes which are unceasingly being woven to more complex or to simpler designs. In the large it appears to be a decaying, simplifying universe which attained to its perfection of organisation in the far-distant past and is now regressing to simpler forms—perhaps for good, perhaps only to restart another cycle of organisation. But inside this cosmic process of decline we notice a smaller but far more significant movement—a streaming, protoplasmic tendency ; an embryonic infant world emerging, throbbing with passionate life, and striving towards rational and spiritual self-realisation. We see the mysterious creative rise of the higher out of the lower, the more from the less, the picture within its framework, the spiritual kernel inside the phenomenal integuments of the universe. Instead of the animistic, or the mechanistic, or the mathematical universe, we see the genetic, organic, holistic universe, in which the decline of the earlier physical patterns provides the opportunity for the emergence of the more advanced vital and rational patterns.

In this holistic universe man is in very truth the offspring of the stars. The world consists not only of electrons and radiations, but also of souls and aspirations. Beauty and holiness are as much aspects of Nature as energy and entropy. Thus " in eternal lines to time it grows ". An adequate world-view would find them all in their proper context in the framework of the whole ; and evolution is perhaps the only way of approach to the framing of a consistent world-picture which would do justice to the immensity, the profundity, and the unutterable mystery of the universe.

Such in vague outline is the world-picture to which science seems to me to be pointing. We may not all agree with my rendering of it, which indeed does not claim to be more than a mere sketch. Even if it were generally accepted, we have still to bear in mind that the world-picture of to-morrow will in all probability be very different from any which could be sketched to-day.

Summaries of Addresses of Presidents of Sections.*

Education and Research in Physics.

SIR J. J. THOMSON devoted his presidential address to Section A (Mathematical and Physical Sciences) to a discussion of "The Growth in Opportunities for Education and Research in Physics during the Past Fifty Years". The limit of fifty years was inevitable, for organised facilities for teaching and research in physics were almost unknown until towards the end of the nineteenth century. Much of the physical work of Joule, Stokes, Spottiswoode, Huggins, de la Rue, Rayleigh, and E. H. Griffiths was done in private rooms or private laboratories. Instruction was also unorganised. These men, like Kelvin and Maxwell, were in regard to physics largely self-taught, but they had learned to use their hands. In the early 'seventies there were only six physical laboratories in England; now there are considerably more than three hundred.

Sir Joseph traced the history of scientific education in universities and schools. Cambridge determined to establish a natural science tripos in 1849 and the first examination, with six candidates, was held in 1851. This number increased to twenty-five in 1881 and to ninety-four in 1891. The great advance has been made in the last fifty years. "It cannot, however, be said that even now Science occupies in our systems of education a place commensurate with its ever-increasing influence on human thought and with its importance in the progress of civilisation." Canvassing the reasons for this important conclusion, he blamed the scholarship system in universities and public schools, with its undue preference to classics. It was true that the teaching of classics and mathematics had a long experience and tradition behind. But the scholarship system, in some cases, enticed boys along a path not leading to their true destinations.

Passing to post-graduate study and research, Sir Joseph commented on the lack of laboratories, of scholarships, and of opportunities for research workers as retarding influences during the earlier part of the period. He referred to the institution of the Ph.D. degree, and mentioned that there are now forty-five students taking physics at Cambridge in preparation for this degree. The year or two of research work thus provided was chiefly a means of training. If conducted under proper conditions its value could not easily be overrated, but under other conditions it might be positively harmful. This thesis was developed in an important passage on the *differentia* of research work in university laboratories as contrasted with governmental or works laboratories. The aim of the university laboratory should not be to turn out the largest number of small papers, to get results, to discover as many new facts as possible. It was necessary to avoid, even in university workers, over-specialisation and over-concentration. A little teaching might assist the research worker in this respect as providing an interruption. "It is, I think, a general experience that new ideas about a subject come when one is not thinking about it."

Sir Joseph discussed the question of careers for research workers, referring especially to the foundation in 1901 of the National Physical Laboratory, which now employs 160 research workers, and to the establishment in 1915 of the Department of Scientific and Industrial Research. Of the twenty research associations promoted by the Department, he remarked that at first there was plenty of money but no well-trained men, now there are plenty of men but no money; but there were good reasons for thinking that the financial gain to the industries had far exceeded the expenses of the laboratories. Considering research work as a profession, he observed that a worker might spend years without getting results of any very striking importance; he might therefore get depressed, lose hope, and try to transfer to administration or organisation. "The researcher, if he is to have a happy life, must regard the game and not the score as the chief thing."

The increase in the number of research workers had led to a corresponding increase in the number of papers on physics. *Science Abstracts* for 1930 contains abstracts of 4165 papers—very nearly a dozen a day. It was obvious that no one could read more than a fraction of these. He urged the need in physics for something corresponding to the annual report of the Chemical Society and for the publication monthly of the titles of physical papers. Progress in physics had been due in part to the improvement of instruments and appliances; in this way industry had repaid its debt to science. But the development had greatly increased the cost of physical research. Theories were the very lifeblood of physics, but theory may be injurious if it makes the worker treat as an annoyance any anomaly which interferes with progress to the goal.

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* The collected presidential addresses delivered in London are published under the title "The Advancement of Science, 1931". The volume is obtainable at 5*s*. net of all booksellers, or at the Reception Room by members attending the meeting, 3*s*. 6*d*.

"The anomaly may be the outcrop of a vein rich in new phenomena." He instanced the discovery of argon by Lord Rayleigh as arising from some vexatious discrepancies in a series of weighings. In conclusion, he said that there was no danger of the supply of new physical phenomena being exhausted and of physicists joining the ranks of the unemployed.

FARADAY AND ELECTROLYTIC CONDUCTION.

In his presidential address to Section B (Chemistry), Sir Harold Hartley spoke on "Michael Faraday and the Theory of Electrolytic Conduction". Faraday was in a sense the discovery of a chemist, he was trained in a chemical laboratory, his early triumphs were in the field of chemistry, and he was one of the great masters of chemical technique. He presided over the chemical section of the British Association in 1837 and in 1846. Sir Harold Hartley gives a brief sketch of Faraday's early life and work, emphasising that the intensely personal character of Faraday's work depends on the fact that it was all done with his own hands, and that if he used the results of others he repeated their experiments.

The year 1831 was the turning point of Faraday's career, probably because of the success of an experiment on the production of a current by magnetic induction which he had tried before without results. The experiments on conduction came a year later, leading up to the publication in 1834 of the fundamental laws of electrolysis. In August 1833 Faraday had entered in his note-book a resolve to try "whether the same quantity of electricity always produces an equivalent of chemical decomposition"; a month later he was using the water voltameter for measuring currents; in December he had extended the law to fused salts, and had also made what Sir Harold calls "a remarkable anticipation of modern methods of electrolytic analysis" by suggesting that electrolysis may finally give rise to "a good principle of analysis". A suggestion that the atoms of bodies were associated with equal quantities of electricity was raised by Faraday, but was not developed, since he was not attracted by the atomic theory. Faraday was quite clear on the essential difference between quantity of electricity and electromotive force, a misunderstanding of which led Berzelius to an unjust criticism of Faraday's work.

During the century which has elapsed since Faraday's work there have been three main phases in the development of the problem of the conduction of electricity in solutions. The first was the discovery of the general relationships between conductivity and the concentration and nature of the dissolved substance, due mainly to the work of Hittorf and Kohlrausch. Hittorf in 1853 had realised that the two ions of a salt usually move with different speeds, and showed how the ratio of these speeds could be determined experimentally. Kohlrausch, in 1876, recognised that the ions of a salt move independently, and in 1878 he introduced the conceptions of equivalent conductivity and mobilities which are still in use, at the same time developing the experimental methods.

The second phase was the enunciation of the theory of electrolytic dissociation by Arrhenius in 1887. This was followed by many important applications in different fields of electrochemistry, such as the theory of the galvanic cell due to Nernst. From the beginning, however, Planck and van 't Hoff had shown that the law of mass action does not apply to strong electrolytes if the degree of dissociation is calculated by the Arrhenius method from the ratio of the equivalent conductivity to that at infinite dilution.

The third phase is the quantitative explanation of the properties of electrolytes, and the removal of the difficulty just mentioned, by the mathematical theories due to Milner and to Debye and Hückel. The new theory takes account of the great forces acting between the charged ions, the magnitude of which was clearly perceived by Faraday, and shows how, starting with the idea that electrolytes are completely dissociated in dilute solution, the empirical square-root law of Kohlrausch can be explained quantitatively. Each ion is surrounded by an atmosphere of ions of opposite sign, and the behaviour of this, and of the solvent carried by the ions, leads to the equations. The idea of the ion atmosphere, with a finite time of formation and dispersion, has been proved experimentally by Wien and others, and the extension of Debye's theory by Onsager has been found to represent the behaviour of a perfect electrolyte in dilute solution. In the case of non-aqueous solutions the chemical nature of the solvent and the affinities of the ions seem to be of great importance, and further developments may be expected in these directions.

GEOLOGICAL PROBLEMS CONTEMPORARY WITH THE BRITISH ASSOCIATION.

In his presidential address to Section C (Geology) Prof. J. W. Gregory points out that the first thoughts of geologists at the centenary meeting of the Association are, naturally, homage to the group of geologists who gave it effective support at its foundation, and consideration of the problems on which they were engaged. In 1831 Great Britain held the hegemony of the world in stratigraphy, the nomenclature of which is permeated with English place-names; and Macculloch declared in 1831 that "the study of Arran alone has taught us more than Asia and America united". The British lead was maintained in the decade after 1831 by Lyell's classification of the formations above the Chalk, and by Murchison's foundation of the Silurian System—the first great step in the arrangement of the rocks earlier than the Carboniferous.

The greatest advance in the decade was the publication of Lyell's "Principles of Geology", although they were condemned by some of his contemporaries. Geology at that time was harassed by three uncertainties. The first was the nature of sea-level. Von Buch's view that Scandinavia was being tilted upon a pivot was at first rejected by Lyell as a baseless and extraordinary notion: but he himself proved its truth to the Association in 1834, and thus established the local mobility of the earth's crust. Faith in that mobility has been confirmed by proof that the transference of a thin layer of sediment causes the rise or fall of the surface; some isostacists now hold that the whole of the earth's surface is in delicate equilibrium, and that the oceanic depressions and continental masses are necessarily permanent in position. That conclusion is opposed to weighty geological evidence, and it appears that the parts of the crust that sink with a slight increase of load are limited to unstable bands or asthenostrophes.

Geological progress was hampered in 1831 by firm belief in the fixity of species. Lamarck's view of the transmutation or evolution of one species into another was rejected by Buckland and by Sedgwick, who denounced "all its train of monstrous consequences". But the doctrine was added to the accepted principles of geology by a recruit of 1831. In that year Darwin began the study of geology and sailed as naturalist with the *Beagle*. The fixity of species was supported by theological influences which were then powerful. Buckland, though blamed by fellow-clerics as heterodox, held that each of the six days of Creation was a natural day. Murchison was the doughty pioneer of the freedom of scientific thought in his assertion in 1832 of the "entire disconnexion of our science with the inspired writings".

The nature of mineral veins was discussed by the Association at an early meeting. Ore deposits were then generally attributed to igneous or electric agencies; but their formation by solutions arising along fractures from the interior of the earth was supported by Fournet and by Daubeny in his address to the Association in 1836. This explanation was for a time discarded in favour of the lateral secretion theory; but opinion has returned to the origin of most ores from a layer below the igneous rocks, and their introduction to the upper layers of the crust by the processes that also determine the ascent of the igneous rocks and the uplift of mountains.

The interpretation of mountain chains was advanced by Elie de Beaumont, whose classification of mountain systems was carefully considered by the Association at its early meetings. In 1842 H. D. Rogers expounded the asymmetric nature of mountain folding, a view developed later by Suess, whose demonstration of the frequent world-wide advance of the sea upon the land reconciled opinion to what the geologists of 1831 called "the dogma of universal formations". Evidence from countries then geologically unknown has shown the world-wide range of the geological systems and of most of the great breaks between them; and the century's work indicates that the main course of geological evolution is controlled by the slow deformation of the earth as the crust adapts itself to the contraction of the internal mass.

A CENTENARY OF EVOLUTION.

Prof. E. B. Poulton points out at the beginning of his presidential address to Section D (Zoology) that the fiftieth anniversary of the British Association, celebrated at York, marked a turning-point in evolutionary controversy. From 1860 up to 1881, evolution itself was the subject discussed, often with intense feeling; in the second half-century, evolution has been generally accepted, and discussion has been concentrated upon its motive cause or causes, the size of the steps, and the rate of progress. Darwin's belief in evolution was the result of his observations on the *Beagle*—the five years' voyage, begun on Dec. 27, 1831, which he considered as by far the most important event in his life. The motive cause, natural selection, did not occur to him until 1838, two years after his return. Wallace's independent discovery, twenty years later, also followed his conviction that evolution was a fact.

It was very different with the two earlier originators of the theory, W. C. Wells (1818) and Patrick Matthew (1831), neither of whom realised the significance of his discovery. Robert Chambers'

"Vestiges" contains illuminating thoughts, and has scarcely received its due. Chambers, not known during his life to be the author, was the cause of the great debate at Oxford in 1860, for it was his persuasion which induced Huxley to be present. Canon Tristram, in his paper on the larks of the Sahara, accepted natural selection as the cause of animal colouring in the desert, following the Darwin-Wallace essay (1858) and before the appearance of the " Origin of Species ".

One of the most important subjects discussed in the second half-century was the hereditary transmission of acquired characters, Francis Galton, Ray Lankester, Fairfield Osborn, and Weismann himself taking part in the debates. The re-discovery of Mendel's work on heredity, by emphasising germinal qualities, played an important part in the spread of Weismann's teaching, and also supplied an answer to a difficulty which had troubled Darwin —" the swamping effect of intercrossing ", as stated by Fleeming Jenkin. Mendelism does not conflict with Darwinian evolution as some have supposed. It is, as Miss E. R. Saunders stated at Cardiff, a theory of heredity, not a theory of evolution. One cause of the imaginary conflict was the mistaken belief that mutations were always large variations and evolution therefore discontinuous, also that small variations were not transmitted. American research has abundantly proved, as H. S. Jennings has stated, that extremely small variations are subject to Mendelian heredity and capable of providing material for natural selection, as maintained by R. A. Fisher in his recent work.

Darwinism is also consistent, discontinuity inconsistent, with the palæontological record and with the evolution, of which we see the stages nearly everywhere in the world, of geographical races into true species.

The age of the earth as determined by Lord Kelvin and Prof. Tait, at one time believed to be a great difficulty, made much of by Lord Salisbury at Oxford in 1894, was shown by Prof. Perry, and later by researches on radioactivity, to be mistaken.

The difficulty of accounting for the earliest stages of useful structures is met by Anton Dohrn's principle, 'change of function', a new use being taken over, by an existing organ, and, co-operating with this, by the 'organic selection' of Baldwin, Morgan, and Osborn—the power of individual adaptability (itself, it was maintained, a product of selection), enabling the species to exist until the needful variations have appeared.

Recent alternatives to Darwinian evolution are chiefly if not entirely manifestations of a supposed 'internal developmental force', a belief accounted for by H. W. Bates, in his classical paper on mimicry, by the prolonged " operation of selecting agents " producing " the impression of there being some innate principle in species which causes an advance of organisation in a special direction ". The evolution of a mimetic resemblance being, as Bates maintained, " a problem which involves that of the origin of all species and all adaptations ", is peculiarly suitable as evidence of natural selection—all the more so because the steps of evolution can often be traced.

The concluding section of the address is devoted to the description of examples of insect mimicry and protective resemblance, which, it is claimed, are wholly consistent with Darwinism but with no other theory of evolution.

GEOGRAPHICAL CONCEPTS OF THE HYDROSPHERE AND MOMENTUM.

In his presidential address to Section E (Geography), entitled " The Human Habitat ", Sir Halford Mackinder lays stress on the distinction between the two answers to the question 'Why there ?' If a man stand on a mountain top he is there in the first place because he climbed there ; that is the genetic answer ; and in the second place because he is upheld by the rocks ; that is the dynamic answer. Sir Halford considers that in the development of geography during the last half century there has been excessive stress laid on the genetic side ; in other words, on geomorphology and historical geography. As a result there is no unity of aim as between the two great branches of geography. It is suggested that if the hydrosphere rather than the lithosphere be treated as the main theme and business of the geographer, then a unity and a philosophy common to the whole subject emerge, and also a complete change in practical outlook, because dynamic considerations come to the fore.

Sir Halford starts from the astronomical fact that the liquid state of matter, in which alone life can exist, is limited to a minute part of the universe. A planet with a hydrosphere is therefore a unique object of study. This earth is important, not merely subjectively and because we men who inhabit it are the students ; in the university of the impartial angels it would be an object of intense interest and speculation. May we not compare it with radium among the elements ? Just as radium, almost infinitesimal in quantity, has by its activity revealed the energy locked up in the commoner atoms, so may not the hydrosphere of our earth present the infinitesimally rare conditions under which life becomes active which elsewhere through the universe is immanent, but potential and not active ?

In biogeography the essential unit is the natural region. This is no mere convenient generalisation. Both by origin and effect it is, when considered from the point of view of the hydrosphere, a fundamental fact. Whether high-lying or low-lying it has a certain area or spread, and the ultimate reason of this is that the surface of liquid water is level. The boundaries which separate it from other natural regions are, according to the new trend of hypothesis based on the study of isostasy, also of aqueous origin in that water is the agent redistributing the cargo carried on the floating granitic rafts which are the continents, and the stresses so caused lead both to mountain building and readjustments of coast level. The natural region is fundamental also from the point of view of life, because local varieties are thereby isolated and fixed as new species.

In regard to momentum, Sir Halford draws a distinction. Geographical momentum is a fact of the present and therefore an element in the dynamic analysis and not merely a subject for genetic consideration. Whether he study the present or the past, the geographer is primarily concerned with space and with time only in the sense that everything has momentum. The present consists of a coming out of the past and a going into the future ; there is a complex dynamic present in the sense of a balance of forces, all severally waxing and waning in different degrees. The student of the hydrosphere is concerned with water, sap, and blood, moving under sun power and life initiative. Water carries and stores energy, whether that energy emanate directly from the sun or be controlled by life. Two agents, the sun and life, work in the same medium, water, and must therefore obey the same conditions. These ideas of the hydrosphere and momentum are then applied in this address to a series of illustrations drawn from human geography.

Finally, the conclusion is reached that if our civilisation is not to go down in blind internecine conflict, there must be a development of world planning out of regional planning, just as regional planning has come out of town planning. The peaceful readjustment of treaties to differential growth will postulate an informed and delicate geographical judgment, for geography must underlie the strategy of peace if we would not have it subserve the strategy of war, and in the formation of such a judgment geomorphology cannot play the major part.

THE CHANGED OUTLOOK IN REGARD TO POPULATION, 1831–1931.

In his presidential address to Section F (Economics and Statistics) Prof. E. Cannan shows how changed is the outlook with regard to population in 1931 from that which prevailed in 1831. Modern science has dispelled the belief that no great progress is likely to take place in the arts of agriculture and other kinds of primary production, and birth-control has destroyed the fear that population is likely to increase sufficiently fast to counterbalance the effects of the progress, however great it may be.

At the meeting of the British Association at Ipswich in 1895, Prof. Cannan directed attention to the fact that the annual number of births in Great Britain, after a long period of rapid increase, was becoming stationary, and suggested that the increase of population might diminish and be nearly at an end by the middle of the present century. Subsequent events suggest that the verification of this forecast is nearly at hand, mortality and emigration having indeed diminished, but the number of births being now only about 650,000 per annum in England and Wales instead of the 880,000 which prevailed fifty years ago, and other countries either already showing the same tendency or being likely to do so shortly under the influence of modern knowledge and ideas.

The change requires the abandonment by economists and statesmen of the old emphasis on food production. This is requiring a smaller and smaller proportion of mankind's activity, and it should be recognised that it is more of the healthy luxuries rather than more of the necessaries of life that we want. Schemes for putting more people on the land, either near the centres or on the outskirts of civilisation, are misconceived. So also are all plans based on the belief that ownership of land is likely to take an ever-growing proportion of the whole produce of industry.

It is also wrong to suppose that cessation of the growth of numbers will cure, or at least alleviate, unemployment. The most powerful cause of unemployment is a rapid absolute decline in the demand for particular kinds of labour, and such a decline is more likely to occur in a stationary than in an increasing population. Mobility in regard to both place and occupation is the cure, and is more necessary when the growth of population slackens and ceases.

To the address as printed is appended a table of the births in England and Wales, showing rapid increase from 616,000 in 1851 to 888,000 in 1876, then little change for fifteen years, rather larger figures owing to the decline of the emigration of persons of the reproductive ages from 1884 to 1910, with a maximum of 948,000 in 1903, followed by a decline below the 1876 level before the War. The War sent the number down to 663,000 in 1918, and the return of men after it produced 958,000 in 1920, but this was a short-lived recovery, followed by a steady decline to 654,000, 660,000, 644,000, and 649,000 in the years 1927 to 1930.

POWER.

At the outset of his presidential address to Section G (Engineering), Sir Alfred Ewing explained that it had to serve a double purpose, for it was also the Bramwell Lecture, delivered at this centenary meeting in fulfilment of a trust. Fifty years ago the late Sir Frederick Bramwell, who was then *pontifex maximus* in the world of engineering, had discussed the progress of mechanical invention at the jubilee meeting of the Association, and had prophesied that the internal combustion engine, then in its infancy, would displace steam as a means of producing power. In fifty years' time, he said, the steam engine would not be spoken of except as a curiosity to be found in a museum. Before his death he backed this opinion by giving the Association a sum to be paid as honorarium to a speaker who in 1931 should take this prophecy "as a sort of text" and deal with the then relation of engines of the two types.

Sir Alfred Ewing finds steam neither dead nor dying: on the contrary, it is actuating engines of vastly greater power than any that were even imagined when Bramwell spoke. But alongside of that we have wonderful achievements on the part of the internal combustion engine which go far to justify Bramwell's faith. Sir Alfred traced briefly the development of the internal combustion motor using liquid fuel, by Daimler, Diesel, and others; and went on to imagine Bramwell brought to earth again, "in an aeroplane, of course", to see for himself what had been accomplished. He would find, among many changes, his old haunt, the Athenæum Club, still a haven of rest for the mature, but now on the outer edge of a vortex of one-way traffic which made it difficult of approach —"a veritable inferno of internal combustion". Nevertheless, he would find steam continuing to do a great part of the work of the world both on land and water; and if he were taken to the Science Museum he would see there steam engines of a kind he never knew, enshrined not as relics of an obsolete past but as precursors of a modern era, the era opened to the world by the genius of Charles Parsons. Parsons's earliest steam turbine dates from three years after Bramwell made his prophecy. Since then the electric distribution of power has come on a big scale; and the work of power stations is almost wholly done by steam. Under modern conditions of high pressure and high temperature, steam furnishes the most economical means of generating power—except, of course, in countries favoured with hydraulic possibilities. In railway traction the dominance of steam is maintained, and electric traction—if it comes—will not affect that, for the central power stations will still use steam. On the roads the internal combustion engine is supreme, and a warm tribute is due to the constructive skill which has made such motors the convenient and reliable things they are.

In the field of ocean navigation, one finds sharp differences of opinion and of practice. For ships of the greatest size and speed, steam turbines are recognised as the best means of securing such a concentration of power as is essential. Many ships of a smaller type are driven by Diesel motors; but Sir Alfred doubts whether this preference is not, in part, a fashion that will pass. At the moment there is a distinct tendency to revert to steam, with, in appropriate cases, the use of pulverised coal.

In conclusion, Sir Alfred remarked that if we were to catch from Bramwell the mantle of prophecy we should be inclined to wear it ruefully. The cheerlessness of the present industrial outlook is in sad contrast to the heyday of Victorian confidence when Bramwell spoke. The world has learnt, through a severe lesson, that the gifts of the engineer are beneficial only if they are wisely used. They have brought obvious dangers through increasing man's ability to kill and to destroy. That is recognised, and now we are becoming aware of a more subtle social menace. We see the mechanised arts of production overreaching themselves, supplying commodities in a volume too great to be absorbed, and with a facility that tends to deprive man of his richest blessing—the necessity of toil. This raises problems, now conspicuously urgent, which the engineer, the economist, and the moralist must jointly set themselves to solve.

PRESENT POSITION OF ANTHROPOLOGICAL STUDIES.

In his presidential address to Section H (Anthropology) Prof. A. R. Radcliffe-Brown deals with the present position of anthropological studies. A realignment of these studies is taking place and should receive recognition. It is suggested that physical anthropology, which is largely confined to comparative racial anatomy, is due to be absorbed into a wider study of human biology which would include, besides physical anthropology and human palæontology, studies such as comparative racial physiology and psychology and human genetics. Prehistoric archæology has now become an independent subject, with its own special technique carried on by specialists. Its natural affinities are with history rather than with human biology or with sociology.

The science of comparative sociology differs from the older social anthropology in several vital respects. It rejects as being no part of its task the hypothetical reconstruction of the unknown past. It therefore avoids all discussion of hypotheses as to historical origins. It rejects all attempts to provide psychological explanations of particular social or cultural phenomena in favour of an ultimate psychological explanation of general sociological laws when these have been demonstrated by purely sociological inquiries. It endeavours to give precise descriptions of social and cultural phenomena in sociological terms, and to this end seeks to establish a suitable exact terminology, and seeks at the same time to attain to a systematic classification of those phenomena. It looks at any culture as an integrated system, and studies the functions of social institutions, customs, and beliefs of all kinds as parts of such a system. It applies to human life in society the generalising method of the natural sciences, seeking to formulate the general laws that underlie it, and to explain any given phenomenon in any culture as a special example of some general or universal principle. The newer anthropology is therefore functional, generalising, and sociological.

The new outlook in the study of cultures of non-European peoples involves the application of new methods both in field-work and in theoretical interpretation. The future of the subject lies with the field-worker. The day of the 'arm-chair' anthropologist is ended. The subject, however, suffers from the lack of anything like proper provision for research, and as the qualification for such research requires several years of special training and a great deal of special knowledge, the progress of the science is seriously hampered. What makes the situation almost tragic is that now, when by the gradual development of theory and the improvement of methods of investigation we are in a position to make the most important contributions to the science of man by the intensive and exact study of the less developed cultures of the world, those cultures are being destroyed with appalling rapidity. This process of destruction, through the combined action of European trade or economic exploitation, government by European officials, and missionary activity, is taking place with accelerated speed. Is there any other science, or has there ever been another science, faced with such a situation, that, just at the time it is reaching maturity, but while through lack of general interest and support it has few workers and very scanty funds, a great mass of most important material is vanishing year by year without the possibility of making any study of more than a minute fraction ?

Important developments in this branch of anthropology—the study of the cultures and languages of non-European peoples—are taking place as the result of the growing recognition of the fact that it can afford valuable and, indeed, indispensable aid in the practical problems of the government and education of dependent peoples. The British Empire, if it is to carry out with any honesty its self-imposed task of governing native peoples, must give much more support than it does at present to administrative anthropology.

BIOLOGICAL NATURE OF THE VIRUSES.

Dr. H. H. Dale's presidential address to Section I (Physiology) takes the form of an introduction to a discussion on "The Biological Nature of the Viruses", in which investigators of the virus diseases of plants are to join those whose studies have been concerned with the viruses infecting men and animals. He reviews briefly the history of the position of physiology in the proceedings of the British Association, and the steps by which it attained independent status in a section which has become responsible for bringing before the Association advances of fundamental knowledge over a wide field of medical and veterinary science ; and suggests that the biological nature of viruses, the discussion of which raises questions as to the lower limit of size compatible with organisation as a living cell and as to the possibility of life and self-multiplication without such organisation, is a proper concern of the physiologist.

An attempt to define the term 'virus' reveals three generally recognised characters: (1) invisibility with the microscope, (2) failure to be retained by bacteria-proof filters, and (3) failure to grow in the absence of susceptible living cells. A definition on these lines must include bacteriophages and the agents transmitting certain tumours, which satisfy all three conditions. Strict application, however, of a definition by such negative characters must narrow its scope with the advance of technique. Already methods of rendering some viruses visible have been found, and conditions permitting their growth on artificial media may at any time be discovered.

Some viruses have apparently been shown to consist of submicroscopic organisms; some physical measurements, on the other hand, suggest that the units of other viruses approach the dimensions of protein molecules in size, or are even smaller. If the agents classed as viruses are all of one kind, it seems necessary to doubt either the validity of some of the physical data or the identity with the virus of particles demonstrated by microscopical methods. If the view is accepted that some viruses, at least, are unorganised toxic principles in a state of molecular dispersion, their apparent power of self-production is without biological analogy. If the explanation is adopted that this is not a true self-multiplication, the toxic principle being reproduced by the perverted metabolism of the cell which it infects, the immunity acquired by an infected animal presents serious difficulties of interpretation.

With reference to the difficulty of attributing organisation to particles of the minute size indicated by certain physical measurements, it is suggested that viruses, as prepared for such examination, are not vegetative. The particles measured may be adapted only for transmission of the infective agent to cells in which it can resume vegetative life, and may therefore consist of material so densely aggregated that comparison of their size with that of heavily hydrated protein molecules affords no true indication of their possible complexity.

In conclusion, it is suggested that the new century of the British Association's history may give us an epoch of advance in knowledge of the viruses not less important than the epoch of discovery of the visible bacteria in the century now closing.

ON THE NATURE OF MIND.

In his presidential address to Section J (Psychology), Dr. C. S. Myers points out that conscious experience can only be enjoyed by the active 'self'—the 'individual' (that is, undivided) mental activity of the living organism—and that at its earliest stage conscious self-activity is differentiated merely into (*a*) 'acts' of the self and (*b*) 'modifications' of the self. The latter become differentiated afterwards into (i) feelings *of* the self and (ii) presentations *to* the self, that is, 'contents' of consciousness. Thus we reach the final stage of distinction between (1) *feelings*, (2) the conscious *acts* of apprehending, recalling, deciding, inferring, etc., and (3) *what* is consciously apprehended, recalled, decided, inferred, etc. The last, the contents of consciousness, are, Dr. Myers suggests, the *un*conscious acts of relatively lower mental levels, which become *conscious* presentations to the self when they are accompanied and received by the self-activity of the highest mental levels.

The self is the highest controlling and directing power within the organism. Its direction, once consciously started, may be continued unconsciously: we may consciously but vainly try to recall some past experience or to solve some difficult problem; and after our giving up the effort, this directive activity may still persist unconsciously, until suddenly the forgotten object or the abandoned solution suddenly flashes full-born and unbidden into the self's consciousness. But purposive activity need not *originate* in self-activity: the inspirations of genius and the intuitive judgments and decisions which, crude as they are before submission to the self's judgment, arise apparently from the unconscious 'depths' of the mind with impulsive force and compelling conviction, afford striking examples of this fact.

The self implies a wide sphere of activity rather than a punctate, pineal gland-like soul. We cannot hope to localise any act of consciousness or any conscious content or feeling in some small region of nervous substance. Because vision ceases when the *area striata* in the occipital region of the cerebral cortex is destroyed, we are not justified in saying that this area is the *seat* of our visual consciousness. All that we are warranted in saying is that it is *essential* for our visual consciousness, that without it vision is impossible—a very different statement. It is impossible to localise consciousness. The higher forms of mental activity have a generalised localisation: even where 'essential' areas can be mapped out for lower conscious processes, such cortical localisation is only relatively definite, and other areas may in some cases assume the function of any particular area when the latter has been destroyed.

The fundamental purpose of consciousness is the preservation of the organism by guidance and direction, by the formation and satisfaction of ends and values. On the physical side, we can form no conception of that activity, throughout life and mind, which distinguishes evolution from the blind running downhill of a wound-up mechanism. We can at present find no metabolic basis for creative, directive activity; it appears, however, as if mental work makes far greater physiological demands than it should, according to the purely physical considerations of mechanical energy.

Both mechanical and directive activities are essential to conceptions of the struggle for existence and the conservation of the self. Mental activity involves the quintessence of the non-mechanical directive activity of life; and consciousness is but that activity raised to its highest power, limited to the highest level of psycho-neural activity—the self.

THE ADVANCEMENT OF BOTANY.

In the first part of his presidential address to Section K (Botany), Prof. T. G. Hill gives a historical outline of the development of botany since 1831, and then considers present and future needs and policy, thus introducing a discussion on the training of botanists for economic and industrial positions.

The year 1831 marks the beginning of a threefold epoch in botany: the search for a natural system of classification; the emergence of morphology as a study separate from taxonomy; and the development of physiology. To the first, Great Britain contributed a full share; but in anatomy, morphology, and physiology, the tale of British activity during the succeeding fifty years, despite the brilliant lead given by Grew, Hales, and Knight, is indeed dismal. Against a battalion of continental workers we can barely range a section.

The brilliant generalisations of Charles Darwin, however, were an outstanding contribution to botany. The reasons for our deficiencies during this period (1831–1882) are patent. The classical traditions of our old universities dominated teaching, with the result that the approach to biology was, in the main, through medicine; botany was, indeed, of the faculty of medicine rather than of science, and the majority of British botanists were qualified medical men. Other reasons lie in the facts that the period was one of exploration, expansion, and development of the Empire, which meant a great inflow of plants for identification, and the labourers were few. Finally, the systematists did not entirely favour the new movement, and if not actively antagonistic, they looked upon it with amused tolerance.

The botanical renaissance in Great Britain began about 1875 and it happened in the Royal College of Science. The credit for it is due to Thiselton-Dyer, who, as Huxley's demonstrator, instituted and conducted the first laboratory classes in botany. The advance was accelerated by the translation of the great German text-books, and the University of London gave powerful aid by the high standard of its examinations and its insistence on practical tests. The volume and importance of British work in all branches of botany gradually increased and expanded in various directions: to take but two examples, the re-discovery of Mendel's work inspired a period of intensive investigations on plant breeding and certain aspects of metabolic physiology and cytology, whilst the development of ecology greatly stimulated the study of taxonomy, causal morphology, and physiology.

Notwithstanding past experience, it required a great war to force the lessons home that man is dependent on the green plant, and that the sustenance, development, and co-ordination of science is a prime necessity in the government of the modern State. These lessons were remembered when peace came, with the result that the systematised investigation of botanical problems became a settled policy not only with us but also with other nations. The immediate effect is a gross over-production of many essential commodities, which has caused a tendency in States and industries to curtail expenditure on research and expert advice. This is a wrong policy, for it is in times of economic depression that research is most essential. In Great Britain many of the problems involved are investigated in numerous research stations, old and new. In them lurk a few dangers: applied research can be over-organised; the tendency to justify their existence may tempt newly founded institutions to disseminate unripe fruit; and the value of pure research may be obscured. These dangers, for the most part, will be eliminated if there be co-operation between the applied workers and their academic brothers, which can be effected by a close connexion between the botanical departments of universities and research institutions, accompanied by an occasional exchange of the workers in both.

The British Commonwealth of Nations is, in the main, an agricultural empire; the need for trained botanists for administrative and technical service is patent: the problem is their supply and their training.

EDUCATIONAL DEVELOPMENT, 1831–1931.

Sir Charles Grant Robertson, president of Section L (Educational Science), in his presidential address disclaimed his ability to defend a subject more vulnerable even than theology to the charge that " whatever is true is not new and whatever is new is flagitiously and demonstrably untrue ". He dated the beginning of the reform movement with Castlereagh's death in 1822, emphasising three general points: first, the influence of the utilitarian group (the Benthamites); secondly, the Oxford movement started by Keble's sermon in 1833; and, thirdly, the organised and widespread campaign against ignorance, leading to the foundation in 1827 of the Society for the Diffusion of Useful Knowledge. But the fundamental question remained open: to whom was the duty of education to be left—to the individual conscience of the parent, to the Church as the depository of Christian truth, or to the State, with a compulsory power and the right to represent the civil mind ?

The years from 1825 to 1840 were devoted mainly to discussion, and the following thirty years, ending roughly in Forster's Education Act of 1870, to Royal and Governmental commissions. This period saw the revolution in public school education associated with Arnold of Rugby, Kennedy of Shrewsbury, Thring of Uppingham, and Haig-Brown of Charterhouse, and saw also the nineteenth century ' renascence of science ' inspired by Faraday's discoveries. That scientific renascence acknowledged both the importance of science as knowledge and its vocational or utilitarian value, but also, under the inspiring leadership of Huxley, " the Achilles and protagonist of the twenty years' battle for the capture of the classical Troy ", its " cultural indispensability ". Sir Charles referred also with feeling to another renascence—the education of girls and women—paying homage to the work of Frances Mary Buss, Dorothea Beale, and Sarah Emily Davies.

The Forster Education Act of 1870, though marking the culmination of a long period of effort and controversy, is not regarded by Sir Charles " as a revolutionary or a creative measure in the true sense of the term ". It made no attempt to correlate elementary and secondary education. It was a compromise. No Government from 1831 to 1931 had tackled fairly and squarely the so-called religious issue, " because a courageous solution of it would be unlike successful operations in surgery; the operation would succeed, the Nation would recover, and the operating surgeon, the Minister, would die ".

Proceeding, Sir Charles invoked a Rip Van Winkle who, having slept through the century under review, wakes to discover the new science of psychology. After commenting somewhat caustically on this new science, Rip Van Winkle remarks, " I observe with immense interest that after a hundred years you are still arguing precisely all the fundamental questions that perplexed us ". But, as Sir Charles said, the science of psychology is only in its infancy. It may be possible in future to define the limits of educability and to come to an understanding of " the functional differentia between the sexes ".

Concluding, Sir Charles acclaimed the social revolution, largely due to the educational progress of the last hundred years, steadily regrading and reshaping the whole Commonwealth that we call the British Empire.

THE CHANGING OUTLOOK IN AGRICULTURE.

Sir John Russell, in his presidential address before Section M (Agriculture), directs attention to the fact that agriculture as an art was already far advanced when the first meeting of the British Association was held in 1831. The great improvers of the eighteenth century wove the new crops into a rotation which provided both animal and human food, and was indeed the best system the world had yet seen, but it was in 1831 entirely empirical. Scientific work was, however, beginning, and round about 1840 three important events occurred: Liebig published his epoch-making essay on the application of chemistry to agriculture, Lawes began the famous Rothamsted experiments which almost at once led to the founding of the artificial fertiliser industry, and the Royal Agricultural Society began its beneficent work of fostering the application of science to practice. Economic conditions favoured the growth of the home agriculture, there was no serious competition from overseas, and from about 1850 until 1890 British agriculture flourished; it attained a high standard of technical excellence, it was financially successful, and it supplied the country with most of the food required. Then within a few years it collapsed. The chain of transport arrangements with the United States and Canada was completed and farm produce came on to our markets at prices with which British agriculturists could not possibly compete. The overseas systems were inferior to our own in production per acre, but the shortage of population necessitated the development of labour-saving machinery, so that the production per man was greater, and this higher efficiency of output won the day. British farmers suffered greatly; many became bankrupt.

Gradually it was realised that the way out of the difficulty was to specialise: to aim at producing, not everything needed, but the things that could be produced best and most easily; and this specialisation favoured the application of science to agriculture. From 1889 onwards, when the Board of Agriculture was founded, agricultural colleges began to grow up; about 1900 the system of county organisers was begun; and in 1909 the Development Fund was set up, out of which agricultural research was financed. A wise administrative policy has always been followed by the Commissioners, and probably no public money has ever been better expended. The relations between the scientific workers, the farmers and the Commissioners, and the Board of Agriculture have always been of the happiest, and as a result of this collaboration agriculture steadily improved and in less than twenty years after the deepest depression it had regained a considerable degree of quiet prosperity.

Then came the War, during which the whole civilised world strove to improve agricultural production. After the War the full force of the improvements was felt, and it was found that the world's power of producing food was far in excess of the power of consumption. There has therefore been a great fall in prices, and agriculture is once more in a state of deepest depression. The chief factors in the new situation have been the development of plant genetics, which has led to the production of new varieties of plants specially adapted to particular regions; improved methods of controlling insects and parasites; the internal combustion engine; and refrigeration. Many regions of the world which in 1840 were waste, and could be nothing else, are now closely cultivated and dotted with homesteads.

The problem now before the agriculturists of the world is to organise their production on a contract basis, so as to supply the world's need of food with a reasonable margin of safety, but without the excess production which benefits no one and only injures themselves.

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wonderful applications have grown out of Faraday's discovery when he produced electricity without actually putting bodies in contact. Dr. Elihu Thomson, the pioneer electrical engineer who invented electric welding, laid stress on the development of electrical power from Faraday's original conceptions. Prof. P. Debye showed the importance of Faraday's work for physical chemistry and the molecular theory of matter; while Prof. P. Zeeman paid tribute to Faraday's genius in conceiving a possible connexion between magnetism and light. The great physicist failed in his attempt to prove his hypothesis from lack of effective apparatus: Prof. Zeeman succeeded many years afterwards, and thus gave his name to the remarkable 'effect' of two magnetic poles on a source of light placed between them. Lord Rutherford referred to the importance of the discovery of the laws of electrolysis by Faraday, whom he honoured as a master in experimental work.

It was left to Sir William Bragg, the present holder of Faraday's position at the Royal Institution, to deliver the commemorative address of the evening, in which he surveyed the remarkable discoveries of his predecessor, explaining their history and meaning, and showing how they illustrate his genius and his character. In his concluding address, the Right Hon. Lord Eustace Percy, M.P., president of the Royal Institution, pointed to the noble example of Faraday as an incentive for scientific education and research. It was by the courtesy of Sir John Reith and the British Broadcasting Corporation that the season of promenade concerts was interrupted to enable the Faraday Commemoration Meeting to be held in the Queen's Hall. But it was befitting to Faraday's memory that the nation and the world at large were able to follow by wireless these celebrations. The following day, Sept. 22, the Institution of Electrical Engineers held a conference at the Kingsway Hall on "The Place of Electricity in Transport, Communications, and the Household", which was attended by a large number of distinguished men of science and the delegates and guests to the centenary celebrations. Sir Josiah Stamp, Mr. J. S. Highfield, Miss C. Haslett, Mr. Ll. B. Atkinson, Sir Oliver Lodge, and Mr. C. C. Paterson, president of the Institution, outlined in turn the bearing of Faraday's discoveries on the amazing developments of modern electricity.

In connexion with the Faraday centenary celebrations, a short talking film, presenting a few simple points concerning Faraday and his discoveries, has been made by the British Thomson-Houston Co., Ltd., and given to the Faraday Centenary Exhibition Committee of the Institution of Electrical Engineers. It has been shown at the Marble Arch Pavilion since Tuesday, Sept. 15, and will be included in the programmes of a large number of cinema theatres throughout the country during the next few weeks. In the production of the film the British Thomson-Houston Company was fortunate enough to enlist the co-operation of Sir William Bragg as narrator, and the audience is thus enabled to see and hear one of Faraday's most eminent successors.

Beginning with a reference to the humble origin of Faraday and his studies as a youth, Sir William Bragg shows in the film the manuscript book in which Faraday wrote out his account of Davy's lectures, and tells how he came to be engaged at the Royal Institution. Tracing his work further, he then shows the part of the "Diary" in which Faraday recorded his epoch-making experiment of Aug. 29, 1831; and after this comes a demonstration by "Faraday himself" with his famous iron ring and the magnetic needle. Then by means of more modern apparatus it is explained how magnets and coils, moving relatively to one another, lead to the production of currents, and reference is made to the experiments with iron filings and Faraday's ideas of lines of force. The connexion of these things with modern electrical development is explained, and the film ends with a series of pictures of electric trains, telephone exchanges, factories, giant magnetic grabs, and X-ray apparatus. The film will, we think, be appreciated by all who have read anything of Faraday's life and work, but it is probable that, in spite of Sir William Bragg's interesting talk, the film is too short and the action too rapid for it to leave any clear impressions on the minds of those unfamiliar with electrical discovery.

Referring to the article "Faraday's London Friends", in Nature of Sept. 19, Mr. T. E. James writes: "Perhaps, after all, the best friend of Faraday was the sympathetic individual, generally referred to as 'a Mr. Dance'—meaning the member of the Royal Institution who either gave tickets of admission or took Faraday in 1812 to hear four of the last lectures of Sir Humphry Davy. It has been possible to identify him as William Dance, who lived at 17 Manchester Street, London. He was born in 1755 and died in 1840. He was a son of James Dance, dramatist and actor with the stage name of Love, who was educated at Merchant Taylors' School and St. John's College, Oxford, leaving the latter before graduation. William Dance was a musician and composer; in 1813 he helped in the establishment of the Philharmonic Society, and acted as its treasurer. He was a brother of Commodore Sir Nathaniel Dance, whose strategic exploit with a French man-of-war in 1804 was the talk of the day."

To the man of science, discovery and the interpretation and correlation of discoveries are his ultimate aim. They mark an end in themselves; whereas to the industrialist such discoveries are only a means to an end, his ultimate aim being the exploitation of discovery and its application to industry. Perhaps there is no example quite so notable as that of Faraday's discovery of a century ago. It marked the inception of an industrial revolution which is still as active and progressive now as it has ever been. The development of electric lighting and power has attained such dimensions that the amount of capital invested in it throughout the world exceeds £5,000,000,000. The substitution of tungsten filament lamps for the old carbon filament in 1908 involved an annual world saving of nearly £50,000,000. Now, in this present stage of the electrical revolution, there are, apart from tube lines, more than 555 route miles of electrified railway in Britain; 200,000 tons of aluminium are produced annually by electrolysis; the 'grid' was brought into use in Great Britain in 1930, and when it is finished, at an approximate cost of £30,000,000, will supply cheap electricity to the country; and electric generating plant of the world has reached nearly 100,000,000 kilowatts. The present flood-lighting, too, is but another portion of the immense superstructure of invention which has been erected upon the foundation of Faraday's research. Such information is admirably presented in the *Times* "Faraday Number", a collection of splendid tributes to Faraday's memory from a number of eminent men of science, published on Sept. 21. The utilitarian value of science is well illustrated in the number; but, perhaps unconsciously, the supplement brings home the historical significance of this centenary and the ethical and cultural value of science, apart from its practical use.

In the *Scientific Monthly* for September, Edith W. Stone writes an interesting article on Joseph Henry, the American physicist. His grandfather came from Scotland and changed his name from Hendrie to Henry. Henry was born in Albany, New York, in 1797, but stayed with an uncle at Galway, Ireland, from an early age until he was fifteen, when he returned to his mother at Albany. He was apprenticed to a watchmaker, but improved his knowledge by attending night classes. When twenty-eight years of age, he was appointed professor of mathematics at Albany Academy. It was during this period that he began to study and perfect the electromagnet. In 1832, Henry was appointed professor of natural philosophy at the College of New Jersey (now Princeton). He was the first secretary of the Smithsonian Institution, a position which he held until his death in 1878. The author points out the many points of resemblance between Faraday and Henry. Both were gentle and unassuming, yet deliberate and persistent, and each was filled with an unswerving and lifelong devotion to scientific research. That Henry was an independent discoverer of the fundamental fact of electromagnetic induction is not now disputed. Faraday, however, was the first to make public his discovery. Henry is reported to have said: "I ought to have published earlier, but I had so little time. I desired to get out my results in good form, and how could I know that another on the other side of the Atlantic was busy with the same thing?" His memory has been kept green by calling the unit of self-induction the henry.

"History", declares Prof. H. E. Armstrong, writing in the *Pharmaceutical Journal* of Aug. 29, on the dyestuff industry, "when you can test it, is more often than not perversion of fact." This is a characteristically hard saying, but Prof. Armstrong's contribution to the early history of that industry does not thereby lose anything in credibility or interest. We are bidden by an observant and critical contemporary to regard Perkin as the originator, but not as the founder, of the British industry. "Perkin did a giant's work and set a giant's example, but he only started the ball rolling. Hofmann, he, and Nicholson were a noble triumvirate; they together made the industry." We failed to develop it "just simply through lack of intelligence". Here is another hard saying; one which is easy to resent but difficult to refute. In such an industry strength and vitality were the fruits—in Germany—of scientific control, of shrewd business ability, and of an intelligent, inquisitive outlook based on wide training in scientific method; so the first prize went to the strong.

The interest of Prof. Armstrong's observations lies particularly in their contemporary origin, but their importance depends on the fact that at this time of crisis they lead us to the root of things. To say that we need in our industrial life a greater measure of scientific direction and of scientific control is merely to say that we ought more often to base our actions upon that exact knowledge which could be, but may not have been, ascertained, and that we should less frequently be guided by guesswork; not that we shall necessarily escape our present difficulties by building a new laboratory, but that we should gain by giving greater authority and employment to intellects trained in the use of the methods of science. "To play the game successfully," says Prof. Armstrong, "management must be in technically competent hands, not of politicians; full support of users must be secured: unless users and producers can be led to see eye to eye the industry will soon be again lost to us. The great danger before us is over-organisation—so-called rationalisation—with its consequent elimination of individuality and talent and lessening of employment."

Although the meteorological records for August received by the Meteorological Office showed that for almost all parts of England the month was a wet one, the figures for the different districts expressed as a percentage of the average were not such as to make the month so remarkable as some others of recent years. Apart from the Channel Islands, the largest excess was 84 per cent for the south-east of England, the Midlands and eastern England following with 57 and 52 per cent respectively. The feature that was most notable was the number of exceptional downpours in limited areas. Some of these were associated with thunderstorms in a sultry spell early in the month, but many occurred in one or other of the windy, cyclonic, and almost wintry spells that followed. Examples of the former were furnished by a fall of 113 mm. in one and a half hours at Langford, Salisbury, on Aug. 4, 74 mm. near Petersfield in about an hour on Aug. 5, and 56 mm. at Greenwich in a short time on the same date. Heavy cyclonic rains include 82 mm. at St. Heliers, Jersey, on Aug. 24, 72 mm. at Cromer on Aug. 8, and 51 mm. at Tynemouth on Aug. 19. Many of these downpours represented the equivalent of a month or more of normal rainfall and gave rise to flooding. Monthly totals were seldom of such exceptional character, but mention may be made of St. Heliers, 214 mm., which is three and a half times the average, and of the total of 200 mm. at Oldham Road, Manchester. In contrast to these, Lerwick had only 5 mm. altogether; for Scotland and Ireland generally there was a deficiency compared with the average.

IT is not often that we hear of West Indian hurricanes visiting British Honduras, but the records of former years show that at long intervals one of these storms, like that which devastated Belize on Sept. 10, has travelled sufficiently far west in a low enough latitude and has at the same time been late enough in recurving northwards to strike that colony. The track followed in the recent hurricane, or one closely resembling it, is shown as a recognised though abnormal one in some works dealing with West Indian hurricanes. The storm of Oct. 12–18, 1916, crossed the colony only slightly farther north. If the statement, made in certain newspapers, that another cyclone followed the recent one along a not far distant track is correct, then there is the curious coincidence that the visitations of 1916 and 1931 were both cases of hurricanes occurring in pairs. In 1916, the later of the two appears to have been the more destructive. It passed directly across Pensacola, Florida, giving rise to winds of 120 miles an hour, fortunately with little or no loss of life, though at an earlier stage it caused a vessel to founder with the loss of twenty lives. In the present year, reports received so far indicate that the first-comer was the more violent; it is possible, however, that the second was not less violent, but did not cross any thickly populated district.

THE annual Exhibition of the Royal Photographic Society was opened on Sept. 11, and will remain open until Oct. 10. As usual, the principal part of the exhibition is pictorial, but there is also a considerable amount of material of scientific interest. The variety of subjects is very large, and it is only possible here to notice a few exhibits. The Safety in Mines Research Board shows an admirable series of photographs of flames in combustible gases moving between the plates of a condenser. With the condenser uncharged, the flames are seen to move symmetrically from the point of ignition; with the plates charged, the movement is directed towards the cathode. In the national history section, Dr. W. D. Walker has been awarded the Society's medal for a series of photographs of the life-history of the kangaroo from birth to maturity; many will be surprised to note that the kangaroo at birth is less than an inch in length. Herr Karl Stülcken shows a series of somewhat similar nature illustrating the development of the peacock butterfly through its various stages of life. Many of the exhibits this year are interesting especially in relation to medicine and surgery. Several examples of the cure of rodent ulcer are shown, but the most striking exhibit in this field is, perhaps, that of two negatives taken inside a stomach by means of a tiny stereoscopic pinhole camera. In order to take the pictures, the camera, with a small lamp attached, was swallowed by the patient.

THE eighth International Congress of Photography took place at Dresden on Aug. 3–8. It is significant that at its closing session the Congress adopted for itself a new name: The International Congress of Scientific and Applied Photography. At the previous Congress, held in London in 1928, an attempt was made to include pictorial photography, but at Dresden there was no time to consider anything but science in relation to photography. Altogether, eighty-two papers were communicated. These will be printed in one volume shortly, and will form a very valuable record of many of the scientific researches carried out during the past three years all over the world. Many of the papers dealt with problems of cinematography and sound-recording on film. These applications of photography have made great demands for an increased accuracy of control in the processing of film, and have necessitated exhaustive researches into the behaviour of sensitive materials under high intensities, which previously had not been much studied.

THE problems of standardised sensitometry were again brought forward before the Congress, and agreement was reached concerning a standard light source for testing negative materials. The proposals are those put forward from America in 1928, and a great deal of credit is due to Messrs. Gibson and Davis, of the Bureau of Standards in Washington, for the careful working out of a series of light filters for producing artificial daylight from various primary sources of light. There still remains much in sensitometry which needs standardisation, and the Dresden Congress will perhaps be notable by reason of the German proposals for standardised testing of commercial products. These were put forward tentatively and will be investigated by the various national committees on sensitometry before any general action is taken. The application of 'H and D' numbers to the evaluation of sensitivity has been attacked very much during recent years, and it may well be that a new basis for 'speed' evaluation will eventually be adopted. One of the evening lectures delivered to the Congress was by Dr. Goldberg, who dealt with the subject of photoelectric cells in recording. The Royal Photographic Society is fortunate in having secured Dr. Goldberg for the Traill-Taylor Memorial Lecture, which is to be given on Oct. 27, at the Society's rooms at 35 Russell Square, W.C.1, at 7 P.M. Dr. Goldberg will again deal mainly with the subject of photoelectric cells.

A NEW Scottish centre of economic and industrial study and research will be inaugurated at Dundee on Friday Oct. 2, when the School of Economics and Commerce is to be opened by Sir Josiah Stamp. The School owes its foundation to the liberality of a prominent leader of the jute industry, Mr. George Bonar, who desired to make available better facilities for higher education in economics and commerce. According to the deed of gift, the courses of instruction are to be of university standard, and the School will aim at preparing its students for responsible administrative and professional positions and providing opportunities for educational advancement to those already engaged in industry. To this end, three different courses of instruction are offered by the School. To graduates of approved universities it offers a one-year post-graduate course; to other qualified students it offers a two-year course; and to students already engaged in industry it provides facilities for evening study. The Principal of the School is Dr. J. A. Bowie, formerly director of the Department of Industrial Administration in the College of Technology, Manchester.

A CHARACTERISTIC of the malignant tumours known as sarcomata is the richness of their blood-supply; frequently even the thin lining membrane of the blood-vessels is absent, so that the sarcoma cells lie in direct contact with the blood-stream and are very liable to be swept away to distant parts of the body. They should, therefore, be susceptible to the toxic influence of therapeutic agents injected into the blood-stream. Positively-charged colloids, injected intravenously, will cause precipitation of the negatively-charged blood proteins; hence it is safe to use only negatively-charged colloids, which, moreover, might react with the basic substances of the cell nucleus and so alter the metabolism of the cell. A. C. Hendrik and E. F. Burton have, therefore, tried the therapeutic effects of a non-toxic colloidal solution of metallic arsenic, in which the particles are negatively-charged (*Canad. Med. Ass. Jour.*, vol. 24, p. 642; 1931). Four cases of bone tumour were selected for the treatment, and the progress after infection was followed radiographically; in two of them deep X-ray therapy was also given. The results in all cases were encouraging: calcification and ossification of the tumour occurred and the bone destruction was retarded or inhibited. The solution was also administered to some patients suffering from carcinoma: the young undifferentiated cells of the tumour appeared to be destroyed; in bone sarcoma this destruction is succeeded by the deposition of calcium, enabling progress to be followed radiographically.

IN a series of papers contributed to the *Electrical Times* during August and September, J. C. Wigham gives an interesting account of the progress Russia is making in industrialisation by the five years plan. Before the War, Russia was largely an agricultural country exporting wheat, timber, and oil. After the revolution, owing to internal disorganisation, the country became too poor to pay for manufactured articles from outside. The Soviet Government therefore decided three years ago to erect industrial plants in Russia to manufacture the goods formerly imported, so as to make Russia economically independent. Amazing progress has been made. The first part of a huge furnace plant at Magnetogorsk, capable of turning out three million tons a year, is expected to be ready by Oct. 1. In about a year's time the Ford plant at Nijni Novgorod for building 140,000 motor cars a year will probably be completed. The outfit brought from America is beginning to be assembled and complete cars will soon be manufactured. At Stalingrad a tractor plant designed to manufacture 50,000 tractors a year is already at work. It is not quite clear how the management of these works is to get the requisite staff of skilled and unskilled workmen. Most of the workpeople employed, men and women, boys and girls, have up to a few months ago been working on the land or as skilled or unskilled labourers in industries other than engineering. The immediate provision of trained skilled workmen is almost an insuperable problem, as training for a new industry always takes time. If the production of these great factories is not carefully balanced, there will be over-production and the unwanted surplus will be sold abroad at any price it will fetch. Good progress has been made in developing electrical power plants and in some other engineering schemes, but the railways are behindhand and the coal mines are said to be poorly equipped.

THE first congress of the Section of Preventive Pædiatrics of the Save the Children International Union of Geneva was held at the Hague on Sept. 7–8, under the presidency of Prof. G. Scheltema, of Groningen, and was attended by members of fourteen different countries. The subjects for discussion were: the mortality during the first ten days of life and its prevention, introduced by Prof. P. Lereboullet and Dr. Lacomme, of Paris, and Prof. A. Schlossmann, of Düsseldorf, and return cases of scarlet fever and their prevention, introduced by Prof. F. von Groer, of Lemberg, and Dr. A. Lichtenstein, of Stockholm. The British representatives who were invited to take part in the discussions were Dr. H. Chodak Gregory, who dealt with neo-natal mortality, and Dr. J. D. Rolleston and Dr. B. Schlesinger, who discussed return cases of scarlet fever. The next congress will be held at Geneva in July 1932.

THE details of the programme for the symposium on the British fuel problem, to be held in the Great Hall, the University, South Kensington, at 10 A.M. on Monday, Sept. 28, in connexion with the meeting of Section B (Chemistry) of the British Association, have now been settled. The symposium will take the form of three addresses in simple and non-technical language. Sir David Milne-Watson, the governor of the Gas Light and Coke Company and the president of the Institute of Fuel, will talk on coal, Sir John Cadman, the chairman of the Anglo-Persian Oil Company, on oil, and Mr. H. T. Tizard, Rector of the Imperial College, South Kensington, on future possibilities.

WE much regret to announce the following deaths: Prof. Percy Groom, M.B.E., F.R.S., formerly professor of the technology of woods and fibres at the Imperial College of Science, on Sept. 16, aged sixty-six years; Sir Howard Grubb, F.R.S., scientific adviser to the Commissioners of Irish Lights, and widely known by his construction of astronomical telescopes and other instruments, on Sept. 16, aged eighty-seven years; Prof. David Starr Jordan, emeritus chancellor of Stanford University, California, formerly president of the University, who was an authority on fishes, aged eighty years; Dr. Joan Proctor, curator of reptiles and amphibia to the Zoological Society of London, on Sept. 20, aged thirty-four years; Sir William Simpson, C.M.G., who was director of tropical hygiene at the Ross Institute, Putney, and editor of the *Journal of Tropical Medicine*, on Sept. 20, aged seventy-six years.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Angular Momentum of Light.

THE work of Compton on X-ray scattering led to the general acceptance of the idea that the scattering of radiation by a material particle is a unitary process in which energy and linear momentum are conserved. A molecule is, however, a much more complicated structure than an electron, and the conservation principles by themselves would give us an erroneous idea of what we should expect in light-scattering. This follows from the fact that a molecule has in general three degrees of freedom of rotation, several degrees of freedom of vibration according to its complexity, and various possible modes of electronic excitation, and that each of these may correspond to one or other of an extended series of quantum numbers. Restricting ourselves to the cases in which the molecule takes up a part of the energy of the quantum, the conservation principles would indicate that the spectrum of the scattered light should contain an immense number of new lines.

Actually, a remarkable simplicity characterises the observed spectra of the light scattered by polyatomic molecules, a simplicity which is in striking contrast with the complexity of their absorption and emission spectra. It is clear that the Compton principles cannot be regarded as capable of *predicting* the observed phenomena of light-scattering, and that their utility lies solely in the *interpretation* of results discovered by experiment. These remarks seem necessary to correct an impression to the contrary which finds expression in some recent publications.

We may extend Compton's principle and add angular momentum to the quantities which we should expect to find conserved in the collision between a light-quantum and a molecule. The fact that, in liquids and solids, the mutual influence of the material particles is very considerable, attaches some uncertainty to the interpretation of the results obtained with them. The recent success of Bhagavantam at Calcutta in measuring the polarisation and intensity of light scattered by gases, however, opens up new possibilities for the development of the subject.

As a working hypothesis, we may follow Dirac and assume that the angular momentum of a photon is *plus* or *minus* $h/2\pi$, intermediate values being inadmissible. This supposition enables us to interpret very simply the known selection rule $\Delta m = 0$ or ± 2 for the change of rotational quantum number of a diatomic molecule in light-scattering, which follows as a natural consequence of it. Further, it follows[1] that a change in rotational quantum number of the molecule should be accompanied by a reversal in the sign of circular polarisation of the photon, when the latter is scattered in the forward direction. This reversal has been actually observed by Bär and by Bhagavantam with the rotational wings accompanying the original mercury lines scattered in liquids, and the data obtained by Bhagavantam with hydrogen gas may also be interpreted as a confirmation of the same result.

It is remarkable that the latter result is also predicted by the classical electromagnetic theory of light for the case of a rotating anisotropic particle scattering circularly polarised radiation. Nevertheless, it is clear that the observed phenomena may be regarded as an experimental proof that radiation has angular momentum associated with it, and that it has the values $\pm h/2\pi$ for each quantum.

C. V. RAMAN.

210 Bowbazar Street, Calcutta,
Aug. 15.

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[1] NATURE, 128, 114, July 18, 1931.

The Penetration of Light through Successive Layers of Tissue Paper.

IN a letter to NATURE,[1] J. R. Ashworth mentioned the use of a stepped wedge of fine quality tissue paper in describing a method of measuring ultra-violet light from the sky, photographically. In a later issue,[2] P. W. Cunliffe pointed out that "a step wedge constructed of a diffusing medium, such as thin tissue paper, does not obey the logarithmic 'law', which is valid only for transparent media". It so happens that I obtained data last spring which bear on this subject.

Mr. G. M. Spooner, working on phototropism, was desirous of reducing illumination by steps, and used sheets of tissue paper for the purpose. The alteration in the intensity of diffuse daylight was measured, using a vacuum sodium photoelectric cell, covered with a double surface flashed opalised-glass plate. The combination has a maximum sensitivity in the violet or near ultra-violet. The results are shown in the table.

No. of sheets	Series A.	Series B.	Transmission per cent.	B (calc.)
1	67·0	69·5	..	..
2	48·7	52·5	75·5	55·0
3	..	40·1	76·4	43·5
4	29·1	30·8	76·8	34·4
5	..	25·3	82·1	27·2
6	..	19·7	77·9	21·5
7	..	16·2	82·3	17·0
8	..	12·8	79·0	13·5
9	..	10·4	81·3	10·7
10	..	8·4	80·8	8·4
			Mean 79·1	

The calculated values in the last column were obtained by using the mean percentage transmission, 79·1 per cent, and multiplying the Series B value for one thickness, namely, 69·5 per cent, by it, to obtain the amount transmitted by two thicknesses, and so on to the tenth.

It may be seen that the calculated and observed values agree well, when allowance has been made for the extra loss by reflection and scattering at the first surface. This amounts to 9·6 per cent. The transmission coefficient appears to increase somewhat with increasing numbers of sheets, at the start. This is probably due to heavy absorption of the shortest wavelengths, which are thus eliminated.

W. R. G. ATKINS.

Marine Biological Laboratory,
Plymouth, Aug. 25.

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[1] NATURE, 127, 893; 1931.
[2] NATURE, 128, 35, 1931.

Analysis of Complicated Band Spectra with the Aid of Magnetic Rotation Spectra.

THE absorption spectra of polyatomic molecules are usually so complicated that an analysis of their rotational fine structure seems impossible. We have therefore tried if the magnetic rotation spectra which are obtained by putting the absorbing gas in a magnetic field between crossed nicols[1] will not simplify those spectra sufficiently so that an analysis becomes possible. It was found that with NO_2 a remarkable simplification occurred. But in this case also the simplified magnetic rotation spectrum is very complicated and we have not yet succeeded in analysing it, further experimental work under higher dispersion being required before an analysis can be attempted.

With NO_2 in a bulb of 3 cm. in diameter at rather low pressure (only slight trace of yellow by transmitted light), a rotation spectrum appeared with a field strength about equal to that of an ordinary permanent magnet. As the field increased, some of these lines disappeared and new lines were developed. The disappearance seems to be a real phenomenon, and not due to a 90°-rotation, as observations with the double quartz wedge of *R*- and *L*-quartz indicated that the rotations involved were of only a few degrees.

In order to clarify the situation and illustrate better the theoretical significance of the magnetic rotation spectra, we studied some diatomic gases, in which case two different conditions are possible: (*a*) at least one of the states involved in the transitions has a magnetic momentum, or (*b*) neither initial nor final state have a magnetic momentum (for example, $^1\Sigma \rightarrow {}^1\Sigma$ transitions).

The amount of the magnetic rotation of an absorption line is determined by its Zeeman effect. If there is a magnetic momentum, it is, except for abnormal cases, along the internuclear axis. In this case there is an appreciable Zeeman effect only for the lower values of the rotational quantum number, as the rotation disturbs the orientation of the magnetic moment in the external field. Accordingly, we should expect in the magnetic rotation spectrum excited by low fields with appreciable intensity only lines which arise from such levels. In higher fields new lines with higher values of the rotational quantum number will appear. An example of such a case is furnished by Na_2, the magnetic rotation spectrum of which has been used already by Loomis [2] for the vibrational analysis of the absorption spectrum. We photographed it with varying field strengths. It behaves exactly in the way indicated above.

If neither the initial nor the final state of the non-rotating molecule have a magnetic momentum, there would be no Zeeman effect, and accordingly no magnetic rotation, if the molecule could be considered as being entirely rigid. (A possible influence of the nuclear momenta is evidently too small.) But by its rotation the molecule is deformed, and this deformation can usually most easily be described as a decoupling of the orbital nomentum from the internuclear axis. A magnetic momentum in the direction of the *rotational* axis is thus produced, which may cause a magnetic rotation of the lines in question. But contrary to case (*a*), the lines with *higher* rotational quantum numbers will be chiefly affected.

We have such a case in the absorption bands of Br_2 and I_2, which are both $^1\Sigma \rightarrow {}^1\Sigma$ transitions. The magnetic rotation spectrum of these gases shows indeed a striking difference from the magnetic rotation spectrum of Na_2. Instead of showing only a few lines, it yields a large number of closely spaced lines, the relative intensities of which do not change perceptibly with the strength of the magnetic field. On account of the insufficient dispersion, we have not yet been able to analyse these spectra in detail, but it is apparent that they are quite different from the absorption spectrum, and it seems that they behave in every respect as is to be expected for case (*b*).

The experiments are to be continued with higher dispersion, and a more detailed account will be given elsewhere.

R. W. WOOD.
G. H. DIEKE.

Dept. of Physics,
Johns Hopkins University.

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[1] See R. W. Wood, *Phil. Mag.*, 1903–1910, also "Physical Optics".
[2] *Phys. Rev.*; 1927.

Structure of the Raman Band of Water.

DURING some investigations, I have remarked that, with the increase of concentration of hydrochloric acid, the complex triplet structure of the Raman bands of water becomes more and more blurred. This result is in contradiction with a remark of Rao,[1] that the above-mentioned bands become sharper with the increase of the concentration of the electrolyte. In order to throw more light on that question I undertook some experiments, a detailed account of which will appear in the *Bull. de l'Acad. Polonaise*, now in the press.

A quartz bulb of the type described by Wood, which contained the liquid investigated, was covered, except for a narrow ring, with a black, opaque coating. It was put inside a low pressure mercury lamp in the form of a ring. The light scattered from the walls of the bulb could be eliminated by placing the bulb in a suitable position. The micro-photometer curves of the Raman spectrum, which I have obtained in this manner, show distinctly the triplet structure of the Raman bands of water, and the influence of the variation of concentration of hydrochloric and nitric acids on the distribution of intensities in the band.

The results obtained in the case of nitric acid are in accordance with Rao's observations, who simply described what could be seen on the plates with the naked eye. The water bands become sharper with the increase of the concentration, the central component splits in two parts, and the intensity of the short wave-length component increases rapidly. It seems strange that on Rao's micro-photometer records only the splitting of the central band could be seen, while the structure of the remaining bands was not visible.

A new band appears on the curve (*c.* 4675 A.), which corresponds to concentrated nitric acid. Gerlach had observed it already on his plates and has ascribed it to the HNO_2 molecules. However, on his micro-photometer curves that band could not be seen.

In the case of hydrochloric acid, this phenomenon has a different character. The intensity of both outer components decreases with the increase of the concentration, and the inner component apparently enlarges. Working with a solution of hydrochloric acid in water, I have remarked that the enlargement of the lines scattered by HCl, without change of the wave-length, has an asymmetrical character. The farther end of the enlarged line dissolves into a band, which ends abruptly on the long wave-length side by a sharp edge, the distance of which from the line is about 150 cm.$^{-1}$.

STANISLAW RAFAŁOWSKI.

Physical Laboratory,
Society of Sciences and Letters,
Warsaw, July 20.

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[1] Rao, *Proc. Roy. Soc.*, A, **130**, 489; 1931.

I HAVE photographed the Raman band of water excited by the mercury line 2536 at a temperature of 17° C. with a Hilger *E*1 spectrograph and exposures of about 125 hours. In the place of the two or three components which, according to the observations of other workers on the water bands corresponding to the same frequency difference and excited by the mercury lines 3650 or 4358, are found, I observed at least nine weak and diffuse components, which could not be reproduced but could be clearly seen with the naked eye under suitable conditions of illumination.

The accompanying reproduction (Fig. 1) is from one of the untouched photomicrographs taken with a large model of Moll's microphotometer, which has been modified in this Institute so as to lessen the irregularities of the registered curve caused by the largeness of the reduced grains of the plate in comparison with their scanty numerical density. The arrow indicates the mercury line 2759, which probably hides a tenth band. The other nine are clear.

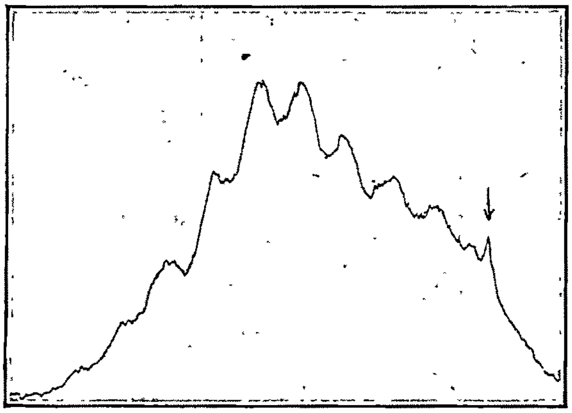

FIG 1.

The wave-lengths of each single component and the corresponding Raman frequency (average of the measurements carried out on photomicrographs of different plates) are given in the following table:

	λ.	$\nu_{\text{vac.}}$	$\Delta\nu$.
Exciting line . .	2536·5	39412·6	
1st component . .	2765	36155	3257·6
2nd ,, . .	2769	36104	3308·6
3rd ,, . .	2773	36052	3360·6
4th ,, . .	2777	35999	3413·6
5th ,, . .	2780·5	35954	3458·6
6th ,, . .	2784	35909	3503·6
7th ,, . .	2788	35857	3555·6
8th ,, . .	2792	35806	3606·6
9th ,, . .	2796	35755	3657·6

The average distance between two components is 50 cm.$^{-1}$.

The structural analogy between the present band and the band of water vapour at 2·7 μ examined by Neunhoeffer should be noted.[1]

A more detailed description will be published elsewhere shortly.

G. BOLLA.

University of Milan, July 25.

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[1] Neunhoeffer, *Annalen der Physik*, **2**, 334; 1929.

Photoelectrons and Negative Ions.

A SUMMARY of the results of an experimental research concerning the formation of negative ions from electrons may prove of interest. The electrons were generated by means of light emitted from a quartz mercury vapour lamp ('Home Sun' D.C. type) and incident upon a gold-plated electrode distant 2 cm. from a similar electrode. Between these two electrodes an alternating potential difference of 'square' wave form was established. During a fraction (f) of the time of a complete cycle the electric carriers advance to the receiving electrode; in the remainder of the cycle their motion is reversed, and they are withdrawn from the gas. The gas contained in the [illegible] vessel was air at various pressures; no purification of the air was attempted other than careful drying.

The experimental procedure consisted in determining for a given gas pressure (p) the curve representing the direct current (i_0) plotted against the applied potential difference (V), and also the curves which exhibited similarly the currents (i_1 and i_2) when the numbers of complete cycles per second were n_1 and n_2 respectively ($n_1 = 30$ and $n_2 = 600$ approx.). The ratios i_1/i_0 and i_2/i_0 were then plotted against $1/V$. The curves obtained were of the type given in the accompanying diagram (Fig. 1). In the curve B, which relates to the higher frequency, one observes a flat portion corresponding to the larger values of V and an apparent point of inflection. It was significant that this point of inflection always corresponded to the voltage which was known to be required in order that the negative ions might traverse the full distance between the electrodes.

In order to explain these curves, a mathematical expression for i/i_0 in its relation to V was developed, the assumption being made that the electric carriers are formed as electrons and that a fraction of these become attached to molecules during their passage through the gas, thus giving rise to negative ions. Mathematically, if N electrons traverse in the free state a distance x from the electrode where they originate, then, after traversing a further distance dx, the number of free electrons will be decreased by $\lambda N dx$, where λ depends on the nature of the gas and is, in addition, a function of V and p. It was found that the theoretical curves thus obtained exhi[illegible] the general characteristics of the experimenta[illegible] however, the values of λ which were require[illegible] the experimental curves into agreemen[illegible] theoretical relations were completely dif[illegible] two curves A and B. As it is not con[illegible] can depend on the frequency of co[illegible] conclusion is inevitable that the ass[illegible] above, which has been made the ba[illegible] experiments in recent years, is quite [illegible]

The mathematical expression for [illegible] modified, the assumption being made [illegible]

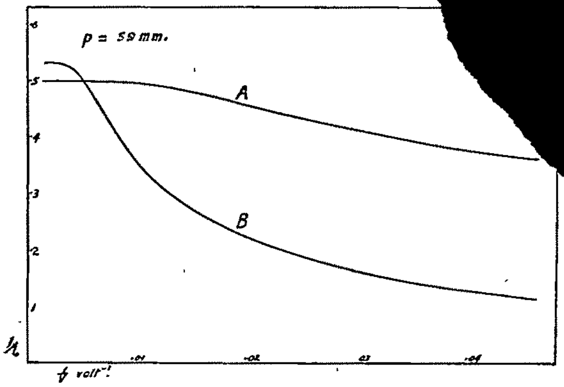

FIG. 1.

electric carriers formed at the electrode, a fraction θ consists of electrons and the remainder of negative ions. The assumption previously made was also retained, namely, that the electrons are liable to further attachment during their progress through the gas, the coefficent of attachment λ being defined as above. A close comparison between theory and experiment disclosed the result that the experimental curves could only be satisfied by values of λ extremely close to zero. On putting λ equal to zero the mathematical expressions for i/i_0 take the simple form:

$$i/i_0 = f - (1 - \theta)vx \qquad (x < f/v)$$
$$i/i_0 = \theta f \qquad (x > f/v)$$

where x is $1/V$, and v denotes nd^2/k, k being the mobility of the negative ion, and d the distance between the electrodes. The velocity of the electron is assumed to be large in comparison with that of the ion. The fraction of electrons (θ) is a function of the impressed voltage and of the gas pressure.

The agreement of experiment with the above theory was established over a range of pressures from 7 mm. to 1 atmosphere. The physical interpretation of the theory is that the great majority of negative ions are formed in the vicinity of the electrode at which the electrons originate; those electrons which do not give rise to negative ions near this electrode traverse in general the whole interval between the electrodes in the free state. Only an inconsiderable fraction of the ions, if any, can be formed by attachment in the body of the gas.

The values of θ in relation to the pressure and to the applied field have been obtained and will be given when the account of the experimental work is published in full.

E. M. WELLISH.

University, Sydney, June 26.

Photosensitised Decomposition of Ozone by Bromine.

As a result of work on the photochemical chlorine-ozone reaction carried out at King's College, London,[1] experiments have been in progress on the bromine-ozone reaction in the hope of explaining the differences [illegible]tween the two reactions noted by Bonhoeffer[2] and [illegible]nted on by various authors since that time. It [illegible]d that chains of considerable length were [illegible] in certain circumstances, and to account [illegible] other facts, the formation of an oxide of [illegible] intermediate product was postulated. [illegible]ed that the formation of a similar un- [illegible]ll account for the high quantum effi- [illegible]omine-ozone reaction, and this receives [illegible]ork on the thermal process.[3, 4]

[illegible]umacher[3] concluded that it would be [illegible]pt the $Br_2 - O_3$ photo-reaction because [illegible] complicating factors, but preliminary [illegible] showed that the effect of the dark re- [illegible]l be minimised by working at atmospheric [illegible]th low concentrations of bromine and ozone [illegible]ge excess of oxygen. Working at 20° C., the [illegible]ion of any solid or liquid oxide is avoided, and [illegible]eaction appears to take place mainly in the gas [illegible]se. The natural dark reaction under these con- [illegible]tions is small for the first few hours, and can be partly eliminated by using balanced cells.[2] A few preliminary results may be of interest at this stage.

A high quantum efficiency is obtained of the same order as that found by Bonhoeffer, who bubbled his $O_2 - O_3$ mixture through liquid bromine before insolating with blue light.

As a general rule, there is no after-effect, indicating that little or no absorption of an intermediate compound on the walls is taking place in these experiments and this is also indicated by the fact that no appreciable change in transmission of $365\mu\mu$ or $546\mu\mu$ takes place on insolation. However, it is probable that this depends on the nature of the surface. The $Br_2 - O_3$ photochemical action differs from the $Cl_2 - O_3$ reaction in that there is no increase in rate of decomposition while the last few millimetres of ozone are being decomposed.[5, 1]

A further difference is that the quantum efficiency at $546\mu\mu$ is practically equal to that for $365\mu\mu$, although the wave-lengths correspond to absorption in the band and continuous regions respectively. (Compare Jost and Jung in the $H_2 - Br_2$ photo-reaction.)[6]

Experiments indicate a direct proportionality of rate to intensity in the region covered, and approximately the same quantum efficiency is obtained for mixtures containing 0·3 to 3·3 per cent bromine and 0·5 to 4 per cent ozone.

In view of the above, it is considered that an oxide of bromine is the 'carrier' in both the thermal and photo reactions. Lewis[4] indeed mentions this possibility, but inclines rather to the view that the carrier is an activated oxygen molecule, although the photo-decomposition of ozone scarcely supports this view.

Further experiments varying different factors are in progress with the view of elucidating both the thermal and photo-reactions.

J. W. T. SPINKS.

University of Saskatchewan,
Aug. 18.

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[1] Allmand and Spinks, *Jour. Chem Soc.*, 1652; 1931.
[2] Bonhoeffer, *Zeit. fur Physik*, **13**, 94; 1923.
[3] Lewis and Schumacher, *Zeit physik. Chem*, **6B**, 423; 1930.
[4] Lewis and Feitknecht, *Jour. Am Chem. Soc.*, **53**, 2910, 1931.
[5] Weigert, *Zeit Elektrochem*, **14**, 591, 1908
[6] Jost and Jung, *Zeit. physik. Chem.*, **3**, 83; 1929

Pottery with Flint Implements of Upper Palæolithic Facies from Swanscombe, Kent.

SOME time ago,[1] there appeared in NATURE a short account of a series of flint implements of Upper Palæolithic facies which I had found in a deposit, presumably of glacial origin, on Flamborough Head, Yorks. The cultural horizon of these implements was situated some six feet below ground-level and rested upon a layer of gravel which, in its turn, capped the Upper Purple Boulder Clay.

Some months later,[2] I announced my discovery of similar flint implements in the Brown Boulder Clay at Kirmington, Lincs, a deposit universally admitted as of glacial origin.

This year I located a similar series of flint implements, but associated with undecorated fragments of rough pottery, at Greenhithe, Kent. The site, which occupies a lateral valley, shows the following section:

G.	Surface soil with ground-level at 50 ft. above O.D.	2 ft.	0 in.
F.	Stony loam containing chalk fragments and an occasional 'raft' of Coombe rock	6 ft.	0 in.
E.	Brickearth with implements and pottery fragments	3 ft.	6 in.
D.	Sand with occupation-level at base .		6 in.
C.	Gravel	1 ft.	6 in.
B.	Coombe rock	5 ft.	0 in.
A.	Chalk		Plus.

Deposit E (the Brickearth) has been examined by Dr. R. H. Rastall, of Cambridge, who states that it is definitely not loess, but that it presents all the appearance of having been deposited by water action. The overlying stratum F (with its erratics, chalk fragments, and 'rafts' of Coombe rock) would seem to confirm the glacial origin of the implementiferous deposit of Flamborough Head previously described.

As a result of the generous assistance rendered by Mr. A. C. Davis, managing director of the Associated Portland Cement Manufacturers Co., Ltd., and the trustees of the Percy Sladen Memorial Fund, a series of excavations has been planned, reports on which will be published from time to time. The first excavation is well advanced, and a fine group of implements and pottery fragments has been recovered.

J. P. T. BURCHELL.

30 Southwick Street, W.2,
Aug. 11.

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[1] NATURE, Feb. 15, 1930.
[2] NATURE, Nov. 15, 1930.

Research Items.

Bird Song and Weather.—Changes in weather, and especially sharp frost or snow, influence the amount of bird song, but the influence is different upon different species. H. G. Alexander has made careful observations of the effect of decided spells of hard weather upon birds in Birmingham (*British Birds*, Sept., p. 97). Frost reduces the amount of song, and effects especially the ground-feeding species, such as skylarks and thrushes, but cold winds have the same effect upon more arboreal feeders. Some species respond vocally to sunshine, like the coal-tit, and some are encouraged by rain, like the blackbird. It is suggested that sunshine or rain may affect favourably the food supply of these birds and thus may induce song, but rain stimulates blackbirds more than either thrushes or robins, although the food is very similar. There may be curious idiosyncrasies in the behaviour of closely related species. The song-thrush, the author says, sings in the early morning, and from late November onwards in favourable weather; the blackbird is rarely heard until February, and most of its early song is in the afternoon. Perhaps the 'song' means something different for the two species—more of a normal outlet for surplus energy for the song-thrush, more of a love song for the blackbird.

Nitrogen Content of Apples in Storage.—Pilling and Pearsall point out (Annual Report of the Agricultural and Horticultural Research Station, Long Ashton, 1930) that until now very little attention appears to have been paid to the changes in protein content in apples during storage. In view of the fact that such proteins, an essential protoplasmic constituent, form no less than 2 per cent of the dry matter of the apple, any considerable changes are likely to affect very seriously the continued life of the apples. Their preliminary observations, carried out in connexion with the fruit storage experiments at Long Ashton, seem to open a fruitful line of attack. During storage protein decomposition ensues, and the products—presumably after passing through amino nitrogen and ammonia nitrogen stages—accumulate as 'rest N' compounds of unknown origin and composition. An interesting result of this preliminary work is the fact that break-down in every case investigated seems to occur when the 'rest N' reaches a proportion of more than 17 milligrams per 100 grams of fresh weight.

Properties of the Earth's Crust.—The Geophysical Supplement to the *Monthly Notices* of the Royal Astronomical Society, vol. 2, No. 8, June 1931, contains four seismological papers, and one on forced tides in rotating rectangular basins of uniform depth (S. F. Grace). H. Jeffreys gives new determinations of the times of transmission of *P* and *S* waves at short epicentral distances, and E. Tillotson discusses the data for a 1923 earthquake originating in Yugoslavia, and finds that the travel times for *P* agree best with Jeffreys' tables; he also makes estimates of the thickness of the various layers near the surface, and of the energy of the earthquake (10^{21} ergs). R. Stoneley also discusses the thickness of the continental layers of Europe, from seismic data. H. Jeffreys in a theoretical paper examines the cause of the oscillatory movement in seismograms; in a homogeneous elastic solid an impulsive disturbance is not drawn out into a train of waves. The paper shows that the continuous variation of the earth's elastic properties with depth would not draw out the disturbance into an oscillation, nor can the mutual gravitation of the oscillating medium, nor friction and scattering, have this effect. The only suggestion that survives is that the oscillations are due to reflections of the original pulse within the surface layers, with partial reflection into the lower layers at each arrival at the interfaces.

The Guayra Falls of the Parana.—The Guayra Falls, a few miles above that town on the upper Parana river, have been known since the sixteenth century but have been seldom visited. In the September number of *Discovery*, Mr. E. C. Rashleigh gives an illustrated account of these falls, which, he claims, have the greatest flow of any falls in the world. There is a total drop of 373 feet in about thirty miles, and while no single fall exceeds 130 feet and no sheer leap is more than 65 feet, the volume and speed of the water make up for lack of height. Above the falls the river is 2½ miles wide, but the gorge below the falls is only eighty yards in width. The flow of water above the falls has been measured and averages 500,000 cubic feet per second, while in flood time it may be 1,000,000 cubic feet. This compares with 212,000 cubic feet at Niagara and 100,000 cubic feet at Paulo Affonso on the Rio São Francisco, which would appear to be the largest two of other falls. A Brazilian commission estimated the horse-power of the Guayra falls at 6,000,000, but Mr. Rashleigh points out that if it were possible to divert and canalise the whole river so as to utilise the total drop of 373 feet, the horse-power in flood season would amount to 174,000,000.

Ultra-Violet Window Glass.—Many of the glasses which have been produced capable of transmitting ultra-violet light of wave-lengths between 320 and 280 micro-millimetres, which are the most active therapeutically, deteriorate in their transmission on exposure for a few months to sunlight. The same effect is produced by exposure for a short time to a source, such as the quartz mercury lamp, richer in ultra-violet light. The August issue of the Bureau of Standards *Journal of Research*, Washington, contains a paper by Messrs. A. Q. Tool and R. Stair describing their experiments on the restoration of the transmitting power of such glasses by heating them in an electric furnace to definite temperatures for longer or shorter times extending to several days. They find that the colour of the glass disappears and the transmission is restored as the heating proceeds. At temperatures below 300° C., though the colour disappears, the transmission is only restored for the longer waves, and a temperature of 500° C. is necessary before it is restored for the shorter waves. The restoration is the more rapid the higher the temperature, but deformation of the glass begins about 600° C.

A New Electron-Inertia Effect.—In Maxwell's "Treatise on Electricity and Magnetism", he described three inertia effects which should exist in conductors, such as metals are now imagined to be. Two of these have been verified experimentally, in particular by Barnett and by Tolman, and in the *Philosophical Magazine* for August (p. 349) Prof. Barnett describes the observation of the third. It consists essentially in the angular acceleration of a coil of wire when the current through it is altered; the free conducting electrons are accelerated in one direction, and the coil itself accelerated in an opposite sense. The apparatus needed is naturally very sensitive, but was already set up in almost the requisite form for an investigation of the Einstein-de Haas effect of rotation by magnetisation. The minute twist imparted to the coil could be measured either by balancing it against another couple applied by the action of a second coil on permanent magnets attached rigidly to the main coil, or by the direct observation of the deflection, the former method proving the more accurate. The results show that the carriers of electricity have a negative charge—from the sense of the deflections—and that the ratio of charge to mass for the conducting particles is close to that found for electrons by other means, the best value obtained for the ratio being $1 \cdot 74 \times 10^7$ e.m.u., and the standard value $1 \cdot 77 \times 10^7$ e.m.u.

Accuracy obtainable with Gas-filled Photoelectric Cells.—In the *Scientific Proceedings* of the Royal Dublin Society for May, Dr. W. R. G. Atkins publishes a useful and interesting paper describing experiments on the accuracy obtainable with gas-filled photoelectric cells. The question arose in connexion with experiments made to determine by means of photometers the light penetration into sea water. Two cells, a gas-filled cæsium hydride cell and a gas-filled potassium hydride cell, were tested. The former was tested for constancy of emission after the glow discharge had been passed momentarily. It was found that when the anode potential was maintained at 143 volts, a variation of about 33 per cent occurred. Immediately after the glow discharge the sensitivity decreases about 2 per cent per minute, but after a time it begins to rise. The potassium cell was tested for constancy of emission in a similar way, and the variation was found to be within two per cent with a current of about five microamperes, the anode potential being 59 volts. At 166 volts the constancy appears to be somewhat less. The rate of decrease of sensitivity after the glow amounts to about 2 per cent at 166 volts and more than 3 per cent at 59 volts. It is therefore advisable to make measurements immediately after the discharge, which should be of momentary duration only. The potassium cell gives results which can be relied upon to within 2 per cent for post-glow readings for currents at least as great as five microamperes. The results refer to measurements made within a short period of time, and offer no evidence as to the constancy or inconstancy of the cell over long periods.

Astronomical Topics.

The Total Eclipse of the Moon on Sept. 26.—The second total lunar eclipse of the year is visible in England in circumstances closely similar to those of the eclipse of April 2. In each case the first contact of the shadow is about the time of moonrise, but as the moon is five degrees farther north on this occasion, the conditions at the end are slightly more favourable. Totality begins at $19^h\ 5^m$ U.T. ($8^h\ 5^m$ P.M. Summer Time), and lasts $1^h\ 25^m$. The moon leaves the umbra at $21^h\ 42^m$ U.T.; the shading of the penumbra remains fairly obvious for some minutes longer.

Total eclipses afford opportunity for observing the occultation of faint stars, which cannot be seen near the moon at other times. In fact, the best determinations of the moon's diameter are those derived from occultations during eclipses.

The study of the colours on the eclipsed moon is full of interest; they vary in different eclipses, and even in different parts of the disc. It is chiefly the lower layers of the terrestrial atmosphere that are effective in bending the sunlight that falls on the eclipsed moon; these layers vary greatly in transparency according to meteorological conditions. Hence, study of the moon reveals the integrated effect of the weather in the regions of earth that have the sun and moon on their horizon at the time. For most of totality the western part of this region will lie in the Atlantic Ocean.

Occasionally lunar eclipses are used for observing faint comets that cannot be seen in a moonlit sky; but it does not at present appear that this eclipse will be of use in this way.

It is of some interest to note that the small solar eclipse of Sept. 12, visible in Bering Straits, was the last eclipse of a series in the Saros cycle; one member of that series was the eclipse of May 3, 1715, when the sun was totally eclipsed at the Royal Observatory, Greenwich, for $3^m\ 12^s$. Flamsteed noted that the "weather was perfectly clear for the whole eclipse".

The Recent Opposition of Eros.—*Astr. Nach.*, No. 5815, contains notes by Prof. J. Hartmann and M. Dartayet on the observations of Eros made at La Plata early in the present year. The times of the exposures of the photographs were electrically recorded to one-tenth of a second. No screening of the planet was necessary, as its light did not differ much from that of the comparison stars. A series of photographs were taken at zenith distance 75°, to check the refrangibility of the planet's light; those for obtaining the parallax were at Z.D. 65° to 60°. 359 plates were taken near the meridian, which will be useful for deducing the mass of the moon. The planet and neighbouring stars were observed with the transit circle on eleven nights.

Plates for the investigation of the light-variation were taken on March 10, 21, and 25. The plates on the first night cover almost the whole of the light-period of 5¼ hours, in which there is a double maximum and minimum. The light range on the first two days was about three-tenths of a magnitude; on March 25 it did not exceed two-tenths. The times of maximum and minimum conformed well with the formula given by Rolf Müller in *Astr. Nach.*, No. 5768.

Perseid Meteors Observed in America.—The United States have a very active body of meteor observers, under the direction of Dr. Charles P. Olivier, director of the Flower Observatory, and author of a well-known text-book on meteoric astronomy. A bulletin from Science Service, Washington, D.C., dated Aug. 17, reports that the weather was unfavourable in the eastern States, but that successful observations were made at 47 stations in the United States and Canada. These are enough to prove that the maximum was quite a good one: "the rate after midnight rose to two per minute, which is well over the average. . . . Many brilliant meteors accompanied the shower."

As there is likely to be a good display of Leonid meteors about Nov. 17, it is desirable that as many observers as possible should co-operate. Those to whom such work is new should make themselves acquainted with the methods of observing them.

The Preservation of Food.*

THE Report of the Food Investigation Board for 1930 is notable, as in previous years, for the great variety of the researches which have been carried out under the Board's auspices. They are concerned with the changes taking place in meat and fish, fruit and vegetables on storage, especially at low temperatures, with the commercial application of the results obtained, and with the engineering problems involved in the construction and running of large stores. The report notes that the work of the Board has already been effective, in that two commercial gas stores for the storage of apples are now in operation: in one, over a period of five months, the losses during storage of 'Bramley's Seedling' apples did not exceed 0·5 per cent. Close touch is kept with investigators in other parts of the Empire: co-operation will be facilitated by the appointment of assessors, representing the Dominions and Colonies, to the Board during the past year.

The model store chamber at the Ditton laboratory, designed to hold 120 tons of fruit, is now in operation. The problem is to secure uniformity of temperature, humidity, and gas content, at desired values, inside a stack of material which generates heat, evaporates water, consumes oxygen, and evolves carbon dioxide. Large scale storage involves special questions, since the heat, water vapour, and gases produced in the body of the stack have finally to be removed from its surfaces: the greater the ratio of volume to surface, the greater is the difficulty of effective removal without the establishment of gradients. The investigations must therefore be carried out in special chambers arranged for the continuous scientific control of the environment and the measurement of the changes occurring in it: all measurements can be made from outside—for example, temperatures by a 200-point resistance-thermometer outfit.

Some of the scientific problems to be met by the biological engineers have also been investigated: one of the most important is the rate of evaporation from stored materials. Investigations have been carried out by A. J. M. Smith, during the year, on eggs and cheese. In the case of the former, there is no close correlation between rate of evaporation and area of surface, nor does the rate of air-movement (at constant humidity) have any effect on the rate of evaporation. In fact, evaporation appears to depend chiefly on the shell, which acts as the limiting factor: the rate falls off with time, but this is apparently not due to the eggs containing less water but to an increase in the resistance to diffusion of one of the membranes. During the first ten days or so of the life of the eggs the loss of weight is also due in part to output of carbon dioxide. The initial movement of water from the white is not only outwards but also inwards to the yolk, since the osmotic pressure of the latter is the higher: later the yolk loses not only the additional water but also some of that originally present. Examination of the water content of cheese at different levels from the surface showed that the gradient of water content was very steep, the bulk of the evaporated water coming from the outer 2 cm.

Investigations on the canning of fruit and vegetables have been carried out by T. N. Morris and J. M. Bryan. Using a tin-iron couple, it was found that oxygen increases slightly the corrosion of the tin by acid, but depresses that of the iron: in the absence of oxygen the corrosion of tin is negligible. The detinning of tinplate is most severe at low hydrogen ion concentrations (pH 4–5) within the range encountered in canned fruits: thus, corrosion is greater with cherries than with gooseberries. On the other hand, at low acidity, oxygen accelerates instead of depressing the corrosion of iron. It was also found that a rough surface accelerates both corrosion and the formation of hydrogen; that at high acidities exposed portions of the metal are attacked, at low, the pits and seams, and that traces of tin in solution inhibit the corrosion of iron. Traces of sulphur dioxide accelerate the corrosion of iron at high acidity, but retard it at low; gelatin and other inhibitors of acid corrosion may exert a powerful influence at high acidity but little or none at low. It may be necessary to store the fruit or vegetables before they are canned: strawberries and cherries can be stored frozen in sugar syrup; peas require blanching by boiling water before being frozen. On subsequent thawing and canning, the latter have the appearance and flavour of fresh canned peas, provided the liquid drained off on thawing is used as a covering in the tin: the thawed peas themselves resemble fresh peas if cooked at once.

During the year a survey of the freezing, storage, and transport of New Zealand lamb was carried out by E. Griffiths, J. R. Vickery, and N. E. Holmes: it was concerned chiefly with the measurement of the temperature, relative humidity, and movement of air surrounding the carcasses, as well as with the temperatures of the latter themselves, in the various stages of storage and transport. It was noticed that the 'bloom' or general appearance of the carcasses depended on breed, age, and nutrition of the sheep as well as on the treatment accorded after death. The value of beef is greater when it is imported chilled and not frozen, since it is ready for immediate sale, is well conditioned and tender, and little different in appearance from home-killed beef. The drawbacks of chilled, instead of frozen carriage, are microbial growth and rancidity. T. Moran, R. B. Haines, and C. H. Lea have shown that air movement delays the growth of moulds and the development of rancidity when meat is stored at 0° C.

Rancidity cannot be measured by chemical tests, as the products responsible for the taste and odour vary in different cases: it can be prevented by storage below $-10°$ C., when the meat is, of course, frozen: at $-5°$ C. the growth of moulds and yeasts is not completely inhibited. Light favours the development of rancidity, by hastening oxidation in the superficial layers of the fat: the process is autocatalytic and continues after subsequent removal to the dark. On the other hand, an unpleasant flavour develops in the dark, which is not due to atmospheric oxidation of the fat. It has also been found that an *Actinomyces* is responsible for the development of a musty odour in meat: it finds its way into the store with straw.

Work has also been carried out on the theoretical aspects of the subject of chilling and freezing: thus, muscle is irreversibly damaged when frozen below about $-2°$ C.: it can still form lactic acid, which can be removed by oxidation; but the resynthesis of the acid to glycogen can no longer take place. J. Brooks has shown that the discoloration of meat is due to the formation of methæmoglobin from hæmoglobin in the superficial layers: this process is inhibited by continuous storage at below $-10°$ C.

In the case of pig products, E. H. Callow has shown that carcasses of pork can be frozen, transported, and then made into bacon, provided that the fat is hard, otherwise rancidity develops: the nature of the fat depends on the diet of the pig. More lately it has been found that mild-cured or tank-cured bacon, frozen at − 35° C. and stored at − 10° C. or − 15° C., after slow thawing, and smoking in the case of the latter, tasted for the greater part like ordinary bacon after cooking, but in each case slight rancidity had developed in small areas of the fat. Work has also been carried out on the swelling of gelatin and pork muscle in solutions of sodium chloride.

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* Department of Scientific and Industrial Research Report of Food Investigation Board for the year 1930. (London: H.M. tionery Office, 1931.) 3*s*. net.

The Torry Fish Research Station acquired the steam-drifter *City of Edinburgh* during the year. C. A. Reay has carried out further experiments on the freezing and cold storage of haddock. Under certain conditions an irreversible change in the muscle occurs which may not be very obvious on thawing but is evident after curing, since the glossy pellicle of the surface is absent and the tissue is friable, inelastic, and opaque instead of elastic and translucent. The rate of change is slowest at 29°–25° F. and − 9° to − 13° F., and quicker at the intermediate temperatures; at the higher, bacterial growth occurs, the lower involves greater expense in refrigeration.

Research work on fruit and vegetables has been continued. J. Barker has found that cyanide at first accelerates the respiration of the potato instead of inhibiting it as in the case of many animal tissues. The effect appears to be due to an activation of the starch-hydrolysing mechanism, so that more respirable material is available: later inactivation occurs. A. S. Horne has found that East Malling apples, which have a reputation for good keeping qualities, owe their freedom from wastage to absence of infection in the orchard: when infected they are less resistant than fruit from other areas. Resistance to fungal attack depends in part on the acid content of the apples, which decreases with age.

The Idu (Japan) Earthquake of Nov. 26, 1930.

SINCE the great disaster of 1923, Japan has been visited by three destructive earthquakes, in the Tazima province on May 23, 1925, when 428 lives were lost; in the adjoining Tango province on March 7, 1927, when 3017 persons were killed, and in the Idu peninsula on Nov. 26, 1930. Prof. A. Imamura has written two interesting papers on the last-named earthquake while a valuable memoir has recently been contributed by Mr. S. I. Kunitomi of the Central Meteorological Observatory.*

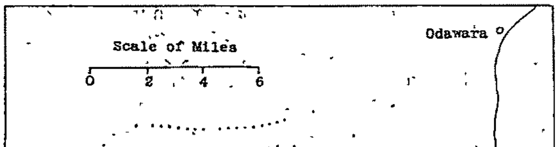

FIG. 1.

According to Mr. Kunitomi, the earthquake was felt over a land-area of 133,000 sq. miles, including the greater part of Japan. The series of Ito earthquakes, more than 4000 in number, closed at the end of May (NATURE, vol. 126, pp. 326, 971). Then followed a pause of about five months until Nov. 7, when a slight earthquake occurred with its epicentre near the Tanna basin. Every day after this, the fore-shocks of the Idu earthquake increased in number until, on Nov. 25, 734 shocks were recorded at the Misima Observatory near the north end of the peninsula. Up to 4 A.M. on Nov. 26, the total number of fore-shocks was 2165, of which 184 were felt at the observatory. Mr. Kunitomi's map representing the distribution of the fore-shock and after-shock epicentres shows that the former were as a rule clustered along the Tanna fault, while the latter were widely scattered over the epicentral region and especially at the bases of Mounts Huzi, Asitake, and Hakone, and off Cape Ooze.

One of the most useful sections of Mr. Kunitomi's paper is that which deals with the origin of the Ito and Idu earthquakes. He has studied the distribution of the directions of initial motion in the Idu earthquake and the stronger Ito earthquakes, especially that of March 22. In all of these earthquakes the distribution is the same, and implies in each a horizontal movement of the crust-blocks along a N.N.W. and S.S.E. line, or nearly along the course of the Tanna fault, the eastern block moving to the north and the western to the south.

The Idu peninsula lies on the west side of Sagami Bay, the bed of which and the surrounding shores formed the epicentral area of the Kwanto earthquake of Sept. 1, 1923. Prof. Imamura points out that there have been three epochs of seismic activity in this region, in 818, 1703 and 1923, and that the first and third were followed, after 23 and 7 years respectively, by destructive earthquakes in the Idu peninsula. The recent Idu earthquake may thus, he suggests, be regarded as an after-shock of the earthquake of 1923.

The earthquake occurred on Nov. 26, at 4 h. 3 m. A.M. (Nov. 25, 7 h. 3 m. P.M., G.M.T.). In a sketch-map, the essential features of which are here reproduced (Fig. 1), the broken lines represent the faults along which dislocations occurred during the earthquake, the outer dotted line bounds the area in which at least 1 per cent of the houses collapsed, the inner dotted lines I-IV, the areas in which the percentage was not less than 25. It was in the areas II-IV that the greatest losses of life and property occurred, 259 persons being killed and 2142 houses destroyed.

Of the faults that appeared during the earthquak four are especially noteworthy. (i) The Tanna fa

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* *Tokyo Imp. Acad. Proc.*, vol. 6, pp. 419-422; 1930, and *Japan. Jour. Astr. Geoph.*, vol. 8, pp. 51-65; 1931. *Tokyo Geoph. Mag.*, vol 4, pp 73-102; 1931.

crosses the Tanna tunnel at right angles, about 500 feet below the surface. In the tunnel itself, the crust on the west side was shifted 7 ft. 10 in. to the south and 2 ft. 0 in. downwards relatively to that on the east side; though, at the surface, the dislocation was much less marked. (ii) The northern or Hakone fault, trending north-west, may be a segment of the Tanna fault. (iii) The Oona fault begins near Ukihasi and runs S. 30° W., with a relative southward shift of the west side amounting in one place to 3 ft. 3 in. (iv) The southern segment of the latter fault, or Kadono fault, trending S. 70° W., with relative shift of the west side of 4 ft. 3 in. to the south and 1 ft. 8 in. upwards.

From a study of the seismograms obtained at Tokyo, Prof. Imamura distinguishes four series of waves coming from as many different origins, that are probably represented by the areas I-IV in the accompanying map. The movement of the whole block-system started north of Ukihasi (in lat. 35° 2′ N., long. 139° 0′ E.), passed northwards with comparative quietness along the Tanna fault, and southwards, with sharp destructive shocks caused by the displacements of the three blocks II, III, and IV. The crust on the west side of the fault-system was shifted relatively southwards, the whole movement coming to an end after the lapse of about 10 seconds. The stress causing this block-movement probably acted in the same way as that in the great Kwanto earthquake of 1923; in other words, the recent Idu earthquake was an after-shock of the Kwanto earthquake.

C. DAVISON.

The National Radio Exhibition.

THE National Radio Exhibition, which was opened at Olympia on Sept. 18, occupies a floor space three times as large as last year and is now the largest radio exhibition in the world. The exhibition is organised by the British Radio Manufacturers' Association, and is arranged in such a well-planned manner that it cannot fail to be of interest to all broadcast listeners, whether technically minded or not. This exhibition definitely supports the idea which was becoming evident last year, that the radio manufacturing industry has passed through its somewhat uncertain experimental stage to that of steady development along trustworthy and well-established lines. The modern commercial radio receiver compared with its prototype of a year or two ago, which resembled an ill-assorted collection of components wired together in a box, is built somewhat on the lines of a car chassis.

Apart from the progress made in the design of receivers based on well-established principles, two recent developments are indicated in the exhibition. The first is an attempt to improve the selectivity obtainable in reception without any appreciable sacrifice of the quality of reproduction. More than one method of reaching this objective is being investigated, and it is possible that the results obtained may to some extent alleviate the interference difficulties which sometimes arise when transmitting stations are in too close proximity to one another, both in a geographical sense and from the point of view of their operating frequencies. The second and perhaps more recent novelty in Great Britain is the introduction of the 'variable-mu' valve, that is, of a valve in which the action of the grid in controlling the anode current varies along the axis of the electrode system, usually as a result of a variation in pitch of the turns of the grid. Such a valve, having a variable amplification factor according to the actual conditions under which it is operating, provides a means of avoiding certain distortion effects encountered in the normal type of screen-grid valve. A means of overcoming the effects of variation of the incoming signal due to fading and other causes is also provided by the new valve, which may be operated under conditions securing automatic volume control in the radio-frequency portion of the set.

A prominent exhibit is that of the British Broadcasting Corporation, which includes a large map of the British Isles showing the density of population in relation to the broadcasting stations. A study of the map reveals that the B.B.C. stations are placed in the most advantageous positions to secure that the great majority of the population are within the service area of one or more stations. Apparatus is also installed on the B.B.C. stand to supply programmes to all loud-speakers operating in the exhibition.

For the rest, the exhibition shows the great range of modern receiving sets which are now available to suit all tastes and length of purse. The great modern tendency is to make the receiver a self-contained unit, including the loud-speaker, and ready for connexion to the electric supply mains. The larger and more expensive models contain also an electrically operated gramophone, and in some cases these now embody automatic record-changing mechanism by means of which half an hour's continuous gramophone music can be obtained without any attention. The more successful of the portable receivers remain in a somewhat improved form, while battery-operated models are still produced for those to whom an electric supply is not available. Altogether it may be said that the receivers show a marked improvement in design and performance over those exhibited last year, while the selling prices are in most cases appreciably lower.

Birthdays and Research Centres.

Sept. 28, 1873.—Prof. J. L. COOLIDGE, professor of mathematics in Harvard University.

I am at present engaged on a history of geometrical methods. This is a long work that will cover many years.

A problem to which attention might usefully be given is the situation of the singular points of a rational plane algebraic curve.

Sept. 28, 1889.—Prof. H. MUNRO FOX, professor of zoology in the University of Birmingham.

Protoplasm contains a considerable number of elements, some of them present only in traces. Of these, some may be of considerable functional importance. During the last two years, in collaboration with Mr. H. Ramage, I have been making a quantitative spectrographic study of the presence of traces of elements in the tissues of a wide variety of animals.

Some years ago I carried out a physico-chemical investigation of chlorocruorin, a green blood pigment present in certain polychæte worms. Chlorocruorin turned out to be the only known substance having a chemical structure closely similar to hæmoglobin. By its resemblances and differences it throws light on the nature of hæmoglobin. At the same time chlorocruorin has a number of peculiarities. I am at present studying the blood circulation, metabolism, and mode of life of the animals possessing chlorocruorin, with the view of elucidating the functional rôle of this respiratory pigment.

Oct. 2, 1875.—Prof. A. W. CONWAY, F.R.S., professor of mathematical physics, University College, Dublin.

In conjunction with Prof. M'Connell, of Trinity College, Dublin, vol. 2 of Hamilton's "Mathematical

Works" is being prepared. This entails the examination of the immense amount of unpublished MSS. which Hamilton left behind. Hamilton left unpublished many dynamical ideas which are attributed to later writers.

As time permits, I am investigating the connexion between wave mechanics and relativity.

Oct. 2, 1876.—THOMAS SHEPPARD, director of the Hull Municipal Museums, and editor of the *Naturalist.*

Realising the importance of the work of my old friend Dr. C. Davies Sherborn, I began early the thankless task of compiling bibliographies relating to British geology, prehistoric archæology, zoology, and botany. These have been published by the Yorkshire Geological Society, British Association, East Riding Antiquarian Society, and in the *Naturalist.* The north of England bibliographies formerly compiled by Dr. A. Harker have been prepared by me since 1893, and in 1915 was published the bibliography of Yorkshire geology, 1534–1914 (666 pages).

In editing the natural history, geological, antiquarian, and museum publications during the past forty years, I have endeavoured to popularise various aspects of science. Towards this end I have written papers and books on numerous subjects, and am gratified by being told that there are more entries under my name in the Geological Society's card catalogue than under that of any other British geologist, living or dead.

Always interested in forgeries, I have caused trouble in high places by exposing fakes.

More than thirty years ago I was appointed to take over the Museum of the old Hull Literary and Philosophical Society, then typical of its kind, and this educational work has been so much appreciated by my fellow-citizens that we now have separate museums specialising in prehistoric archæology, natural history, commerce and transport, fisheries and shipping, applied art (ancient and modern), a memorial to William Wilberforce, and folk-lore. Three others are in preparation.

Societies and Academies.

LONDON.

Institute of Metals, Sept. 15 (Annual Autumn Meeting, Zurich).—**A. J. Murphy**: The constitution of the alloys of silver and mercury; with an appendix by **G. D. Preston** on the X-ray examination of the system silver-mercury. Progressive additions of mercury to silver cause a continual reduction in the temperature of the initial freezing point down to − 38·8° C., the freezing point of mercury. No alloy in the series has a freezing point lower than that of pure mercury. Silver can retain in solid solution 55 per cent by weight of mercury at 276° C., the amount probably increasing somewhat at lower temperatures.—**A. von Zeerleder**: Influence of variations in heat-treatment and ageing on duralumin. Quenching in hot water or in oil causes less deformation, and if the temperature of the quenching medium, as well as the ageing temperature, be 50° C., there is no disadvantageous influence on the physical properties. Measurements of the electrochemical potential, electrical conductivity, tensile and corrosion properties showed that a temperature of 145° C. (293° F.) had a decidedly disadvantageous influence.—**W. E. Alkins** and **W. Cartwright**: Experiments in wire-drawing. (1) Behaviour of a composite rod. Composite round rods of annealed copper, built up by drawing a number of tubular layers of equal thickness over a central solid core, have been drawn in drafts of varying severity through straight-sided dies of three different angles of taper. Butt ends when drawn through the dies become concave without showing any steps between the layers; the concavity increases with the angle of taper of the die and also with the amount of reduction at the draft. All the layers undergo a proportionate reduction in thickness and therefore the same relative reduction in area of cross-section.—**E. L. Francis** and **F. C. Thompson**: The drawing of non-ferrous wires. The power required to draw wire is directly proportional to the maximum stress of the original material. With tungsten carbide dies, the pull required is practically independent of the speed of drawing over a wide range. A comparison is made between the efficiency of steel, carbide, and diamond dies.—**H. W. Brownsdon** and **E. H. S. van Someren**: Application of the spectrograph to the analysis of non-ferrous metals and alloys. The possibilities and limitations of spectrographic methods are reviewed. Methods for the routine spectrographic examination of brass and some lead alloys are outlined, and tables are given indicating the relationship between impurity or minor constituent concentration and relative line intensities.—**D. M. Smith**: The spectrographic assay of some alloys of lead. The method is based on standards of known composition either synthetically prepared or determined by accurate chemical analysis. One of its great practical advantages is that it is very much more rapid than ordinary chemical assay of these metals. Spark spectra are preferred, as giving more consistent results than arc spectra. By simple direct comparison of spectra the constituents can be determined within the range 0·1-1 per cent, with an accuracy of 10 per cent.—**John L. Haughton** and **Ronald J. M. Payne**: Transformations in the gold-copper alloys, with an appendix on X-ray examination of gold-copper alloys, by **G. D. Preston**. By recording autographically the variation of resistance with changing temperature of alloys of composition ranging between 20 per cent and 70 per cent atomic of gold, and by measurements of the specific resistance of alloys slowly cooled to room temperature, the transformations in alloys with compositions in the neighbourhood of those corresponding with the compounds AuCu and $AuCu_3$ have been confirmed, and the presence of another transformation in alloys approximating to the concentration of compound Au_2Cu_3 has been established.—**N. S. Kurnakow** and **N. W. Ageew**: Physico-chemical study of the gold-copper solid solutions. Both annealed and quenched alloys were studied. The existence of the compounds AuCu and $AuCu_3$ has been confirmed by constructing isothermal diagrams of the electrical resistance, and the limits of the solid solutions have been indicated.—**M. Cook** and **E. C. Larke**: Physical testing of copper and copper-rich alloys in the form of thin strip. Consistent results for tensile strength and elongation are obtainable on all the materials down to and including 0·02 in. thickness. One of the most satisfying methods of measuring hardness is the diamond pyramid static indentation method. Cupping machines, although they may measure some kind of ductility and, if properly correlated, may afford a good sound indication of the behaviour of a material for cupping and drawing operations, are limited in respect of specification.

(*To be continued.*)

PARIS.

Academy of Sciences, August 3.—**A. Lacroix**: The tectites of the Philippines. These correspond closely in appearance and chemical composition with the tectites from Indo-China, Malay, and Borneo, and have probably the same origin as the latter.—**Aimé Cotton**: Polarising prisms with normal field based on internal crystalline reflection.—**Charles Achard, Augustin Boutaric, and Maurice Doladilhe**: The physical properties of the blood serum and of the proteins separated from this serum by the acetone method in man and in some animals in the normal state. The experiments detailed show that colloidal suspensions made up from the proteins separated from a serum and a volume of water equal to the original volume of a serum possess a viscosity and an optical density practically identical with those given by the original serum. Hence the properties of the proteins separated by the acetone method appear to remain unaltered.—**Gabriel Bertrand and P. de Berredo Carneiro**: The active principle of guarana. The presence of a new alkaloid in guarana (Schar, Thoms, Nierenstein), not caffeine, is definitely negatived by the author's work. He found 4·8 per cent of caffeine, and careful examination of this failed to show the presence of any other alkaloid.—**André Blondel**: Some new forms of the method of recording and observing the angular deviations of internal combustion engines. A neon lamp is substituted for the spark or arc lamp used in earlier methods.—**A. Bigot and J. Dubois**: The presence of the Ordovician in the Moroccan Anti-Atlas. This is proved by the discovery of an *Acidaspis Buchi* in an exceptional state of preservation near the base of the schists and quartzites of Djebel Tachilla.—**G. Pfeiffer**: The reciprocal relation between two systems of linear equations in involution.—**Jean Placinteanu**: The true vibration of ionised gases.—**J. Cabannes and E. Canals**: The Raman effect in a crystal of sodium nitrate.—**René Audubert and Jean Roulleau**: The rôle of the phenomena of photoconductance in the photovoltaic effect. The results of experiments described show that the phenomenon of photoconductance cannot be considered as the essential factor of the photoelectric effects: if it intervenes, it should be considered as a secondary phenomenon.—**G. Darzens and André Lévy**: The direct bromination of metacresol. The exact conditions for the direct bromination of metacresol to monobromocresol are given: the compound was proved to contain the bromine atom in the para position to the hydroxy group.—**P. Vayssière**: Some observations on the migratory acridians.—**Louis Bounoure**: The Golgian nature of a characteristic cytoplasmic element of the germ in the first stages of the development of the frog.—**A. Paillot**: Parasitism and symbiosis in the aphides.—**E. Landauer**: Study of a medium for cultivating the spirochæte of fowls.—**G. Delamare and C. Gatti**: Some characters of *T. rigidum*.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 6, June 15).—**E. M. East**: Immunity to sugar cane mosaic acquired by the host. Sugar cane infected with mosaic can throw off all pathological symptoms and remain apparently healthy for a time. It is not known whether reappearance of mosaic is due to re-infection or whether the mosaic virus is merely reduced in virulence. Strains subject to mosaic, though apparently healthy, give the same precipitin test as those definitely infected with mosaic, whereas strains never known to have mosaic react differently.—**D. C. Cooper and R. A. Brink**: Cytological evidence for segmental interchange between non-homologous chromosomes in maize.—**Andrew Watson Sellards**: The behaviour of the virus of yellow fever in monkeys and mice. Yellow fever virus maintained by passage from brain to brain of mice loses its virulence for monkeys by ordinary routes of injection. Intraperitoneal injection of such virus immunises monkeys against typical yellow fever virus; similar inoculation of man may sometimes be justifiable.—**Frederick D. Rossini**: The heat of combustion of methyl alcohol. A stream of air was saturated with the vapour and burnt at constant pressure in an oxygen atmosphere. An electrical method was used to determine the thermal effect (NATURE, 127, 506, March 28, 1931). The heat of reaction found was 173·63 ± 0·05 kgm.-cal. per mole at 15°.—**Eric G. Ball and W. Mansfield Clark**: A potentiometric study of epinephrine.—**William Hovgaard**: The distribution of stresses in welded and riveted connexions. Theoretical investigations suggest that when a girder of limited length is attached to a major structure subject to tension or compression parallel to the girder, there is marked concentration of shearing stresses at the ends of the girder, and their intensity is much greater than ordinarily supposed. Experimental evidence of the effect is given. This has important consequences in ship design and may account for fracture of deck plating at corners of deckhouses, hatches, etc.—**Harry Grundfest**: The relative effectiveness of spectral radiation for the vision of the sun-fish, *Lepomis*. The fish is placed in a cylindrical glass tank surrounded by a cylindrical screen of equal and alternate vertical bars and spaces. The tank is placed on a glass-topped table and illuminated from below. Light is reflected through the screen round the tank from the inside of a hollow truncate 45° cone. Rotation of the screen causes movement of the fish, which is usually motionless. The least amount of illumination (spectral energy) causing movement is determined for various regions of the spectrum; the wave-length of maximum efficiency is 535–545mμ, corresponding well with the maximum of the visual purple absorption (540mμ). This indicates that visual purple is the photosensitive agent for dim vision. Substituting a fine wire mesh for the screen, measurements were made at bright illuminations. The maximum efficiency is then at 640mμ. This suggests that in fishes, as in man, there are two visual mechanisms, for dim and bright illuminations respectively.—**J. F. Ritt**: Systems of algebraic differential equations.—**Gordon Pall**: The number of representations function for positive binary quadratic forms.—**Edward Kasner**: Dynamical trajectories and the ∞^3 plane sections of a surface.—**Einar Hille and J. D. Tamarkin**: On the summability of Fourier series (4).—**W. T. MacCreadie**: On the stability of the motion of a viscous fluid.—**A. Adrian Albert**: Normal division algebras of order 2^{2m}.—**Edwin H. Hall**: Electric conductivity and optical absorption in metals, once more. A discussion of the results obtained by Meier and by Hagen and Rubens on the basis of the dual theory of conduction.—**W. W. Coblentz, R. Stair, and J. M. Hogue**: The spectral erythemic reaction of the human skin to ultra-violet radiation. Isolated spectral lines from a large quartz monochromator were used, and the time of exposure to produce a minimum perceptible erythema on the authors was determined. The wave-length range of the erythemogenic rays begins about 315mμ; the response wave rises abruptly to a maximum at 297mμ, descends less abruptly to a minimum at about 280mμ, and rises to a less intense maximum at about 250mμ. The erythema produced by the shorter wave-lengths is very transitory. The response curve is practically the same for different persons.

Official Publications Received.

BRITISH.

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 1, No. 2: A Contribution to the Molluscan Flora of the Laki and Basal Khirthar Groups of the Indian Eocene. By L. R. Cox. Pp. 25-92+4 plates (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 10*s*

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1930. Pp. 35 + 3 plates. (Kingston: Government Printing Office.)

India: Meteorological Department. Scientific Notes, Vol. 3, No. 22: The Structure and Movement of a Storm in the Bay of Bengal during the period 13th to 19th November 1928. By Dr. K. R. Ramanathan. Pp. ii+29-33+9 plates. 2 4 rupees; 4*s*. 3*d*. Scientific Notes, Vol 3, No. 23: Historical Note on the Catch of Raingauges. By H. R Puri. Pp. ii+37-59+6 plates. 1 rupee; 1*s*. 9*d*. (Calcutta: Government of India Central Publication Branch.)

Board of Education. Educational Pamphlets No. 85 (Industry Series No. 10): Report by H.M. Inspectors on the Provision of Instruction in Applied Chemistry in Technical Schools and Colleges in England and Wales. Pp. 55. (London: H.M. Stationery Office.) 1*s*. net

Rothamsted Experimental Station: Lawes Agricultural Trust. Report for 1930. Pp 172. (Harpenden.) 2*s* 6*d*.

Imperial Agricultural Research Conference, 1927. Abstracts of Papers on Agricultural Research in the United Kingdom, published during the Year October 1929 to September 1930. Pp. 166. (London: H M. Stationery Office.) 1*s*.

Union of South Africa: Department of Public Health. Report on Investigation into Malaria in the Union of South Africa, 1930-31. By Prof. N. H Swellengrebel. Pp. 45. (Pretoria: Government Printer.)

Proceedings of the Royal Irish Academy. Vol. 40, Section B, No. 4: A Tentative Reconstruction of the Successive Margins of the Quaternary Ice-Sheets in the Region of the North Sea. By Prof. J. Kaye Charlesworth. Pp 67-83. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

The National Physical Laboratory. Report on the Physics Department for the Year 1930. Pp. 62-99. (London: H.M. Stationery Office.) 2*s*. net.

The Cordwainers Technical College (Incorporated). Prospectus of Classes in Boot and Shoe Manufacture and Making, and Leather Goods Manufacture. Day and Evening Classes, Session 1931-32. Pp 43 (London.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1379 (Ae. 504—T 3010): Biplane Fins on a Model of R.101. By Dr. R Jones and A. H. Bell. Pp. 13+3 plates. 9*d* net. No. 1391 (Ae. 512—S 73): Measurements of Lift and Drag of Southampton Seaplane. By A. S Crouch Pp. 8+3 plates. 6*d* net. (London: H.M. Stationery Office.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 7, July. Abstracts Nos. 1141-1338. Pp. 223-258. (London: H M. Stationery Office.) 9*d*. net.

Apia Observatory, Apia, Western Samoa. Report for 1928 and 1929. Pp. 176. (Wellington, N.Z.: W. A. G. Skinner.)

FOREIGN.

Bureau of Entomology. Report of the Entomologist Pp. 34. (Washington, D.C: Government Printing Office.)

World Social Economic Congress, under the Auspices of the International Industrial Relations Association. Principles and Practicability of Economic Planning. Section 1: Principles and Practice of Scientific Management. By Dr. H. S. Person. Pp. 64. Section 2: Europaische Aspekte der Rationalisierungsbewegung-Bedeutung des Scientific Management fur die Sozialökonomische Planung. Von Hugo von Haan. Pp. 37. Section 3: The Problem of Economic Planning. By Dr. Lewis L. Lorwin. Pp. 43. (The Hague: International Industrial Relations Association.)

Cornell University Agricultural Experiment Station. Bulletin 519: Studies of the Genus Delphinium. By Earle I. Wilde. Pp. 107. Bulletin 520: Fertilizer Tests of several Soil Types. By T L. Lyon. Pp. 19. Bulletin 521: Cultivation Experiments with certain Vegetable Crops on Long Island. By H. C. Thompson, P. H. Wessels and H. S. Mills. Pp. 14. Bulletin 523: The Sociology of a Village and the Surrounding Territory. By Bruce L. Melvin. Pp 138. Bulletin 525: A Survey of some Public Produce Markets in Up-State New York. By F. P. Weaver. Pp. 149. (Ithaca, N.Y.)

Bernice P. Bishop Museum. Bulletin 76: Social Organization of Manua. By Margaret Mead. Pp. iv+218 Bulletin 79: History and Culture in the Society Islands. By E. S. Craighill Handy. Pp. iii+110+6 plates. Bulletin 80: Archaeolgy of Kauii. By Wendell Clark Bennett. Pp iv+156+15 plates. Bulletin 81: Vascular Plants of the Leeward Islands, Hawaii. By Erling Christophersen and Edward L. Caum. (Tanager Expedition, Publication No. 7.) Pp. 41+16 plates. Bulletin 82: Report of the Director for 1930. By Herbert E. Gregory. Pp 36. Occasional Papers, Vol. 9, No. 12: Notes on Joinvillea. By Erling Christophersen. Pp. 7. Occasional Papers, Vol. 9, No. 13: Vascular Plants of Johnston and Wake Islands. By Erling Christophersen. (Tanager Expedition, Publication No 6) Pp. 20. (Honolulu.)

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 50: Fourteenth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1929-1930. Pp. 26. 10 cents. Bulletin No. 49: Public and Semi-Public Lands of Connecticut. By Philip Laurance Buttrick. Pp. 151. 1 dollar. (Hartford, Conn.)

Division of Fish and Game of California: Bureau of Commercial Fisheries. Fish Bulletin No. 28: Handbook of Common Commercial and Game Fishes of California By Lionel A. Walford. Pp. iii+183 Fish Bulletin No. 29: The Striped Bass of California (*Roccus lineatus*). By Eugene C. Scofield. Pp. 84. Fish Bulletin No. 30: The Commercial Fish Catch of California for the Year 1929. By the Staff of the Bureau of Commercial Fisheries. Pp 135 Fish Bulletin No. 31: Studies of the Length Frequencies of the California Sardine (*Sardina caerulea*). By the California State Fisheries Laboratory. Pp. 55. (Sacramento: Calif. State Printing Office.)

Proceedings of the American Philosophical Society. Vol. 70, No. 3. Pp. 215-316. (Philadelphia.)

The Science Reports of the Tohoku Imperial University, Sendai, Japan. Second Series (Geology), Vol 14, No 2A. Pp. 97-183+plates 29-39 (Tokyo and Sendai: Maruzen Co., Ltd.)

CATALOGUES.

'Caprokol' Brand of Hexylresorcinol, the Urinary Antiseptic for Oral Administration. Pp 8. Acriflavine "B D." Pp. 8. (London: The British Drug Houses, Ltd.)

Books on all Technical and Applied Science. Pp. 104. (London: W. and G. Foyle, Ltd.)

Diary of Societies.

FRIDAY, SEPTEMBER 25.

INSTITUTE OF BREWING (at Queen's Hotel, Birmingham)—Dr. F Windisch: New Results Concerning the Metabolism of Yeasts in their Relation to the Fermentation of Wort and Beer.

THURSDAY, OCTOBER 1.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—W. A. Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

FRIDAY, OCTOBER 2.

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society), at 6.—N. E. Rambush and F. F Rixon: The Gas Generator as a Direct Producer of Metallurgical Products.

SATURDAY, OCTOBER 3.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square. W.C.1), at 3—Dr P. Flemming: Harley Street, Historical and Topographical Notes (Lecture).

CENTENARY.

OCTOBER 1 AND 2.

JAMES CLERK MAXWELL CENTENARY CELEBRATION (at Cambridge).

Thursday, Oct. 1.—Sir J. J. Thomson: Memorial Lecture.

Friday, Oct. 2 (*morning*).—Addresses by Prof. Max Planck, Sir Joseph Larmor, and Prof. Niels Bohr.

(*Afternoon*).—Addresses by Dr. William Garnett, Sir Ambrose Fleming, and Sir Oliver Lodge.

CONGRESSES.

SEPTEMBER 20 TO 27.

INSTITUT INTERNATIONAL D'ANTHROPOLOGIE (at Paris).

SEPTEMBER 23 TO 25.

INSTITUTION OF MINING ENGINEERS (at Manchester).

SEPTEMBER 23 TO 30.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (Centenary Meeting). (For Programme see NATURE, Sept. 19.)

SEPTEMBER 24 TO 27.

SWISS SOCIETY OF NATURAL SCIENCES (at La Chaux-de-Fonds and Le Locle).

SEPTEMBER 29 TO OCTOBER 2.

IRON AND STEEL INSTITUTE (at Royal Metal Exchange, Swansea)

Tuesday, Sept. 29.—Prof. C. A. Edwards and A. Preece. The Constitution of the Iron-Tin Alloys.

C. O. Bannister and W. D. Jones: The Diffusion of Tin into Iron with special reference to the Formation of Columnar Crystals

G. Burns: The Effect of Molybdenum on Medium-Carbon Steels containing 1 to 2 5 per cent of Manganese

R. Harrison: The Influence of Silicon on Nickel Steel.

Wednesday, Sept. 30.—J. C. Jones: Mottled Tinplates.

The Equilibrium of Certain Non-Metallic Systems. Part I. By J. H. Andrew, W. R. Maddocks, and D. Howat Part II By J. H. Andrew, W. R. Maddocks, and E. A. Fowler.

F. Adcock: Alloys of Iron Research. Part X. The Chromium-Iron Constitutional Diagram

G. A. Hankins and M. L. Becker: The Effect of Surface Conditions Produced by Heat Treatment on the Fatigue Resistance of Spring Steels.

B Matuschka: The Solidification and Crystallisation of Steel Ingots: The Influence of the Casting Temperature and the Undercooling Capacity of the Steel.

Thursday, Oct. 1—O. Cromberg: Production Economy in Iron and Steel Works. Part II. Costs of Production.

W. H. Cunningham and J. S. Ashbury: The Surface Hardening by Nitrogen of Special Aluminium-Chromium-Molybdenum Steels on a Production Basis.

N. T. Belaiew: The Structure of Nodular Troostite.

Prof. F. C. Thompson and R. Willows: A Critical Study of the Origin of the Banded Structure of a Hot-Worked Hypo-Eutectoid Steel.

OCTOBER 5 TO 10.

CONGRESS ON TUBERCULOSIS (at Davos).—*Principal Subjects for Discussion*:—Development and Course of Tuberculosis of the Lungs; Extra-Pulmonary Tuberculosis; Collapse Therapy.

NATURE

SATURDAY, OCTOBER 3, 1931.

CONTENTS.

PAGE
Racial Prejudice 557
Symbiosis 558
Plants and Geology. By D. H. S. 559
Science at a New Angle. By J. C. H. . . . 562
Short Reviews 562
Faraday Centenary Exhibition 564
Power. By Sir Alfred Ewing, K.C.B., F.R.S. . . 567
The British Association Centenary 572
Obituary:
  Prof. A. S. Pringle-Pattison. By Prof. J. H. Muirhead 575
News and Views 576
Letters to the Editor:
  Isolated Quantised Magnetic Poles.—Prof. O. W. Richardson, F.R.S. 582
  Similarity between Cosmic Rays and Gamma Rays.—Prof. R. A. Millikan and Dr. I. S. Bowen 582
  Graphical Indication of Humidity in the Upper Air.—Dr. C. W. B. Normand 583
  Activated Adsorption.—Prof. W. E. Garner . 583
  Change of Dielectric Polarisation of Nitrobenzene with Temperature.—Prof. M. Wolfke and Dr. J. Mazur 584
  Charged Aerosols and Ball Lightning.—William C. Reynolds 584
  Resonance Spectrum of Hydrogen.—Dr. K. R. Rao and J. S. Badami 585
  Contraction Constants of Enzyme-Substrate Re-actions.—M. Sreenivasaya and H. B. Sreerangachar 585
  The Treatment of 'Gapes' in Chickens.—Dr. W. R. G. Atkins, O.B.E., F.R.S. . . . 585
  A Spark Method of Measuring High Resistance.—J. A. C. Teegan 585
Research Items 586
Astronomical Topics 587
The International Illumination Congress . . . 588
Photographic Analysis of Explosion Flames . . 589
The Construction of Man's Family Tree . . . 590
A Retrospect of Wireless Communication . . . 591
Beyond the Milky Way 592
Birthdays and Research Centres 594
Societies and Academies 594
Official Publications Received 595
Diary of Societies 596

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Racial Prejudice.

PROF. FRANZ BOAS showed his usual courage in taking "Race and Progress" as the subject of his presidential address to the American Association for the Advancement of Science, at Pasadena on June 15 last. He essayed once more to raise the complex question of the intermingling of racial types from the slough of political controversy into which it has fallen in the United States and to discuss it dispassionately in the 'dry light' of scientific evidence.

Unfortunately, in this matter, science, or perhaps it would be more correct to say those who seek to interpret scientific data and apply their interpretations to practical affairs, speak with no united voice. Prof. Boas, looking on Europe with a cosmopolitan eye, views it as a whole, a congeries of peoples, each of no single fixed and determinate type, or able to lay claim to be regarded as a pure race—racial types, in fact, being largely ideal. Thus, he pointed out, it would be "a rash undertaking to determine the locality in which a person is born solely from the bodily characteristics". In the populations of the various parts of Europe many individuals might as well belong to one part of the continent as another. Yet, he goes on to argue, while it is not necessary to consider the great difference in type that occurs in a population as due to mixture of different types, it is easy to see that intermingling has played an important part in the history of modern populations. Further, there is no evidence that mating between individuals of different descent or different type results in progeny less vigorous than that of their ancestors. After dealing with the effects of heredity, environment, and selection upon bodily form, Prof. Boas surveyed the data of physiology and psychology from the racial aspects, and arrived at the final conclusion that the biological difference between races is small and that it is the social setting with which we have to reckon. Race antagonism is thus resolved into a matter of social group consciousness.

In this conclusion, Prof. Boas inevitably challenges comparison with the view taken by Sir Arthur Keith in his recent rectorial address in the University of Aberdeen. Sir Arthur, naturally preoccupied with the political and economic situation as it is in Europe to-day, and looking upon it as a phase in a long course of an evolutionary process, gives the fullest weight to the survival value of the concept of race. While he would agree with Prof. Boas that 'racial type' in its complete implication is an ideal rather than an observed fact, he views ‘ racial prejudice ’ as a potent factor of progress in human affairs. Prof. Boas does not ignore the opposition in their respective views. Not only does he explicitly disagree with Sir Arthur in his view of the beneficial effect of war, but he also traverses his dictum that “ race antipathy and race prejudice Nature has implanted in you for her own end—the improvement of mankind through racial differentiation ”. Of this Prof. Boas says, “ I challenge him to prove that racial antipathy is ‘ implanted by Nature ’ and not the effect of social causes which are active in every closed group ”.

In reality, Prof. Boas is by no means so far removed from Sir Arthur Keith’s position as he would have us believe. In the practical problem Prof. Boas has specially in view, racial and social group tend to coincide. In Europe the lines of demarcation are geographical. In the United States the conflict is internal ; the races are not segregated within national boundaries as they are, broadly speaking, in Europe. Sir Arthur Keith has expressed the view that every nation is a potential race. Hence the conflict that presents itself to Prof. Boas as calling for the consideration of anthropological science is both simpler and yet in some ways more difficult of solution than it is in Europe. He points out that the difference between racial groups is an important element in establishing racial grouping and in creating conflicts—there are no ethnic groups in Europe so widely diverse as negro and white ; but the actual relation is identical whether the grouping be racial, national, or denominational. The group is idealised and there is an emotional desire for its perpetuation. This leads to group endogamy in the desire to keep the race or group pure.

Here it will be seen that Prof. Boas is virtually in agreement with Sir Arthur Keith, in so far as the latter would not exclude social factors from the influences which mould the potential race. This would seem to be the line upon which the negro problem is at present developing in the United States. However, regarding the situation as it stands, Prof. Boas’ conclusion is that while society is stratified in social groups which are racial in character, there will be racial discrimination ; but that wherever members of different races form a single social group with strong bonds, racial prejudice and racial antagonism will lose their importance and eventually disappear. Applying the terms of a general conclusion to a particular instance, Prof. Boas’ address virtually sets out the argument for the case that so long as the United States insists upon a social stratification in racial layers, the penalty must be paid in the form of a racial struggle.

In effect, then, Prof. Boas interprets the evidence of anthropological science as favouring the ‘ melting pot ’ view of population problems—that is, racial fusion, as against the conception of a dominant superior racial type, the theory which at present holds the political field. Although he might not admit it, on his view the United States might well qualify to be regarded as at a stage in Sir Arthur Keith’s evolutionary process on its way to becoming a ‘ potential race ’.

Symbiosis.

Tier und Pflanze in Symbiose. Von Paul Buchner. Zweite vollig umgearbeitete und erweiterte Auflage von “ Tier und Pflanze in intrazellularer Symbiose ”. Pp. xx + 900. (Berlin : Gebrüder Borntraeger, 1930.) 96 gold marks.

THE growth of knowledge in this subject since the first edition of this work in 1921 is reflected in the present edition of 900 pages as compared with its predecessor’s 462 pages. In an introduction of 18 pages the main branches of the subject are briefly surveyed. The oldest of these dates from the fifties of last century, when attention was directed by several observers to the presence of chlorophyll in infusoria, *Hydra*, Turbellaria, and the fresh-water sponge (*Spongilla*) ; but the green colour was regarded by some authorities as due to a special kind of ‘ animal chlorophyll ’ or to the minute plants taken into the respective animals from without and living as parasites or serving as food. When Hamann (1882) showed that the green bodies in the egg of *Chlorohydra* do not arise there but wander in from the parent, he established the transmission of symbionts, and further work demonstrated that the green bodies are complete cells. Other investigations showed that the yellow cells in the Radiolaria issue after the death of the animal and a flagellate stage ensues.

In a section of about 180 pages the author considers the cases in which symbiotic Algæ are concerned, beginning with the Protozoa and working systematically through the phyla up to the Tunicata. For each group of animals the history of our knowledge of the symbiosis is briefly surveyed, and the position occupied by the symbiont, the mode and course of infection of the animal and the resultant effects are described. In his comment on the published observations upon the relations between Algæ and corals, the author states

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his belief that the amount of animal food taken by corals has been generally underestimated, and this is substantiated by the recent observations of Dr. C. M. Yonge on the feeding of corals on the Great Barrier Reef. A particularly interesting part of the volume is that on the artificial suppression and on the artificial establishment of symbiosis of Algæ with Protozoa, *Hydra*, and *Convoluta*, with a discussion of the factors necessary for these partnerships.

The first observations on the symbiotic relations of fungi with animals were those upon the culture, by ants and by termites, of fungi as food. Modern work on intracellular symbionts of fungal nature dates from 1910, when Pierantoni and Šulc independently explained the true significance of the so-called pseudovitellus of Homoptera—up to that time regarded as a food reserve, but then shown to be a complicated structure, termed the mycetome, harbouring the symbionts. All Homoptera that have been investigated have been found to live in more or less complex symbiosis. Some have two, three, or even four different sorts of symbionts. Following the discovery of symbionts in insects which feed on plant juices came that of symbionts in blood-sucking animals—tsetse flies, lice, ticks, mites, leeches, and more recently in bed bugs and the Pupipara—which the author suggests may prove to be of medical interest as some of the symbionts perhaps belong to the Rickettsias.

The author gives a number of interesting recent observations on insects which feed on wood or on a diet rich in cellulose, and carry yeasts, bacteria, and other organisms, the systematic position of which remains uncertain; for example, in the mature female of the cerambycid beetles tubular intersegmental glands associated with the vagina are organs filled with the symbionts, clusters of which are expelled as the eggs are being laid and can be demonstrated on the outer surface of the eggs.

In a chapter of 90 pages are brought together the observations on bacterial symbionts concerned in the production of light in animals, especially by the luminous organs of *Pyrosoma*, of fishes and of cephalopods, and by the 'accessory nidamental glands' of certain cephalopods.

The author traces the steps in the modes of transmission of symbionts, beginning with insects in which the organisms are present in the rectum, from which they are readily passed out as eggs are laid. In other cases anal folds or sacs, or vaginal and intersegmental sacs filled with bacteria, are responsible for infection of the eggs, while in *Glossina* and the Pupipara the symbionts are transmitted to the larva by the uterine 'milk glands'.

In discussing the part played by symbionts in development, the author points out that in many cases the presence of these organisms causes little or no modification; but in the viviparous aphids the abundant flow of symbionts into the developing embryo brings about far-reaching modifications.

While the work of Cleveland and others has elucidated the part played by the Protozoa in the intestine of termites, there appears to be no definite conclusion as to whether the numerous ciliates in the stomach of ruminants—in 1 c.c. of the contents of the rumen of the sheep nearly a million ciliates were found—or in the cæcum of the horse are helpful to the host.

The volume concludes with a list of works on the subject occupying 47 pages, an index of authors referred to, and an index of the genera of animals and plants considered in the text.

Dr. Buchner, who is to be warmly congratulated on his thorough treatment of the subject, has produced a volume of great interest. With justifiable pride he states that what he describes he has in large part seen himself, and that considerable portions of the subject have been investigated either by him or with the help of his pupils, to a score of whom he expresses his thanks. The 336 illustrations are beautifully reproduced and many of them are original. A statement of the magnification and, in a number of cases, additional lettering of the parts, would have made the drawings of still greater value.

Plants and Geology.

Plant Life through the Ages: a Geological and Botanical Retrospect. By Prof. A. C. Seward. Pp. xxi + 601. (Cambridge: At the University Press, 1931.) 30*s*. net.

IN this book, Prof. Seward fulfils his promise to supplement his four volumes on fossil plants by a general review of the floras of the past, more intelligible to the general reader than the text-book. The result is an admirable treatise, which perhaps no one but Prof. Seward could have written, bringing the records of fossil plants into constant relation with the geological changes in their environment. As he says: "It is one thing to study the fossils by themselves; it is another and a more attractive thing to think of them as living plants in a real world".

The book is abundantly illustrated by pictures, maps, and tables of distribution. A striking and novel feature is introduced in the ten reconstructions of ancient landscapes, drawn for the author by a skilled artist, Mr. Edward Vulliamy. These views, at once accurate and picturesque, are probably the best restorations of past floras hitherto attempted. As in some of the author's earlier writings, every chapter is preceded by an appropriate motto, sometimes rather cynical, as in that of the chapter on classification of plants, "We do but learn to-day what our better advanced judgments will unteach to-morrow" (Sir Thomas Browne); sometimes poetic, as in the quotation from Isaiah, introducing the barren Triassic period: "And the desert shall rejoice, and blossom as the rose".

The first four chapters are purely geological, setting the stage, as it were, for the mysterious drama of plant evolution. The discussion of Wegener's famous hypothesis of shifting continents shows that no decision is possible, though the palæobotanist may be inclined to favour a supposition which would help him out of some of his difficulties.

Referring to the petrified remains with structure preserved, the author says: "We see in the architecture of stem and leaf the same accuracy of correlation between structure and function as in plants of the present day" (p. 48)—an important and true conclusion, which has not always been recognised.

In considering the Cambrian, Ordovician, and Silurian records, the author points out that the almost exclusively marine strata of these periods lead us to exaggerate the suddenness of the creation of a land-flora when we reach the continental Devonian sediments. "Land-plants may well have existed long before, but their remains had no fair chance of preservation" (p. 101). Speaking of the early Devonian land-flora he says: "The probability is that some of the older Devonian plants are examples of transformed Algæ; others . . . are more likely to be descendants of simpler ancestors which had long been accustomed to live above the sea" (p. 112). In connexion with this subject, one of the very rare slips in description must be mentioned. In describing Lang's very early *Dadoxylon Hendriksi*, from Cornwall, it is stated that the secondary tracheids are pitted on all the walls, not, as in recent Gymnosperms, on the radial walls only. This is true of *Palæopitys Milleri* but not of the Cornish plant, which Lang has shown to be a true *Dadoxylon*, with the typical Araucarian structure.

Going on to the much richer and more advanced Upper Devonian flora, we are at once confronted with difficulties of distribution. The existence of a luxuriant vegetation so far north as lat. 77° N. is one of the many unsolved problems of geological history.

The earlier Carboniferous vegetation was comparatively uniform all over the world, as shown by the occurrence of practically identical forms of *Lepidodendron* in Australia, Spitsbergen, Europe, and North America. The subject of the abundant later Carboniferous vegetation is introduced by the excellent reconstruction of a Coal Age landscape. The author warns us against supposing that the giant Calamites and Lepidodendra of the Coal-forests were the ancestors of our modest horsetails and clubmosses. The latter groups probably owe their origin to such extinct forms as *Equisetites* and *Selaginellites*, which were always comparatively small plants.

Attention is directed to the important work of Prof. Halle on the Permo-Carboniferous flora of northern China. It is interesting to find that this flora presents more points of contact with Mesozoic vegetation than that of more western lands. Coming to the close of the Carboniferous period, the somewhat meagre *Glossopteris* flora of Gondwanaland is contrasted with the rich contemporary vegetation of the north; the latter is compared to the Dismal Swamp forest of Virginia, the former to the arctic vegetation of Greenland or Alaska. This comparison, though admittedly an exaggeration, brings out the relation of the *Glossopteris* flora to the extensive southern glaciation at that period. "A Scene in Gondwanaland" is pictured.

The chapter on the Triassic period is of special interest as it covers the transition from the Palæozoic to the Mesozoic vegetation, in some respects the most striking transformation in the history of the world's flora. While the earlier phases of the Triassic period were characterised by almost world-wide desert conditions, the abundant remains of plants in some Upper Triassic deposits indicate a renewed spread of forests. It is then that we discover the magnitude of the change in the facies of the vegetation since Palæozoic times. In the southern hemisphere, however, the two eras shade more gradually into one another.

The late Triassic and Rhætic floras show a rich vegetation, even comparable in some districts with the luxuriant forests of the Coal Age. The author inclines to the view that some Carboniferous types still persisted, regarding such genera as *Thinnfeldia* as probably Pteridosperms rather than true ferns. In coming to this conclusion, Prof. Seward is probably relying on work by Dr. Hamshaw Thomas not yet fully published. In Rhætic times the highly organised Cycadophytes, typical of the

Mesozoic age, first appear, while the maidenhair trees already occupied a strong position. "Before the end of the Triassic period the vegetation had put on a new dress, the dominant genera were of a much more modern type, and most of them bore no obvious marks of direct relationship to the trees in the Palæozoic forests" (p. 331).

In the succeeding Jurassic period, Mesozoic vegetation is seen in its most typical phase; fully developed, and not yet appreciably modernised. It was a period of stability, free from the violent movements of the earth's crust which disturbed the world both before and after. Though the Jurassic vegetation was not absolutely uniform throughout the world, it appears "less diversified and less affected by geographical position than that of any other stage in geological history" (p. 342).

Speaking of the great class of the Cycadophytes, the most characteristic plants of the era, the author rightly emphasises the total dissimilarity of Mesozoic and modern types of Cycads, as regards their fructification. He scarcely refers, however, to the evidence, scanty it is true, for the presence of a few Mesozoic Cycads of the recent family. Ferns, maidenhair trees, and conifers were other prominent groups at that period. The author suspects that even in the Jurassic some survivors of the old race of the seed-ferns still persisted.

Dr. Hamshaw Thomas's striking discovery of *de facto* Angiosperms (*Caytoniales*) is recorded. A critical discussion is postponed to the concluding chapter. The author seems scarcely to do justice to the hypothesis maintained by Wieland himself, and ably supported by Arber and Parkin, of an affinity between the Mesozoic Cycadophytes and the Angiosperms.

The Cretaceous period witnessed a profound change. While the Wealden, the oldest formation referred to this period, had an old-world flora, persisting from the Jurassic, "the late Cretaceous Floras are essentially modern, the flowering plants had already assumed the dominant position which they still hold" (p. 382). In Greenland, however, the oldest Cretaceous flora contains very modern-looking flowering plants (for example, magnolias, plane-trees, and bread-fruits) side by side with Cycadophytes, maidenhair trees and ferns still of a Jurassic type. Such facts have led to the hypothesis that Angiospermous vegetation came from the north. It is remarkable that the earliest Angiosperms, if rightly determined, belonged to well-characterised families, still flourishing in our own time.

Throughout the Tertiary period the dominant plants were Angiosperms, much as they are now. The author considers that "palæobotanical evidence supports the view that herbaceous flowering plants as a class are the more recent product of evolution", trees being older (p. 429).

The older Tertiary floras of North America and Europe point to the conclusion that from the beginning up to the early Pliocene, the climate was warmer than at present. This, however, does not apply to more eastern regions, where the fossils indicate a temperate, or even somewhat cold, climate in Tertiary times. The succeeding Ice Age destroyed most of our vegetation, and it has never quite recovered, though gardeners now endeavour to restore a few of the innumerable treasures then lost (p. 463).

There is a chapter on the Quaternary period, but this division of time is admittedly artificial—it is really the Tertiary continued. The occurrence of the great Ice Age is its only justification. Prof. Seward finds evidence that the destruction at that terrible time was not quite complete—a few species survived the cold.

The final chapter is devoted partly to questions of evolution, partly to the evidence for past climates. "Through the whole course of geological history . . . cyclic disturbances of the earth's crust were powerful factors in directing the course of evolution in the organic world" (p. 518). To such causes is due, for example, "the difficulty of discovering connecting links in the chains joining the Palæozoic to the Mesozoic world".

The evolution of the Angiosperms is left, as it must be, "an unsolved problem". Of Dr. Thomas's *Caytoniales* the author says: "They may be representatives of a branch from some ancestral stock from which was evolved, possibly at a later date, the whole Angiosperm alliance" (p. 521). He inclines to the view that possibly the Pteridosperms and the Angiosperms may be on the same line of evolution, an interesting hypothesis which may well be fruitful in leading to further research. "Evolution", he says, "has not been a simple progression; it has been a process of trial and error, a series of experiments" (p. 529).

The subject of the climates of the past is one long associated with the name of the author. The difficulties are serious and proportionate caution is shown. Yet the changes in distribution are so great and obvious that the palæobotanist is almost compelled to take refuge in Wegener's theory of continental drift.

The book concludes with an impressive passage on the æsthetic charm of the contemplation of the plant world, past and present. "The more we know the more conscious we become of the little we really know: the passion for the search grows as we read the story of creation" (p. 544).

D. H. S.

Science at a New Angle.

Novius Organum: Essays in a New Metaphysic. By James Clark McKerrow. Pp. ix + 277. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 9*s*. net.

Mr. McKerrow says that his book exhibits "a heterodox metaphysic in relation to some scientific problems". In other words, he tries to see some old problems from a new point of view—one which is primarily scientific. But he differs from a good many students, in that he knows what to expect from science, and what not to expect. He perhaps under-rates his own acquaintance with scientific theory, in speaking of his knowledge as "very limited, second-hand and 'popular'". At any rate, the present volume is evidence that the author is able to handle difficult problems with an adroitness which argues grasp and originality.

One of Mr. McKerrow's objects is to solve the ancient dualism which regards necessity as being the law of inanimate Nature, whereas man is a law unto himself. He uses the conception of 'habit' to achieve this. "The appearance of necessity is either due to the relative fixity of habit, or is a statistical effect, or is due to the organisation of a system." An organism is "a system of habitual activity". The living creature is not something animated by habit; the habit *is* the organism, and the organism *is* the habit. Its essence is not substance but activity. Yet the biologist or physiologist, in his zeal for the study of structure, thinks in terms of "cross-sections of duration" and of events determined by conditions. According to the author, this is to think in terms of fictions.

Mr. McKerrow admits (p. 53) that his point of view often involves the profession not so much of beliefs as of various unbeliefs. He believes in 'activity' and 'habit', but not in 'cause', or in 'mind' (though he is not a behaviourist), or in 'events'. Even time is a useful and necessary fiction—"We do not live in time, we simply live and invent time to be lived through". Fictions are only dangerous, however, when they are taken seriously, and when the attempt is made to explain them in terms of fact—as when we seek physiological explanations of 'mind'. Similarly, "there is no explanation of 'mass', because it is a fiction invented to explain the behaviour of material bodies". As a matter of fact, the 'being' of a massive body is to move. "It enters into spatial relations, becomes aware, as it were, of being somewhere and naturally prefers anywhere else." The trouble with scientific explanations is that they mingle fact and fiction. "With diffidence we venture to suggest that the scientific superiority of Einstein's view over Newton's is due to the fact that it is more completely divorced from reality, Newton's time being comparatively real, the harmless, superfluous fiction, duration—and Einstein's a mathematical abstraction, a succession—a causal series ?—of cross-sections of duration. Fact and fiction ought not to be mixed."

This is a stimulating book, and is written in a vigorous and occasionally epigrammatic style. Most students of science will profit from reading it. They will be sure of meeting a number of ideas, a good many of them challenging some accepted notions. A study of the metaphysical side of his subject need not necessarily dispose the man of science to scepticism and distrust of his own methods. It will only teach him the useful truth that we cannot get more out of a pint pot than we put into it. "There is no such thing as mathematical truth; there are only right and wrong equations," says the author. This remark may have a wider application than we think.

J. C. H.

Short Reviews.

The Subject Index to Periodicals, 1929. Issued by the Library Association. Pp. x + 318. (London: The Library Association, 1931.) 70*s*. net.

The "Subject Index to Periodicals" issued by the Library Association is a valuable key to papers scattered among a large number of journals. Many of these papers, though containing useful information and suggestions, are in some danger of being overlooked because those interested in their subjects would not find any reference to them in the literature they are accustomed to read. Although the "Subject Index" is not confined to science, yet so large a number of subjects of interest to readers of Nature are dealt with, that the "Index" should be placed on the shelves in every good scientific library.

The "Index" was begun in the year 1915 and has since been published for every year with the exception of the years 1923–1925.

The present volume indexes the literature for 1929 as it appears in about 550 English and

American periodicals, 24 French, Belgian, and Swiss periodicals, 21 German and Dutch, and 2 Italian periodicals. It must not, however, be assumed that the "Index" is complete, even as regards English and American periodicals; for in order to avoid overlapping, and also to restrict the size, no attempt has been made to index periodicals covered by certain named publications, such as *Science Abstracts*, sections A (Physics) and B (Electrical Engineering), *Journal of the Society of Dyers and Colourists*, *Revue de Géologie, Minéralogie et Crystallographie*, etc.

We do not think that the exclusion of papers already indexed in publications readily accessible to the scientific investigator will be considered a disadvantage. In any event, the "Index" for 1929 contains references to some 24,000 articles arranged under alphabetical subject headings. Verse and fiction are excluded from this catalogue.

The general editor is Mr. E. E. G. Tucker, who has been assisted by a very large number of voluntary contributors, including the chief librarians and staffs of a large number of important British libraries.

Astronomy: an Introduction. By Prof. Robert H. Baker. Pp. xix + 521. (London: Macmillan and Co., Ltd., 1930.) 16s. net.

This book is intended for use as a text in introductory college courses in astronomy. It covers a very wide field, but the subject is so large that, in spite of the considerable size of the volume, only the most cursory treatment of the material is possible. Problems of practical astronomy, as the preface states, have for this reason been almost entirely excluded. Bearing this general and inevitable characteristic of the book in mind, it may be recommended as a thoroughly sound and well-constructed textbook, as far up to date as the time of publication allowed, and enriched by a large number of excellent, well-chosen, and well-reproduced illustrations. It demands little previous knowledge of physics or mathematics, and is clearly and interestingly written.

The economy in expression is well exemplified by the title. Roughly about half the book is devoted to the solar system and the remainder to the stellar universe—perhaps a fair distribution of space among applicants to consideration whose claims are of such widely different character. As a reference book it will be of value to a much larger public than that formed by elementary college students. The only point of criticism serious enough to refer to relates to the method of numbering the paragraphs. Each paragraph is indicated by the number of the chapter containing it, followed, after a dot, by the serial number of the paragraph in that chapter; for example, 11·16 is the 16th paragraph in chapter 11. This is quite clear when the system is grasped (it is not explained in the preface), but the dot is so reminiscent of a decimal point that one would naturally expect to find 11·16 before 11·3, and accordingly may fail to locate a reference. This defect should be remedied in some way in future editions.

A Manual of the Slide Rule: its History, Principle and Operation. By J. E. Thompson. Second printing. Pp. vii + 220. (London: Chapman and Hall, Ltd., 1931.) 5s. net.

Many users of the slide rule will be surprised to find that it can provide enough material for a book of 220 pages.

The first of the five chapters is perhaps the most interesting; in it the history of the slide rule is given in full. Most of the information in Chap. ii., which deals with the elementary theory and operation of the slide rule, will be familiar to many users of the instrument.

The remaining chapters of the book deal with special forms and typical settings of the slide rule. In this part of the book the solution of right-angled and oblique triangles is explained. This particular use of the slide rule is of special interest in gunnery and the solution of the *BOT* triangle might have been included. Incidentally, the solution of triangles deserves a place in Chap. ii., for most readers will be more interested in the first two than in the remaining chapters.

The Treatment of Chronic Deafness by the Electrophonoïde Method of Zünd-Burguet. By Dr. George C. Cathcart. (Oxford Medical Publications.) Second edition. Pp. xiii + 111. (London: Oxford University Press, 1931.) 5s. net.

The successes obtained by Dr. Cathcart in the treatment of 665 cases of deafness by re-education are of peculiar interest to otologists and to patients with this crippling affliction; he obtained definite improvement in three-quarters of his cases of nerve-deafness, two-thirds of the cases of chronic otitis media, and in a half of the cases of otosclerosis. The treatment involves one or two exercises of five minutes' duration daily. He used the electrophone as the source of sound; this is an electro-mechanical oscillator of the vibrating reed type, with controls for variation of pitch and intensity. Nowadays, an audio-frequency oscillator incorporating two or more thermionic valves would be found easier to handle, but the arrangement of the exercises might well follow the plan of Dr. Cathcart, which has already proved so successful.

An Elementary Course in General Physiology. Part 1: *Principles and Theory.* By Prof. G. W. Scarth. Part 2: *Laboratory Exercises.* By Prof. F. E. Lloyd and Prof. G. W. Scarth. Pp. xxi + 258. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 13s. 6d. net.

The best avenue of approach to the study of biology and medicine is by way of the physical chemistry underlying the general principles of plant and animal physiology. For students who have not had the advantage of a preliminary training in physical chemistry, the first part of this book, which is written by Prof. Scarth, will just supply the deficiency. The second part of the book, under the combined authorship, provides a course of carefully planned laboratory exercises in general physiology suitable for class use.

Faraday Centenary Exhibition.

WITH the possible exception of Italy, which in 1899 and 1927 organised the notable exhibitions to commemorate, first, the centenary of the invention of the voltaic pile, and secondly, the centenary of the death of Volta, no country, we believe, has arranged so interesting and striking a display of scientific instruments, apparatus, and appliances in honour of one man as that which is to be seen in the Faraday Centenary Exhibition at the Albert Hall, formally opened by the Right Hon. J. C. Smuts on Sept. 22, just after his inauguration as president of the British Association.

It is in every way an exhibition worthy of the man and of the occasion. But however important we may regard Faraday's discovery of electromagnetic induction which has given rise to the present celebrations, and however much interest may be felt in the apparatus with which he made that discovery, the exhibition as a whole is an eloquent reminder that the world's debt to Faraday is not confined to a single discovery in one branch of science, but to that very remarkable series of investigations which, spread over more than a quarter of a century, opened up new fields of inquiry and led to an immense increase of natural knowledge and of its application to the needs of mankind. That the origin of so many of the most important developments in communication, transport, and industry can be traced to the work of a single man is an extraordinary tribute to the genius of Faraday, and whether the visitor starts with an inspection of the inner circle of exhibits, which illustrate the various branches of Faraday's researches, and then proceeds to examine the outer circles of exhibits where the modern developments are shown, or reverses the order of his examination, he cannot but be impressed with the truth of the statement, so often made, that Faraday was the greatest experimental philosopher the world has ever seen.

The arrangement of the exhibits is simple and admirable. In the centre on a raised platform stands a replica of Foley's statue of Faraday which is in the Royal Institution, and around this are grouped some of Faraday's apparatus and his notebooks, diaries, manuscripts, and letters. From this platform radiate eight avenues, between which, in three concentric circles, are arranged twenty-four stands, the inner eight of which illustrate Faraday's various researches, while the remaining sixteen are devoted to the branches of industry and science which owe so much to his original work.

The display of Faraday's apparatus and the illustration and demonstration of Faraday's inquiries have been arranged by the staff of the Royal Institution, but the exhibits of apparatus and machinery on the other stands have been arranged by various institutions and organisations connected with the electrical and chemical industries. Like all the events arranged in connexion with the Faraday centenary celebrations, the exhibition is a result of the co-operation, in the first place, of the Royal Institution and the Institution of Electrical Engineers, but the exhibition as a whole has been the work of the Exhibition and Publicity Sub-Committee, of which Lieut.-Col. W. A. Vignoles is the chairman and Mr. J. I. Bernard, of the British Electrical Development Association, is the secretary. Col. Vignoles is also the editor of the Souvenir Catalogue and Guide.

It has often been remarked that many of the most important discoveries in science have been made with the simplest of apparatus. The truth of this is exemplified by the work of such as Wollaston, Hughes, and Rayleigh, and it is well illustrated by many of the relics of Faraday's work as shown in the exhibition. Foremost among the relics is, of course, his iron ring with which he made his discovery of Aug. 29, 1831. Of this a large model is also shown, which, though it does not actually function, is made to appear as if it did so, thus enabling his experiment to be repeated on a scale suitable for the public to see. Many other pieces of apparatus are shown in the glass cases around the central platform, and then come the eight stands devoted in turn to electric science before 1831, Faraday's discoveries in 1831, effects of induced currents, Faraday's researches in magnetism, Faraday's researches in chemistry, Faraday's researches in electro-chemistry, Faraday's researches in electrostatics and the electric discharge. Each stand is lettered, each exhibit numbered, a staff of voluntary demonstrators is present to explain and demonstrate, and in the excellent Souvenir Catalogue and Guide are a valuable series of extracts from Faraday's writings, together with descriptive notes. The books shown include volumes of his Diary laid open at interesting pages, his MS. notes of Davy's lectures, a part of the MS. of Faraday's "Chemical Manipulation", and his Commonplace Book. Some of his medals and orders are also on view.

PHYSICAL AND ENGINEERING EXHIBITS.

Leaving the exhibits intimately associated with Faraday, the visitor has a choice of examining the interesting collections of telegraphic or telephonic apparatus, electrical measuring instruments, dynamos, X-ray apparatus, and of plant used in the chemical and metallurgical industries, and for the generation and transmission of electricity, and for communication and broadcasting.

The displays illustrating the generation of electricity, electrical measurement, and transformers have been arranged by the British Electrical and Allied Manufacturers' Association (Inc.). Many of the early magneto-electric machines and dynamos are shown, including the little-known generator built by Woolrich of Birmingham in 1844 and used up to 1877 for electroplating. This appears to be the first industrial generator. The main exhibit, however, is a large model of a complete generating, transforming, and switching plant with a pulverised coal-fired boiler and a 25,000 kw. turbine.

On the stand illustrating the development of electrical instruments and transformers there are nearly 300 exhibits, dating from the early electroscopes down to the most modern instruments. They are grouped in chronological order, and contain examples of the work of many famous investigators.

An exhibit which will attract much attention is that arranged by the Electric Lamp Manufacturers' Association of Great Britain, Ltd., to show in as simple a form as possible the principal stages of lamp manufacture. The operations include the coiling and insertion of the filament, the sealing in, and the exhausting of the lamp of air. In the latter operation it is of interest to note that after the exhaustion of the air the bulbs are 'washed' out several times with nitrogen, and argon is then admitted to about half atmospheric pressure.

The transmission and distribution of electricity is illustrated by a series of exhibits arranged by the Cable Makers' Association; the Central Electricity Board has placed on view a large coloured map showing the complete 'grid' transmission system in Great Britain; while electricity in transport is illustrated by models of electric locomotives, flying boats and aeroplanes, signalling apparatus, and a model of the s.s. *Viceroy of India*, the first turbo-electrically-driven vessel in the British mercantile marine. Electricity in the home and electricity for industry, in both of which electrical heating plays a chief part, are illustrated by displays of exhibits on two stands arranged by the British Electrical Development Association.

In the use of electricity for communication, first came land telegraphy, then submarine telegraphy, followed many years afterwards by wireless telegraphy, wireless telephony, and broadcasting. These are the sections in the exhibition which the General Post Office and British Broadcasting Corporation have arranged. The exhibits occupy the four stands *W*, *X*, *Y*, and *Z*. On *W* Stand the B.B.C. has arranged the actual transmitting units forming a part of a regional transmitting station capable of supplying a power of 75 kw. to its aerial system and of giving a nearly equal response to all frequencies between 30 and 8000 cycles per second; while another exhibit in three sections shows modern improvements in valves for radio broadcast reception. Stand *X* of the Post Office is devoted to telegraphy. About half the exhibits here have been provided by the Imperial and International Communications, Ltd., and relate to submarine telegraphy. Among the other half of the exhibits is a working and true reproduction of the electromagnetic telegraph installed by Gauss and Weber at Göttingen in 1833, which has been presented to the Institution of Electrical Engineers by the Elektrotechnischer Verein, Berlin, as a tribute to the memory of Faraday. Further exhibits of submarine cables are shown on Stand *Y*, where are also to be found an automatic telephone equipment and radio apparatus. One notable exhibit is the five-hundred-kilowatt thermionic valve manufactured by the Metropolitan Vickers Electrical Co. for the Post Office for use at Rugby. Described as "probably the most remarkable achievement in the development of wireless communication since the introduction of the three electrode thermionic valve in 1907", the valve is designed to handle the enormous output of 500 kw., thereby replacing fifty ordinary high-power valves in the main Rugby transmitter. Made mainly of steel, copper, and porcelain, standing ten feet high, and weighing more than a ton, the valve is "a robust piece of engineering construction". Needless to say, its construction has only been rendered possible by that scientific research of which the whole exhibition is indeed the fruits. Side by side with these notable exhibits is a display of X-ray apparatus arranged by the Institute of Radiology; while on Stand *Z*, also arranged by the General Post Office, are further exhibits connected with telephony and wireless telegraphy.

Two other features in the exhibition may be briefly referred to. Many scientific workers in the past have made their experiments in kitchens and cellars and the like. Faraday's work, in the main, was done in the stone-floored basement of the Royal Institution. What that old laboratory was like is known from the water-colour drawing made of it in 1852 by Miss Moore. The laboratory has undergone many alterations, and the numerous bottles containing Faraday's chemicals and much of his apparatus have long since disappeared. But enough information has been forthcoming to enable a reproduction of the laboratory to be made, and thanks to the labours of Mr. Malcolm, the director, and of the staff of the Wellcome Historical Medical Museum, visitors to the exhibition can now picture in what surroundings Faraday made his discoveries. The reproduction of the laboratory has been arranged in the King's Room, on the first floor of the Hall.

Another interesting feature of the exhibition is that of the admirable system of lighting and decoration. From the roof of the building has been suspended a great roof canopy or velarium of cotton dyed primrose and cream. On to the under side of this the light from 200 concealed projectors is thrown, each projector having a 1000-watt lamp, and the hall is thus illuminated throughout by the light reflected from the velarium. A great tubular lantern also hangs in the centre of the hall, while there are half lantern lights on the pilasters. The result is that every exhibit is adequately illuminated, while the effect throughout is pleasing and restful.

CHEMICAL EXHIBITS.

The organisers of the Faraday Centenary Exhibition did well to devote a portion of the space available at the Albert Hall to the commemoration of Faraday's chemical labours and to a demonstration of some of their fruits. Faraday was first and foremost a chemist; it was the fascination of chemistry which drew him to Davy and to the Royal Institution. By way of his epoch-making studies in electrochemistry, to which a stand is devoted, he climbed to the heights of his achievements in the study of electricity and magnetism. His greatness as a physicist rested on a secure chemical foundation. Nowadays we surfeit our physicists with quantum theory and relativity and starve them of chemistry. Thus trained, how can they have a balanced outlook on natural phenomena? It would be well if some of our universities took Faraday's career to heart in mapping out the training of their students.

As Sir William Bragg said at the Queen's Hall in his eloquent eulogy, Faraday had a flair for fundamentals. This is revealed as much in his chemical as in his physical work. Whatever he touched—optical glass, alloy steels, rubber, sugar from beet, oil products—is a century later of first importance. His heavy lead borosilicate glass achieved importance at the time, and is of historic interest, since with a piece of it Faraday discovered diamagnetism, thereby breaking down the apparently insurmountable barrier between magnetic and non-magnetic substances. In his researches on alloy steels he was ahead of his time. Alloying iron with chromium, nickel, and some of the precious metals, he foreshadowed much of the modern work which has resulted in the production of all kinds of alloys essential to many latter-day engineering triumphs.

The annual world consumption of special steels to-day is five to six million tons. An aircraft engine may have as many as seven different kinds of alloy steels used in its construction, containing nickel, chromium, vanadium, and molybdenum in varying proportions, all specially adapted to the tasks they have to perform in different parts of the structure. Among the many achievements illustrated at the Albert Hall are the manganese steels, developed by Hadfield in the early 'eighties, heat-resisting steels, high electrical resistance steels (containing aluminium, chromium, and nickel), non-magnetic steels (containing manganese, nickel, and chromium), cobalt and tungsten steels for permanent magnets, tungsten steels for high-speed tools, and finally stainless steel and iron, the housewife's boon, the development of which goes from strength to strength.

From the discovery of benzene to the latest commercial dyestuff is a long and brilliant stage in the progress of chemistry. The whole edifice of organic chemistry has been built up in this period—surely one of the greatest achievements of the human intellect. It is difficult to put ourselves back into Faraday's condition of chemical thought, so secure are we now in our knowledge of the structure of organic compounds. He discovered benzene, the fundamental substance of hundreds of dyestuffs, of drugs, antiseptics, explosives, even of the secretions of the glands which regulate the functions of our bodies. The figure of Faraday, under the dome of the Albert Hall, appears to gaze with appreciation at the brilliant array of colours "at the sign of the Hexagon", illustrating how from benzene and the other constituents of coal tar, succeeding generations of chemists have conjured dyestuffs of every hue for every kind of material. Our veteran chemist, Prof. H. E. Armstrong, conceived the idea of exhibiting these marvels, not in uninspiring bottles, but in their brilliant hues on delicate fabrics.

Never before, we believe, has it been made possible at a public exhibition in this way to trace the history of dyestuffs and follow the development of colours in terms of structure. More than a hundred different dyestuffs are shown. It is hoped to transfer this exhibit, which has been got together at great pains, and could not have been assembled at all without the generous assistance of a number of colour-making and textile firms, to another temporary home in South Kensington before it is dispersed.

Faraday, as is well known, discovered benzene, which he called bicarburet of hydrogen, in 1825, in the oil which accumulated in cylinders of compressed oil gas, made in the early days of gas-lighting by decomposing at a red heat—as we should say, cracking—whale oil. He isolated the crude benzene by fractional distillation, purified it by freezing, and determined its composition and vapour density. Not until twenty years later was it detected by Hofmann in coal tar, from which it is now obtained in millions of gallons annually. Faraday observed the almond-like odour when nitric acid acts upon benzene, but Mitscherlich first isolated nitrobenzene in 1834. Zinin first reduced nitrobenzene to a base, which he called benzidam, in 1841, and in 1845 Hofmann showed that this was identical with a base, aniline, obtained by Fritsche, also in 1841, from indigo. Thus was the relationship of benzene to a colouring matter first established. Nevertheless, it took Bayer twenty years to settle the constitution of indigotin, the colouring constituent of indigo. Many years of further research were required to establish the manufacture of indigotin as a commercial success; though its manufacture was commenced in 1881, it was not really successful until near the end of the century.

This, however, is a digression. Faraday has another claim to the homage of dyestuff chemists. In 1826 he discovered the two sulphonic acids of naphthalene, which he described in a communication to the Royal Society as sulphonaphthalic acids. This work is little known, but it very probably had considerable influence on the trend of investigation into the action of sulphuric acid on organic compounds. Reading Faraday's paper, one marvels at his skill in detecting the two acids, distinguishing them by the solubilities of their barium salts and the manner in which these burned. He worked out the whole technique which we still use for isolating sulphonic acids, analysed the two, and concluded that they had the same constitution. The phenomenon of isomerism had been discovered just before by Liebig and Wöhler (silver fulminate and silver cyanate), and Faraday had himself recently shown that acetylene and bicarburet of hydrogen (benzene) had the same empirical composition. He does not stress the point of the isomerism of the two sulphonates, but he makes a very shrewd guess at the mechanism of the sulphonation process, as we now call it. These two sulphonic acids are, of course, of first-rate importance in the dyestuff industry, the β-acid being the source of β-naphthol, one of the most important dyestuff intermediates. Sulphonation is used for rendering all classes of dye soluble in water.

The history of the development of dyestuffs, from Sir W. H. Perkins' discovery of mauve in 1856, by oxidising crude aniline from coal tar by means of sulphuric acid and bichromate, down to the latest discoveries of modern times, is extraordinarily well told in the catalogue of the exhibition. Perkins' mauve was a beautiful shade on silk (a dyeing of a preparation made by Perkin himself is shown), but it is fugitive and became superseded by better dyes. The primitive artificial dyes were safranine, the magentas, and the Manchester group (aminoazobenzene, Bismarck brown, Manchester yellow), then followed Witts' chrysoidine, the tropæolins, azo scarlets, and reds (from β-naphthol). A sensation was caused by the direct cotton dyes (1884), then followed the gay but fugitive triarylmethane dyes. Synthetic alizarin and some of its congeners were developed by Perkin in England and also by German chemists; later came the fast acid anthraquinone dyes, to be followed at the beginning of the twentieth century by the wonderfully fast anthraquinone vat dyes. Jade green, the most brilliant and fast of this series, is a British post-War development, as is also an improved form of indanthrene blue, the great discovery of Bohn. The indigoid dyes, sisters and cousins of indigo itself, in shades of yellow, blue, red, and violet, form a gay quartet and arouse speculation as to the influence of constitution on colour. In this connexion there is a remarkable series of dyes of the indolenine series, basic dyes containing two substituted indolenine groups joined by a chain of $(:\mathrm{CH}\cdot)_n$ groups. When $n=1$ the colour is yellow; $n=3$, pink; $n=5$, blue; $n=7$, green. In other words, in this series an absorption band moves right across the visible spectrum as the length of chain increases. This series will interest students of the carotin series of natural dyes. Finally, mention must be made of Prof. Robinson's exhibit of preparations of synthetic flower colours and their chemical relationships.

Power.*

By Sir Alfred Ewing, K.C.B., F.R.S.

To explain the task of the Bramwell lecturer we must recall the meeting of 1881, when the Association was celebrating its jubilee in the heyday of Victorian prosperity and confidence. It was a jubilant jubilee. Never, perhaps, was applied science more actively progressive. From day to day its achievements compelled attention. Electricity was knocking at the door, bringing a wallet big with gifts, wonderful gifts that established new contacts between the sciences of the laboratory and the arts of social life.

Think for a moment of what the late 'seventies and the early 'eighties gave to mankind. The telephone, the phonograph, the incandescent lamp, the dynamo in a practical form, the electric motor, the storage battery, the transformer, the internal combustion engine using liquid fuel, cold-storage and refrigerated transport of food, the idea of public electric supply, the use of alternating currents, the first clear recognition of the potentialities of electricity as an agent for lighting, for traction, for the conveyance and distribution of power. There, indeed, was a dish to set before the potential rulers of a kingdom which was waiting to be explored, where every engineer in the bud might well fancy himself to be a coming king.

> " Bliss was it in that dawn to be alive,
> But to be young was very heaven."

Among those fertile years I would specially mention 1881, which was the date of Bramwell's prophecy as well as the jubilee of the British Association. Apart from that, it marks an epoch. For the world then realised that a problem was at last solved with which it had been much concerned, the problem called the subdivision of the electric light. Before that the electric light had meant the electric arc—a dazzling unit, brilliant, overpowering, capricious, admired out of doors, but quite unfitted for the home. It was a tiger burning bright which declined to become a domestic pet.

Then came Edison and Swan, who, working separately, taught us how to tame it by inventing the incandescent filament enclosed within a vacuum bulb. Near the end of 1881, Sir William Thomson (as he then was) lighted his house in Glasgow by means of Swan's lamps. For prime-mover he chose the new gas engine of Dugald Clerk, which completed its cycle in two strokes, unlike the already familiar Otto engine, which required four. Clerk's engine was itself a novelty the importance of which we have come to recognise. To this day all internal combustion engines use either the Clerk or the Otto cycle, and for large powers the Clerk cycle has advantages which tend to give it the favoured place.

Fifty years ago the gas-engine was much in the public eye. No engineer who gave the matter serious thought could fail to see the advantage of having heat developed within the working substance itself instead of being conveyed to it by conduction through a containing shell. Another obvious merit of internal combustion was one that Carnot had recognised in the immortal little treatise where he laid the foundations of thermodynamics—the advantage which you secure by supplying heat to the working substance at a much higher level of temperature than can be reached with steam. Finally, there was this broad difference: the gas engine had the indefinite promise of youth;

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* From the presidential address to Section G (Engineering) of the British Association, being also the Bramwell Trust Lecture, delivered in London on Sept. 25.

the steam engine was an old servant the limitations of which were well known. Nobody expected that steam would change its ways. Small wonder then that the engineers of those days looked to the future of the gas engine with exaggerated hope.

It was in that spirit that Bramwell made the prophecy we have now, after fifty years, to review. At the jubilee meeting in 1881 he gave an address "On Some of the Developments of Mechanical Engineering during the last Half-Century". It reviews a great field with the lucidity of which he was a master, dealing specially with applications of the steam engine, and it includes a section relating to the transmission of power. Electrical transmission is barely touched on: it had, in fact, scarcely begun; but he speaks of transmission of power by means of gas, and in that connexion he remarks:

"I think there is a very large future indeed for gas engines. I do not know whether this may be the place wherein to state it, but I believe the way in which we shall utilise our fuel hereafter will, in all probability, not be by way of the steam engine. . . . I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum."

Bramwell returned to the question when president of the British Association in 1888. In his address he repeated the forecast of 1881, and added: "I must say I see no reason after the seven years which have elapsed since the York meeting to regret having made that prophecy or to desire to withdraw it". It is evident that he took his 'prophecy' very seriously. He was the acknowledged sage and spokesman of the engineering profession, occupying, in that regard, a unique position, such as no one could possibly hold in the more complex conditions of to-day. He was a humorist, and doubtless there was a conscious touch of humorous exaggeration in what he said; but for all that it was an engineering judgment delivered *ex cathedra*, and his judgments were accustomed to command respect.

Finally, when within a few months of his death, at the age of eighty-five years, he wrote to the president of the British Association, saying that he wished to keep alive the interest of the Association in this subject, and for that purpose offered a sum, which was to be paid as honorarium in 1931 "to a gentleman to be selected by the Council to prepare a paper having my utterances in 1881 as a sort of text, and dealing with the whole question of the prime-movers of 1931, and especially with the then relation between steam engines and internal combustion engines".

That is the task I am now attempting to discharge. The prediction has, in great measure, failed to come true. Steam is neither dead nor dying. To-day, it is a much more efficient medium than it was for the conversion of heat into work, and we find it actuating engines of vastly greater individual and aggregate power than any that were even imagined when Bramwell spoke. But alongside of that we have wonderful achievements on the part of the internal combustion engine which go far to justify the enthusiasm that stirred him fifty years ago.

Looking back now, one is amazed at the boldness of his prophetic outlook. It was more than bold; it was almost foolhardy. Remember that he had nothing to go by except the performance of the gas engine, and that only in very small powers. Gas, whether the ordinary illuminating gas distilled from coal, or the cheaper product of the Dowson process, was the only fuel then in practical use for internal combustion. The oil engine in its various forms, the petrol engine, the Diesel engine—these were still to come.

The success of the Otto gas engine led makers to design engines operating in much the same way, but using for fuel a spray of oil instead of gas. Such engines found a place where gas was not available, as in the driving of agricultural machinery. For the most part their fuel was the safe and familiar oil of the paraffin lamp. Like the gas engine, they were heavy and they ran at very moderate speeds, such as 200 revolutions per minute. About 1883, Gottlieb Daimler set himself to produce an engine with much lighter working parts which should run at a far higher speed, five times as fast, or more, and should use for fuel an oil so volatile that a carburettor would serve to charge the incoming air with combustible vapour. After successful trials with a bicycle he applied his motor, in 1887, to drive a car on the road. That was the beginning of a new era in locomotion. The world discovered in Daimler's petrol engine an appliance such as it had not possessed before—a light, convenient, inexpensive prime-mover, yielding amounts of power which were ample for road vehicles, easy to start and stop and regulate, demanding little attention and no particular skill. Before long it gave city streets an altered character and country roads an unsuspected value. Man acquired a new mobility which changed his notions of distance and of time. In due course the petrol engine also achieved the conquest of the air. At the end of 1903, only a few days after Bramwell's death, the brothers Wright took their first flight in a motor-driven aeroplane. It is the petrol engine that must bear the responsibility—the grave responsibility—of having made it possible for man to fly.

The era of the road-motor began with Daimler's experiment of 1887, but a good many years were to pass before it took the dominant position it holds to-day. The horse was already in possession, and did not yield without a struggle. That sensitive animal had a frank dislike of the horseless car. To meet his objections our legislators ordained for mechanically-driven vehicles a speed not exceeding 4 miles an hour, and required each of them to be in charge of three persons, one of whom should carry a red flag in front. Not until 1896 was the Red Flag Act repealed. The sinister emblem has gone, and the horse has nearly gone too. But engineers will not let his memory perish. Thanks to the initiative of James Watt, they treasure his name in one of their most necessary words. The horse may become little more than an instrument of sport or an excuse for betting, but it is safe to say the horse-power will never die.

About 1895, Rudolph Diesel initiated another epoch-making change. Instead of compressing a combustible mixture, he compressed the air alone, bringing it to a very high pressure, and thereby making it so hot that when the charge of oil was forcibly injected at the dead-point there was instant ignition. This escaped all risk of pre-ignition and greatly augmented the efficiency of the action, as a thermodynamic consequence of the very high temperature at which the fuel gave up its heat. To force the fuel in, he at first employed an auxiliary supply of still more highly-compressed air, but this plan is now less common than the simpler one of using a high-pressure pump, which delivers the oil in a spray of exceedingly fine drops. The essential feature of the engine is that the fuel does not enter the cylinder until the air there is highly compressed and the working stroke is about to begin. It is this feature which has made the Diesel engine the most efficient of all known means of obtaining mechanical work from the combustion of fuel.

Imagine our prophet of 1881 brought back to earth so that he may see for himself in what measure his expectations have been fulfilled. He will come, of course, by aeroplane, and on the way the pilot will tell him of the part which the internal combustion engine played in the War; of submarines and road-motor transport, and tanks and aircraft. He will be told of Zeppelins and air-raids, of the horrible superiority of attack over defence that characterises modern war. He will learn how prodigiously man has increased his power to kill his fellows and destroy their works. The old gentleman will be saddened to think that the world owes this to engineers, and especially to the internal combustion engine. It will grieve him to reflect that the island safety of England has departed, never to return. On the other hand, he will be told of air-mails to India and Australia and the Cape, and it will interest him much to learn that the engine which is bringing him so swiftly and comfortably to earth weighs no more than a couple of pounds per horse-power, and that engines of the same type, but lightened and tuned to the uttermost for racing, can develop more than a horse-power for every pound of weight. He will hear, perhaps with less enthusiasm, of speed records by air and sea and land, amazing records which are set up only to be broken. "Brief life is here our portion" might be said of the records, and also, alas, of many of the record makers and record breakers. As he approaches London our aerial voyager will note the highways thick with motor-cars, coaches, and lorries, and will wonder for a moment what has happened to the railway shares he left behind, doubtless selected as a secure investment of the terrestrial fruits of his industry and thrift. For in Bramwell's time there were still people who practised these now exploded virtues, and there were even Chancellors of the Exchequer who encouraged them.

We may imagine that the pilot brings him over the river and the docks, where he may see big motor-ships like the Nelson liners arriving with their frozen or chilled cargoes. One of his pet bits of engineering was mechanical refrigeration, and he will take particular satisfaction in noticing ships that are not only driven but also cooled by internal combustion engines. From the docks they will proceed over the City, where at every crossing he will observe the congestion of motor-cars and taxis, and the multitudinous motor-bus—but never a 'growler', which was the vehicle he used to favour. I well remember his taking me to visit a cold store on the south side of the river; we were on our way in a 'growler' when the bottom fell out and we were left sitting in the road. He was, as I have hinted, no light weight; my part in the comedy was only that of the last straw. The cab stopped without injury to life or limb, Bramwell forming an effective automatic brake. His genial dignity suffered no eclipse. His spirits were undamped—and his person too, for luckily the street was dry.

Finally, let us think of the pilot bringing him over Waterloo Place to revive his memories of the beloved club where he used to spend many placid hours. Below him will be the Athenæum, more than ever a haven of rest for the mature, but now on the outer edge of a vortex which is fed by torrents of one-way traffic from the Haymarket and Trafalgar Square—a veritable inferno of internal combustion—an inferno that would be intolerable were it not tempered from time to time by authoritative outstretchings of the arm of the law. As he watches the maelstrom, and perhaps sees a bishop trying to reach the club, he will thank the fate which has removed him from the present-day terrors of the pedestrian, from compulsions to unseemly agility and temptations to unseemly profanity. Such temptations are, of course, only for laymen, but life in Waterloo Place, even for bishops, must sometimes be furious as well as fast.

When all these things have been seen, we must not imagine Bramwell posing as the satisfied prophet who complacently remarks "I told you so". He had too judicial a temper for that. He would want to know about other users of power, and would ask many questions. What about our navy, and other navies, the biggest liners, the railways and the great factories, and the coal pits with their plant for winding and ventilating, and what about the distribution of light and power from central stations—on what kind of prime-movers do these rely? And the answer would be steam, and steam, and yet again steam. He would soon learn that steam still does a great part of the work of the world, and that one need not go to the Science Museum at South Kensington to find specimens of its remains. But if he did go to the Science Museum he would see admirably displayed there some remarkable engines. Side by side with the mementos of Newcomen and Watt, those fascinating heralds of the dawn, he would see engines of a far more recent type enshrined in the honour they so well deserve, not as relics of an obsolete past but as precursors of the modern era which was opened to the world by the genius of Charles Parsons. For among the treasures of our national museum of science is Parsons' first steam turbine, which dates from 1884, the first turbine to which he fitted a condenser, which dates from 1891, and also a part of his famous little craft, the *Turbinia*, by which in 1897 he demonstrated the applicability of the steam turbine to the propulsion of ships.

These dates are all subsequent to Bramwell's prophecy of 1881. Many factors have contributed to prevent that prophecy from being fulfilled, but none has been so potent as Parsons' development of the compound steam turbine. That invention was no mere throwing out of a happy thought. It was the life-work of a man who, to an extraordinary degree, combined creative imagination with energy and persistence and practical skill.

Such a man lives on in his achievements. To Parsons it was granted as to few men to see the fruit of his ideas and his labours. Long before he died the world recognised that he had revolutionised steam engineering. He had taught us how to generate power on a scale and with a concentration never before approached. Nothing, in a sense, could be simpler than his steam windmill with its successive rings of vanes, each in turn taking up a small fraction of the whole energy of the blast. To conceive such a device was one thing, to give it being and action was quite another. That meant many subsidiary inventions and years of toil; it meant the removal of mountains of prejudice and difficulty. But the triumph is complete. Engineers, all the world over, are whole-heartedly converted. They build their steam windmills on a colossal scale, crowding 50,000 or 100,000, sometimes even 200,000 kilowatts into a single unit, confident in the knowledge that no more trustworthy and economical prime-mover is available for the gigantic stations which play so important a part in modern civilisation as centres for the production and distribution of light and of power.

Review the great power stations of the world, and you find their method of manufacturing electric energy from heat is almost wholly through the medium of steam. To illustrate how small a place is taken in them by the internal combustion engine, let me quote some figures for British power stations. A return published in 1930 by the Electricity Commissioners gives the aggregate capacity of the generative plant of various types as follows:

	Kilowatts.
Steam turbines	5,531,952
Reciprocating steam engines	138,806
Oil engines	71,331
Gas engines	17,473
Water-power plant	42,208

Oil engines and gas engines together make up only 1½ per cent of the whole. Abroad, as well as at home, the steam turbine is dominant.

It is in great power stations equipped with large turbines and coal-fired boilers, using steam of high pressure and high superheat, that we find the most economical production of power from fuel. A modern turbine can generate one electrical unit with a consumption of barely 1 lb. of cheap coal, which means that it converts into electrical energy fully 30 per cent of the potential energy of the fuel. The internal combustion engine finds little favour in power stations, save as a stand-by to assist occasionally in meeting the peak load.

Turning now to another field, we find that in railway traction the supremacy of steam is maintained. Much attention has been paid to the Diesel engine as a possible alternative, but so far the number of Diesel locomotives that have found employment in main-line working is a negligible proportion of the whole. If the steam locomotive is to disappear, there is no indication that its place will be taken by an internal combustion rival. What is much more likely is that it will in time be driven out—wholly or in part—by electric traction, as Lord Weir's Committee has recently suggested for the British railways. But electrification will mean that the prime-mover is still steam, though acting at a central station—except, of course, in countries which have available reserves of hydraulic power.

Such a country is Switzerland, and there the transformation from the steam locomotive to electric traction is already almost complete. The playground of Europe has lost little or nothing of its charm through becoming dotted with hydraulic power houses. Already its exports to less favoured neighbours include many million units of electric energy, which it delivers through the graceful catenaries that girdle its mountains and span its valleys. The shrewd inhabitants doubtless demand a remunerative price for exported electricity, just as they quite properly do for the other amenities of their delightful land. A time may come when subterranean stores of coal and oil run low, but, so long as the sun shines and the rain falls, mankind will be able to continue its struggle for existence, though it may suffer a change in the centre of gravity of its industrial life. Industry will learn, like the Psalmist, to look to the hills whence cometh its help, and Geneva will be more than ever the natural rallying point of a community of nations, physically linked by a comprehensive 'grid' on which they depend for whatever modicum of light and power they are still permitted to enjoy.

For road motors, and for the air, the internal combustion engine is, of course, supreme; it has created as well as supplied a vast demand. We ought, I think, to pay tribute to the constructive talent that has made these engines the convenient and reliable prime-movers they have in fact become.

Turning to the field of ocean navigation we find a situation which is puzzling, unsettled, and difficult to analyse. For in the selection of prime-movers for ocean-going ships, there are sharp differences of opinion and of practice; there is no sense of finality; there is even—so it seems to me—a good deal of fashion and caprice, and of the probability of change which one associates with such moods of the mind.

In our own navy and foreign navies there is a practical monopoly on the part of steam, except, of course, in submarines. But the mercantile marine is in a state of flux. Before the War there were almost no motor-driven ships. The *Selandia*,

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which dates from 1912, was the first conspicuous example of a large ship driven by Diesel engines. Her economy of fuel at once commanded attention. She was naturally hailed with delight by the powerful oil interests whose position, already strong in the mercantile marine through the extended use of oil under boilers, would become impregnable if the Diesel engine were generally adopted. In some important quarters the Diesel engine became the vogue. During the post-War years of marine reconstruction the number of oil-driven motor-ships rapidly increased, and it is still increasing. Of merchant vessels launched during the year 1930, considerably more than half the tonnage was motor-driven. At this rate, a superficial observer might fancy that steam was in process of being driven off the high seas. But if that were his conclusion I think he would be quite wrong.

None of the greatest and fastest ships is motor-driven—neither the *Leviathan,* which at present heads the list, nor any of the other leviathans of the deep, with their tonnages of 40,000 or 50,000 tons or more, and their speeds ranging from 20 to 28 knots. This is true not only of the older ships but also of the newest, such as the *Europa* and the *Bremen* and the *Empress of Britain,* and the giant Cunarder which is now on the stocks and is confidently expected to surpass them all. For such vessels, motors do not give the concentration of power that is needed, whereas turbines do give it, and give it easily.

When we turn to vessels of intermediate types, we find the liveliest contest between the steam turbine and the Diesel motor. Some nations, such as Denmark, Norway, and Sweden, conspicuously favour motors. Others, such as America, no less conspicuously favour steam. One feels that both cannot be right. Nor can British practice, which is much divided, be right either. The choice would sometimes seem to depend more upon the taste and fancy of a dominating personality than upon a careful weighing of arguments such as appeal to engineers. One finds some shipowning companies going strongly for Diesel engines and other companies going no less strongly for steam. A notable example in the steam group is the Canadian Pacific Company, the superintending engineer of which, Mr. J. Johnson, has communicated to the Institution of Naval Architects a very full statement of the grounds which have governed that company's engine policy. His paper deserves careful study; I have not been able to find any equally detailed and convincing statement on the other side.

When we attempt to appraise the merits of the rivals and to estimate their chances in the more distant future, we see that from the thermodynamic point of view the Diesel engine still has a small advantage. On the other hand, its oil is more costly than fuel oil for boilers; it must have lubricating oil, too, and the first cost of the engine is substantially greater than that of steam plant. In respect of weight and of space occupied there is not much to choose. As to durability, I cannot speak; so far as I know, there is still a dearth of published facts about the cost of upkeep with Diesel engines. *Prima facie,* the great number of reciprocating parts is a serious drawback. There must be a great number because the safe limit of cylinder size is soon reached, and it is only by having many cylinders that any large aggregate of power is developed. In a recent Diesel-engined liner of the luxurious type, 12 Diesel cylinders operate on each of four shafts, making 48 in all, to produce a speed of 18-20 knots. Besides these 48 main cylinders, there are 24 more which serve purposes that are auxiliary but essential to the working of the main engines. Consider the number of working joints, of valves, of valve-rods and tappets, besides pistons and connecting-rods, which this involves. Does such an accumulation of reciprocating pieces with their hammer-blow accelerations mark a real engineering advance as compared with the cosy hum of a turbine engine-room, and has it come to stay? Frankly, I think not.

Now, a final question. Can anything be done to re-establish the ancient connexion of the merchant service with the British coalfields? Remember that here, and in most other places, the cost of coal is substantially less than that of oil for the same quantity of heat. Where oil scores is in its greater convenience of handling. Much has been said and written about restoring prosperity to the miners by converting coal into oil. As a chemical operation it is quite possible to make oil from coal; as a commercial proposition it is impracticable, so long as Nature continues to supply oil directly from the bountiful stores on which man now draws with prodigal ease. Ships that burn oil must have it come to them from sources outside Great Britain. Can we expect ships to return to the use of coal as fuel? For some classes of ships I think we may, though not all classes. Neither in the navy nor in what one may call the upper division of the mercantile marine—the luxurious express liners which carry fastidious passengers and must keep to a time-table that means quick fuelling—can one expect a reversion to coal so long as oil fuel can be got at anything like its present price. But with cargo-liners and big cargo-boats the case is different. I think those engineers are right who contend that for such ships a highly economic mode of working would be to use pulverised coal for steam-raising in a small number of large boilers of the water-tube type, with a pressure of, say, 500 lb. and a temperature of 750° F., each boiler having its own pulverising mill and being fitted also for burning oil as an alternative fuel. In such a scheme there would be no untried elements, but the combination of the elements would be experimental, and a conclusive demonstration of its advantages can be obtained only by testing it out on a large scale in sea-going ships.

In taking leave of our prophet of 1881, if we were to catch from him the mantle of prophecy we should wear it ruefully; we should all be Cassandras or Jeremiahs, obsessed with the cheerlessness of the industrial outlook, and finding no escape from the conviction that the easy supremacy of Britain, as Bramwell knew it, can never be recalled. But my last word must not be an unqualified Ichabod. The engineers of to-day have as much courage and enterprise as their fathers, and they have an infinitely better understanding of the scientific principles on which, as on a smooth highway, the advance of engineering must steadily proceed. Moreover, to recognise evils, and the causes of evils, may be the first step towards their cure. The world has learnt, through a sharp lesson, that the gifts of the engineer are good gifts only if they are wisely used; that the new powers he has evoked have brought new dangers against which mankind must resolutely guard if it is to save its soul alive. The malignity of individuals and the madness of nations now command forces of destruction such as more primitive communities never knew, and were happier not to know; and apart from clamant and appalling abuses of gifts which ought to be beneficent, we have become aware of a more subtle and perhaps graver social menace. We see the mechanised arts of production overreaching themselves, supplying commodities in a volume which cannot be absorbed, and with a facility that tends to deprive man of his richest blessing to body and spirit—the necessity of toil.

But these thoughts take us too far afield. They point to problems now conspicuously urgent, which, for the salvation of society, the engineer, the economist, and the moralist must jointly set themselves to solve.

The British Association Centenary.

Commemorative Service at Liverpool Cathedral.

The Dean and Chapter of Liverpool lose no occasion to make their great Cathedral the scene of public commemoration, and the centenary meeting of the British Association for the Advancement of Science was celebrated there with a ceremony on Sunday, Sept. 20, which will remain vivid in the minds of everyone who assisted in it. It happens that this year's Lord Mayor of Liverpool, Alderman Edwin Thompson, was one of the Association's local secretaries for the meeting in Liverpool in 1923, and is the son of a local secretary of the meeting of 1896. He was therefore able in a special sense to express the feelings of Liverpool people on this occasion; he entertained the president and president-elect of the Association at the Town Hall, and conducted them in full state to the Cathedral, where representatives of the University of Liverpool, the medical profession, and other public bodies, in academical robes, made a bright mass of colour in the choir, and the nave was filled to the doors; indeed, the greater part of the service had to be repeated later in the day. The thanksgiving service fell into three parts. The Dean, with the two presidents, and other members of the Association, presented themselves before the Bishop at the junction of choir and nave, and the president-elect, General the Rt. Hon. J. C. Smuts, addressed him in the following words:

Sir,—Bid a Blessing on this congregation assembled to render thanks for the increase of knowledge by the devoted labours of men and women in many lands, and more especially for the British Association for the Advancement of Science. This body was established a hundred years ago to give more systematic direction to scientific inquiry, to promote intercourse between those who cultivate science in different parts of the British Empire with one another and with philosophers of other countries, to direct the general attention to the objects of science, and to remove disadvantages of a public kind which impede its progress. The Spirit of God has used it to interpret the process of Nature and the doings of man, and by unrestricted interchange of observations, projects, and beliefs, the outlook of the nations on the world in which they live has been transformed. Vain fears and anxieties have been assuaged by clear thinking and wise endeavour. The real dangers and perplexities of our daily lives have been relieved by forethought and mutual help. The amazing structure and intricate processes of the universe have been set forth for reverent and devoted contemplation by students young and old, of all sorts and conditions. In these several ways human sympathy has been widened in the common task of mutual enlightenment and public service, men's minds have been awakened to the revelation of that which works in all and through all, and their grasp has been strengthened on the principles and the meaning of life.

The Bishop replied to General Smuts in historic words, as follows:

May God, the Fountain of all knowledge, fill you, who have gathered in this house for commemoration, with understanding and joy. May He keep you steadfast and persevering in your search for truth. And may the blessing of the Lord come upon you abundantly.

O Thou, who in every generation hast moved Thy chosen servants to seek Thy truth: continue we beseech Thee, so to inspire us in this age that, searching the works of Thy hands, we may find Thee in all that Thou hast made, and finally may know Thee perfectly revealed in the Spirit of thy Son, Jesus Christ our Lord.

A lesson was read from Ecclesiasticus xliv., by the president, Prof. F. O. Bower, "Let us now praise famous men, and our fathers that begat us", and an anthem was then sung:

Lord, who hast made us for Thine own, hear as we
sing before Thy throne.
Alleluia, Alleluia.
Accept Thy children's, rev'rent praise for all Thy
wondrous works and ways.
Waves, rolling in on ev'ry shore, pause at His footfall
and adore,
Ye torrents rushing from the hills, bless Him whose
hand your fountain fills.
Earth, ever through the power divine, seedtime and
harvest shall be Thine.
Sweet flowers that perfume all the air, thank Him
that He hath made you fair.
Burn, lamps of night, with constant flame, shine to
the honour of His name.
Thou sun, whom all the lands obey, renew His praise
from day to day.
Alleluia, Alleluia.

The commemoration was delivered, in the form of a bidding prayer, by Prof. J. L. Myres, one of the general secretaries of the British Association, and formerly Gladstone professor of Greek and lecturer in ancient geography in the University of Liverpool. After each prayer the response of the Dean was "Bless ye the Lord", and of the congregation "Praise him and magnify him for ever".

Ye shall remember those who in all times and in all places have devoted their gifts of intellect and imagination to interpret the laws of thought, the place of man in the universe, and the nature of reality;

Such as were Aristotle, Da Vinci, Bacon, Descartes, and Kant.

Ye shall remember all who have explored the properties of numbers, and the mysteries of time and space;

Such as were Pythagoras, Archimedes, Newton, Leibniz, Gauss, and Poincaré.

Ye shall remember all who have determined the courses of the stars, the place among them of sun, moon, and this earth of ours, and have given to all those, whose business is in the great deep, sure guidance to the haven where they would be;

Such as were Ptolemy, Copernicus, Kepler, Tycho Brahe, Halley, Herschel, and Huggins.

Ye shall remember all whose profound vision and infinite patience have revealed the ever-changing uniformities of the great forces of Nature; and made light and sound, heat and cold, lightning, wind, and flood subservient to the purposes of man;

Such as were Galileo, Gilbert, Watt, Faraday, Joule, Clerk Maxwell, Rayleigh, Hertz, and Parsons.

Ye shall remember all who have distinguished the natural elements, verified their properties and affinities, and thereby compounded substances unknown before, serviceable to health and in the arts;

Such as were Paracelsus, Boyle, Dalton, Priestley, Lavoisier, Davy, Berzelius, and Mendeleeff.

Ye shall remember all to whose vision across the ages the mountains and the seas are but of yesterday; who have laid bare the foundations of the world, and revealed its hidden treasures surely and safely for our uses;

Such as were Hutton, Nicolaus Steno, William Smith, Lyell, Bouchier de Perthes, and Suess.

Ye shall remember all who, not sparing life or fortune, set forth to find and win new homes for the multitude of our folk, to build the waste places of the earth, so that the desert should rejoice and blossom, and the men who stood far off might see a great light; for all travellers and explorers, and for those who were moved by great thought to send them forth, and to set down and make known their discoveries;

Such as were Marco Polo, Prince Henry the Navigator, Christopher Columbus, Banks, Cook, Humboldt, Franklin, Livingstone, Nansen, and Scott.

Ye shall remember all who have set in order the lineage of all living things, animals and plants, observed their habits and haunts, their struggles and survivals through the long lapse of time, the wonderful variety, infinite beauty, and subtle adaption of each to its proper life; their coming to birth and passing away: who have distinguished among them the friends and the foes of man, and sought to diversify by human skill the manifold works of creation;

Such as were Hippocrates, Galen, Linnæus, Cuvier, Lamarck, Darwin, Hooker, Huxley, and Mendel.

Ye shall remember all who have applied the principles of the several sciences to the tillage of the soil, the avoidance of famine and pestilence, the breeding and sustenance of flocks and herds, and the abundant provision of our daily bread;

Such as were Jethro Tull, Daubeny, Liebig, Lawes, and Theiler.

Ye shall remember all who, by their intimate study of the functions of life, have made plain the mysteries of many diseases and abated their ravages; and brought knowledge of our bodily frame to the better study of the mind in sickness and in health;

Such as were Vesalius, Harvey, Hunter, Claude Bernard, Johannes Muller, Pasteur, and Helmholtz.

Ye shall remember all whose contemplation of the divers races of mankind, the manner of their lives, the ordering of their societies, their customs and beliefs, and their manifold dealings each with his neighbour, for the enjoyment of Nature's gifts and the fruits of reason and toil, to the increase of the wealth of nations, have contributed to mutual understanding among the peoples and peace on earth among men of good will;

Such as were Bodin, Locke, Montesquieu, Adam Smith, Quetelet, Galton, and Tylor.

Ye shall remember all by whose precept and example, schools, colleges, and universities have been founded, so that true religion and sound learning may ever flourish and abound; for all teachers of those who learn; for all guides and masters of those who teach;

Such as were Socrates, Plato, Herbart, and in our own land William of Wykeham, Colet, and Arnold, Thring, Sanderson, and all founders and benefactors of the University of Liverpool.

The Bishop, at the end, taking up the same theme in more general terms, said:

And lastly, let us remember all who in the wise use of their abundance or their power, by their gifts of tongue and pen, by their particular skill, industry, and patience, have contributed to the advancement of learning, the application of science to the common good, or to the spread of the new light of reason among dark places and cruel habitations. Line upon line, precept upon precept, here a little and there a little, the works of each proclaim the Spirit of Him who wrought in them.

Then, after a hymn, the sermon was preached by the Bishop of Birmingham, Dr. E. W. Barnes, on the words, "The things that are not seen are eternal".

Finally, after hymn and anthem, the congrega- was dismissed with blessing by the Bishop.

In the evening a more informal gathering, such as is customary in Liverpool Cathedral, was conducted by the Chancellor of the Diocese, and addressed by General Smuts and Sir Oliver Lodge. The Cathedral was full, and an even larger number was turned away.

SECTIONAL MEETINGS AND DISCUSSIONS.

The meetings of the British Association have become part of our intellectual life as a nation and as an Empire. The general public awaits with an eager interest the messages of our leaders of thought about the actual trend of civilisation, while research students expect to find in their pondered pronouncements an indication of the landmarks in the unknown reached by science, and inspiring examples and methods for its own studies. The meeting of the British Association this year had, however, a wider interest, owing to the centenary celebrations of its foundation. When one looks back on the work of the Association during these hundred years from its first meeting organised at York by

Brewster and a band of enthusiastic men of science, one can only recognise the immense services it has rendered to science and the growing importance of its work.

The opening address of General the Right Hon. J. C. Smuts and summaries of the addresses of the presidents of sections have already appeared in Nature of Sept. 26. Taken together, they represent a broad survey of what science has done in recent years and what is to be expected of it in the near future. The problems of the constitution of matter, of the origin of life, of the various aspects of physiology, and of the increase and applications of mechanical power have been restated and broadly illustrated, while the papers read at the sectional meetings have considered special points of particular interest in the various branches of knowledge, from asymptotic partition formulæ to London tunnelling problems, the psychology of facial expression, or the early bronze age site in western Macedonia.

Questions dealing with integral calculus, higher pure geometry, and the application of mathematics to such problems as the relativistic wave equation, viscosity, and molecular physics seem to have been prominent among the mathematicians; while questions referring to the invention and use of powerful optical instruments and to the study of atmospheric conditions have been dealt with in the department of cosmical physics. The outstanding discussion in the department of Section A was one on the evolution of the universe, opened by Sir James Jeans at a crowded assembly in the Central Hall, Westminster. We propose to publish in a later issue the contributions to this discussion. In the Chemistry Section, much interest was shown in the study of the properties of electrolytes in various conditions, and also in the constitution and biological effects of vitamins, as well as in molecular and atomic structures. A fine collection of exhibits of various chemical compounds added to the practical value of this important section.

Geologists were interested to hear of the unknown prehistoric conditions of the London district. But the conflicting views of Sir Arthur Keith, Prof. H. L. Hawkins, Prof. H. F. Osborn, Prof. Swinnerton, Prof. A. E. Trueman, Prof. D. M. S. Watson, and Dr. W. D. Lang on the evidence of palæontology with regard to evolution could scarcely serve as a safe guide to the layman in one of the fundamental questions affecting the human race. Geological problems, however, are closely connected with geography; so that the transition between these two sciences appears to be easy and natural. The retrospect of geography at the British Association, sketched out by Dr. H. R. Mill, was a useful introduction. Yet the trend of the discussions has shown that physical geography rather than descriptive geography has the favour of the man of science. Perhaps we know already too much about what we have on our planet: what we want to know is how all this came about, or, to put it in technical terms, what are the origin and nature of the earth's crust.

As would be expected, zoology was dominated by inquiries on evolution, natural selection, genetics, and Mendelism, applied to the whole range of living organisms; while physiology dealt with the advanced aspects of the subject, especially with reference to human beings. A most interesting discussion in this connexion was that on problems of resuscitation from asphyxia, electrocution, drowning, etc., when the learned diagnoses of Sir Bernard Spilsbury, Prof. Y. Henderson, Prof. J. S. Haldane, Sir Francis Shipway, and other experts were given. Mechanical causes, inhalation of air deprived of oxygen, paralysis of the respiratory centres were considered under their various aspects as the chief causes producing asphyxia, and methods of resuscitation were suggested. Going further into the problems of the human complex, psychologists discussed the diverse questions pertaining to child psychology, analytical and abnormal psychology, and the experimental side of their inquiries. The delicate subject of mental deficiency and the psychology of the senses were also among the items considered. On the other hand, the ancient history of man was presented in a series of technical papers in the section of anthropology, in which primitive races and prehistoric man were studied side by side. Among the archæological theories put forth in this section, Dr. R. E. Mortimer Wheeler's paper on the excavations of Verulamium (St. Albans) was of a special interest.

Botany and agriculture received also full consideration. Plant morphology and plant diseases, especially the questions connected with wood preservation in forestry, were carefully analysed. At the same time the practical value of botany was the subject of a symposium on the training of botanists for economic and industrial positions, in which Sir Arthur Hill, Sir John B. Farmer, Prof. V. H. Blackman, Dr. W. B. Brierley, and Mr. J. Ramsbottom took part. Problems referring to agriculture proper were dealt with in a variety of papers which should prove of immense value to the practical side of farming, cattle breeding, and the allied arts of the countryside. The economic questions relating to agriculture in the British Empire were also discussed generally.

Economic science had naturally an important part to play in the meeting, and the sections devoted to economics and statistics, with the connected subjects of industry and engineering, scored high in the proceedings with some brilliant papers by experts and leaders of industry. A cursory remark may also be made about the section of education, in which the suggested establishment of a central institute for imperial education was thoroughly discussed.

On the whole, the addresses and papers read at the centenary meeting of the British Association show conclusively that if the scientific worker knows more and more about Nature, he is less and less inclined to present any clear-cut or definitive solutions to the major problems he sets forth to answer. A quarter of a century ago, the positivistic and materialistic conception of science allowed him a greater pride, almost a sense of infallibility, about his conclusions. Now, however, the very magnitude of his knowledge compels him to greater modesty. Perhaps that is the proper attitude he should adopt; if one admits that the final light that man seeks in this world should come from other sources which, though different from those of science, tend, however, to mould the human mind and its aspirations into a nobler and finer unity.

The freedom of the City of York was conferred on General Smuts when an invited party visited the city on Sept. 26.

At a reception given by the University of London on Sept. 28, the vice-chancellor delivered an address of welcome to the delegates to the centenary meeting, and then, by desire of the Senate, conferred the honorary degree of doctor of science, *Honoris Causa*, on the following:

General the Rt. Hon. Jan Christiaan Smuts, C.H., F.R.S.;
Prof. Sir Frederick Gowland Hopkins, P.R.S.;
Sir Joseph John Thomson, O.M., F.R.S.;
Sir Charles Scott Sherrington, O.M., G.B.E., F.R.S.;
The Rt. Hon. Lord Rutherford of Nelson, O.M., F.R.S.

OFFICERS AND COUNCIL.

Sir Alfred Ewing, lately principal and vice-chancellor of the University of Edinburgh, has been elected by the General Committee president of the Association for next year, when the meeting will be held at York. Hitherto the president has assumed office at the inaugural meeting of the Association and has then given his presidential address. By an alteration of one of the Statutes, recommended by the Council and adopted by the General Committee, the president will in future assume office on Jan. 1, will deliver his address at the annual meeting held during his year of office, and will retire at the end of the year. The advantages of these changes are stated by the Council as follows:

(1) The president will be responsible administratively for the major part of the preparation of arrangements for the annual meeting over which he is elected to preside, and his influence can be more directly brought to bear upon them.

(2) In particular, he will take the chair at the joint meeting of Organising Sectional Committees in the January preceding the annual meeting, which has now become a regular and principal part of the mechanism of preparing the programme.

(3) As a point of minor but still recognisable importance, he will arrive at the place of the annual meeting as president, not as president-elect, and possible confusion in the local public mind will be avoided.

(4) After the annual meeting he will still be in office to preside over those meetings of the Council at which matters arising out of the annual meeting are principally dealt with.

The new members of Council are Dr. J. Drever, Prof. T. E. Gregory, Prof. H. S. Hele-Shaw, Prof. E. B. Poulton, and Prof. A. M. Tyndall. Considerations of health would not permit Prof. F. J. M. Stratton to take full part in the preparations for the centenary meeting; and he cannot be present at next year's meeting. Prof. P. G. H. Boswell was therefore appointed as an additional general secretary. Prof. J. L. Myres, who has been one of the general secretaries of the Association since 1919, has intimated that he will not seek re-election after next year.

Obituary.

PROF. A. S. PRINGLE-PATTISON.

BY the death of Prof. Andrew Seth Pringle-Pattison on Sept. 1, at the age of seventy-five years, philosophy lost one of the outstanding figures in a period of remarkable activity in that department. He was one of the first to see the significance for English thought of the impulse that came from the sympathetic study of Kant and Hegel in the 'sixties and 'seventies of last century. With the late Lord Haldane he organised the epoch-making manifesto contained in "Essays in Philosophical Criticism" which appeared in 1883 and included contributions from others who afterwards became famous in their several lines of research, J. S. Haldane, Bernard Bosanquet, W. R. Sorley, W. P. Ker, Sir Henry Jones, and James Bonar.

More cautious and more determined to make sure that no vital element in experience was being sacrificed to a first enthusiasm than some of his more ardent colleagues, Pringle-Pattison came forward in the next period of his philosophical development as a trenchant critic of what he held to be sinister features of the new movement. The doubts expressed in "Hegelianism and Personality" in 1887 seemed to be confirmed by the publication of Bradley's "Appearance and Reality" in 1893, and his essay in criticism of this work in "Man's Place in the Cosmos" seemed to separate him more widely still from his former idealistic associates. But the apparent recoil was only the preliminary to a more confident advance to the more personalistic form of that doctrine that found full expression in his Gifford Lectures in 1912–13 on "The Idea of God in the Light of Recent Philosophy" and has since had a growing influence both in England and America.

The general line of Pringle-Pattison's thought is indicated in the phrase which, so far as I know, he was the first to use of philosophy as "Criticism of Categories". The category prominent in nineteenth century thought was that of mechanical causation—the attempt to resolve everything into elements with which, as *effect*, it could be equated. This he held to be applicable (and possibly adequate) in certain limited spheres of phenomena, as in mechanics. But as we pass to other orders of fact, as to that of life, no preceding set of facts can account for their combination in a phenomenon essentially different from them. Here on the contrary "the true nature of the cause only becomes apparent in the effect". Equally certain was the insufficiency of any merely biological interpretation of the world of moral and religious experience. It is impossible to do justice to the sense of obligation and the instinctive admiration of unselfish devotion to far-reaching ends such as truth, beauty and moral perfection on any theory which takes the survival and material well-being of the species as the supreme goal and all else as instrumental to them—incidental results and by-products of the cosmic system. All explanation in a word of the higher by the lower is philosophically a *hysteron proteron.* Everything remains unintelligible until we invert the order of naturalistic explanation and go to work on the supposition that a purposeful moral intelligence is in reality the key to the world's meaning, the fact in the light of which all other phenomena must be read. In his own words, "every true philosophy is an attempted theodicy"—the vindication of a divine purpose in things.

However extravagant this claim may seem to those wedded to another order of thought, its vindication has been the dream of a long line of great thinkers since the time of Plato who found alone in the Good the adequate principle at once of the being of things and of our understanding of them. Pringle-Pattison's interpretation and defence of this thesis against prevalent forms of naturalism on one hand and forms of idealism, which sought for the principle of reality in a sphere beyond Good and Evil, on the other, ranks him with the great teachers, including Sir William Hamilton, who preceded him in the chair he so long occupied in Edinburgh.

An account of Pringle-Pattison's opinions gives, however, an imperfect idea of his work as a writer. It was the way in which he developed them out of a singular fullness of knowledge of contemporary philosophy, and the command of a peculiarly graceful style derived from an equally wide knowledge of the best in literature, that gave that work its peculiar distinction. Added to this he was known to his friends and his fellow-townsmen as a man of singular gentleness of manner and dignity of presence. He lived and looked the philosopher. Yet when called upon by the inheritance of an estate in the country to play the part of a Scottish laird, he surprised his friends by the firmness and efficiency of his management. Without the interest of his brother and colleague Prof. James Seth in the practical life of his city, and contrasting with 'Prof. Jim' in the more formal method of his teaching from written lectures, these self-limitations enabled him to give a certain completeness to the literary expression of his ideas in a long series of works of uniform distinction, closed only last year by the publication of his "Studies in the Philosophy of Religion", described by the *Times* of Sept. 2 as "among the best in the apologetics of rational theism".

Pringle-Pattison was LL.D. in his own university, honorary D.C.L. of Oxford, and a fellow of the British Academy. Among his early friends, besides those already mentioned, were Ambassador J. G. Schurman and the late Lord Balfour, who founded the lectureship under that name in the University of Edinburgh with the express purpose that Andrew Seth, as we then knew him, should be the first to hold it. Seldom have youthful appointments been better justified.

J. H. Muirhead.

We regret to announce the following deaths:

Sir Gregory Foster, Bart., formerly provost of University College and vice-chancellor of the University of London, author of many educational works, on Sept. 24, aged sixty-five years.

Dr. Charles A. Keane, formerly principal of the Sir John Cass Technical Institute, Aldgate, on Sept. 18, aged sixty-seven years.

News and Views.

As we go to press, we have received the following radiogram, dated Sept. 28, from Sir C. V. Raman, F.R.S., and S. Bhagavantam: "Experimental demonstration of spin of light.—The depolarisation of Rayleigh scattering of monochromatic light in carbon dioxide gas does not diminish to one quarter of its value when spectroscopically separated from rotational scattering, as demanded by existing theories of radiation. The actual observed diminution, from 10 per cent to 6 per cent, is quantitatively explicable, assuming that common light consists of spinning quanta possessing one Planck unit of angular momentum.—C. V. Raman and S. Bhagavantam."

This is the centenary of the discovery of miners' safety fuse—more generally known as Bickford fuse—by William Bickford. He was a Devonshire man, but having married a Cornishwoman, he went to live in the little village of Tuckingmill in the mining area of Cornwall, and there he first started his experiments on safety fuse. In this he was actuated by humanitarian motives, for he had nothing whatever to do with mining, his business being that of a currier. Blasting operations as conducted one hundred years ago were exceedingly difficult and dangerous. The only explosive then known was gunpowder, and though the handling did not involve any great risk, the methods in use for conveying the fire to the charge were definitely dangerous. It was at this stage that accidents were of such frequent occurrence, and the old records in Cornwall and elsewhere show that the fatalities were very great. But it was the number of permanently maimed men utterly incapacitated for work through the loss of fingers, an arm, or a leg, visible evidence of the hazardous nature of mining, which spurred Bickford on with his work. The most effective and possibly the safest device employed in Cornwall for conveying the fire to the charge was to fill goose quills with crushed gunpowder, after nipping off the thin ends. Thus a thin end of one quill was fitted into the wide end of another, and by this means, a column of powder was built up which, though fragile, was fairly effective but very uncertain. This in turn was set off by touch-paper.

BICKFORD had naturally many disappointments and failures when carrying out his experiments, and indeed was just on the point of abandoning the whole thing when in visiting a friend in his rope-walk he had the idea that the fibre of the rope might be so spun as to enclose a core of powder fed from a funnel. He achieved success in the end mainly with the assistance of a mechanical genius called Davey, who must share the credit. Application was in due course made for a patent, and the specification, which is dated Sept. 6, 1831, reads as if it had been drafted yesterday, so minutely and correctly are the operations described. Unfortunately, Bickford did not long survive his invention, but his family carried on the work. The little workshop where the first manufacturing operations were carried out still exists, but around it has grown a fine up-to-date works. Through the safety lamp invented by Sir Humphry Davy, one of the two great causes of accidents in mining was removed, and through Bickford fuse the other was, after a time, definitely eliminated. These two inventions have probably done as much as any other to conserve human life. Bickford reaped no financial reward from his invention, and it was only after many years that the fuse was known outside of Cornwall. Nevertheless, his name is worthy of a passing thought even in these crowded days.

THE discussion on human population which was held in Section D of the British Association on Sept. 26 is of peculiar interest in view of the general theme of Prof. E. Cannan's presidential address to Section F. Prof. Cannan's argument is that the population of the world is almost stationary. He, like Prof. J. S. Huxley in the discussion, points out that migration is rapidly coming to an end. With contraception affecting all countries a new problem is arising—that of either over- or under-population. Prof. Huxley also emphasised the effect of progress in medicine, sanitation, and so forth in lessening the rigour of natural selection. The fertility and possible sterilisation of individuals is also receiving much attention now, thus placing the problem of population on biological bases. Prof. A. M. Carr-Saunders considers that there is not so much cause for concern over the decline in birth-rate as there is in the connexion between this decline and western civilisation and culture. Prof. L. T. Hogben made a plea for more intensive physiological research into human reproduction. The recent decline in the European birth-rate is undoubtedly due to limitation of parenthood owing to the spread of contraceptive measures, but Prof. Hogben is not prepared to place all the responsibility on contraception.

PROF. E. W. MACBRIDE considers that, now the problem of over-population cannot be settled so easily by migration to unoccupied territories, one of two things is possible: either war or internal degeneration. Prof. F. A. E. Crew looks upon the problem from the point of view of the geneticist. He emphasised the inability of pure-bred British stocks to claim biological harmony with habitats outside the temperate zones. If, therefore, parts of Australia cannot be colonised by the Australians, but can be by Italians, Japanese, or Chinese, then the latter have the prior right. Similarly have the Indians preferential claim for the greater part of East and South Africa. Nevertheless, being of such mixed racial composition ourselves, it might be possible finally to suit the whole Empire by a better distribution of our migrants among its diverse parts. In this connexion it is interesting to note Prof. Cannan's conclusion, that the remedy for unemployment is mobility in regard to both place and occupation.

A GROUP of biologists of the University of Minnesota has filed a memorandum with the White House Conference on Child Health and Welfare, suggesting that a special conference of experts on heredity be called, to see what can be agreed upon as a positive programme looking to the application of knowledge of heredity to the human species, and to recommend how such a programme should be carried out. In this connexion, Dr. E. P. Lyon, dean of the Medical School, University of Minnesota, has issued through Science Service, Washington, D.C., a statement in which he points out that man has enormously improved domestic animals by the intelligent application of the laws of heredity, and should be able to apply the same intelligence to similar ends in regard to his own species. Human rights are involved, but the right of every individual to have children is opposed by the right of the hopelessly diseased baby to remain unborn. It is not necessary to have any model towards which to aim, but progress can begin with elimination of the manifestly unfit by breeding only from the fit. He suggests that public opinion should be educated on this matter, and that a programme might be adopted extending over one hundred years. This would be further ahead than the human race has ever planned before. At present, very large expenditure and enormous social effort are directed to the environmental side, while the practical aspects of heredity as applied to man are comparatively neglected.

THE twelfth Annual Report of the Ministry of Health, which relates to the year ended on March 31, 1931, has recently been issued. (London: H.M. Stationery Office. 5*s*. net.) The subjects dealt with fall under the main heads of public health, local government and local finance, poor law, national health insurance, and contributory pensions, the Annual Report of the Chief Medical Officer of the Ministry being published separately. During 1930, 136,515 samples of food and drugs were analysed, of which 6496 were reported against, a percentage of 4·8, which is the lowest recorded. A notable feature of the year was the considerable decline in the number of notified cases of, and in the deaths from, pneumonia; there has also been a steady decline in the number of cases of encephalitis lethargica, but the prevalence of mild smallpox continues. With regard to housing, the average cost of non-parlour houses, £344, is only £18 less than that in 1928, and dissatisfaction is expressed that there should not have been a more substantial reduction. Attention is directed to the serious lack of reliable information regarding the flows of rivers and streams, and a sub-committee of the Advisory Committee on Water has been appointed to consider what measures can be taken for the accurate gauging of rivers and underground water.

THE activities of local authorities in Great Britain in the sewering of their areas have, according to the Annual Report of the Ministry of Health, been more than maintained during the year, and loans sanctioned for this purpose amounted to nearly nine million pounds, and the total sum for this purpose since the War is approximately fifty-two million pounds. The report by Mr. Owen Llewellyn, inspector under the Canal Boats Acts, is of the nature of a retrospect, for he is retiring after thirty-two years' service. He remarks that during his period of office many hundreds of miles of canals have become derelict or have fallen into disuse. Motor-engined boats are taking the place of steamers and of horse-drawn boats, though the last-named are the most economical form of transport in many, especially hilly, districts. On canals as a whole, there seems to be no decrease in the number of children found on boats, and the 'floating school' at West Drayton for canal-boat children has proved a success. It is impossible to state with any certainty how many boats exist and are at work, for there is no legal obligation to report the end of once-registered boats. The last portion of the volume contains the report of the Welsh Board of Health, with a number of appendices.

IN his evening discourse to members of the British Association on Sept. 24, entitled "Zoos and National Parks", Sir Peter Chalmers Mitchell described the problems of and need for three types of animal reserves—zoological gardens, zoological parks, and national parks. There are many popular ideas of how various animals should be kept; but Sir Peter pointed out some of the difficulties of keeping animals under conditions resembling so far as is possible their natural habitat. Such problems are not relieved by the diverse nature of the different species of animals seen at our great zoological gardens. Experience in the keeping of animals under such conditions brings out some surprising facts. Examples are the necessity for sunlight and a suitable temperature. Nearly all animals love sunlight, even polar bears and owls; given the chance, they bask in the sun and benefit from it. A constant temperature is not desirable for any kind of animal; variations should be made for the well-being of all animal types. Another great asset, to nearly all animals, is plenty of opportunity to obtain fresh, open air.

ONE point especially emphasised by Sir Peter is the fact that the zoological garden should not be looked upon merely as an adjunct to the amusement and general instruction of the public, but should be regarded as a splendid field for research. Much more should be done in this respect. An example of this is the behaviour of the kangaroo when under an anæsthetic. The kangaroo is never known to utter any kind of sound normally, yet when subjected to an anæsthetic, probably partly through fright and partly due to the anæsthetic, the animal utters a cry similar to that of the marsupial wolf. Here is an opportunity for research into the cries of animals under various conditions. Many other such problems are still awaiting investigation, which can be carried out advantageously only in a zoological garden. Zoological parks present a still further difficulty in that they allow much more freedom, and therefore only animals with a considerable range of adaptability can be chosen. National parks are useful for the preservation of types of fauna in danger of extinction, the American bison being now a historical example. The chief agent in animal extermination is the advance of civilisation and not sportsmen or scientific collectors.

THE Trustees of the British Museum celebrated on Sept. 29 the fiftieth anniversary of the opening of the Natural History Museum building at South Kensington. The exact date of the opening was April 18, 1881, but the celebration was deferred so as to come within the period of the centenary meeting of the British Association. About a hundred and fifty delegates of museums and learned societies at home and abroad were received by the Trustees at the afternoon meeting. The Earl of Crawford and Balcarres, chairman of the Jubilee Celebration Sub-Committee of the Trustees, presided, and was accompanied on the platform by Lord Rothschild, Sir David Prain, Mr. F. Cavendish-Bentinck, and other Trustees, as well as by the director of the Museum, Dr. C. Tate Regan. Lord Crawford, in opening the proceedings, welcomed the delegates and expressed the pleasure which the Trustees felt that so many had been able to attend the celebration in spite of the world-wide financial difficulties which were then prevailing. Dr. Regan then gave a brief account of the history of the Museum and of the development of the collections contained in it. The delegates were then individually received by the Trustees. In the evening, the Government gave a reception at the Museum, which was attended by the delegates, as well as by a large number of naturalists and other scientific workers attending the meeting of the British Association. The guests were received by the Prime Minister, Rt. Hon. J. Ramsay MacDonald, M.P., and Miss Ishbel MacDonald.

A RECENT writer in the American journal *Forest and Stream* gives an account of a lion farm at El Monte, U.S.A., the property of Mr. and Mrs. Gay. As an adult lion is worth a thousand dollars even untrained, the domestication of the lion—long known as the readiest of sensational 'wild beasts' to breed in captivity—is evidently a paying proposition; and, apropos of this, it may be as well here to give a tentative list of the known domestic mammals, as no such list, embodying all the latest results, appears to exist. The only other feline domesticated is the common cat; of the dogs, we have now, besides the ordinary dog, the common and arctic foxes; of the weasels, the ferret, mink, and skunk. The domestic rodents comprise the rabbit, guinea-pig, rat (*Mus decumanus*, not *rattus*), mouse, and musk-rat, probably also the coypu and the Patagonian cavy (*Dolichotis patagonica*). Of ungulates, nearly all the known species of *Bos* have been domesticated—the common ox, zebu (if this be really distinct), water-buffalo, yak, gaur (the domestic form being known as gayal or mithan), and banteng, while the two bisons are at any rate emparked; other domesticated hollow-horned ruminants are the sheep and goat and probably the Barbary sheep (*Ammotragus lervia*) and blackbuck (*Antilope cervicapra*), and in East Africa, at any rate, the eland. Among the deer, the milou (*Cervus davidianus*) has never been known except as a park animal; while the reindeer and fallow deer are well known as domestic, and there are park races of the red deer and doubtless others. The two camels (only known certainly as domestic), the llama (the domestic descendant of the guanaco), the pig, the horse, the ass, and Bennett's wallaby, a well-established park animal, complete the list, in which it is to be noted that among the recent achievements in domestication only that of the eland has practical utility as its object.

MR. DENIS BUTLER, of Goodhart Way, West Wickham, Kent, has sent an account of curious behaviour in a North American corn-snake (*Coluber guttatus*) in reference to moles. The snake, which had been kept in an open-air cage, escaped, and on recapture, after about a week, showed by a bulge in the stomach-region that it had fed well. When the cage was next visited, three decomposing moles were found there, which the snake had eaten while at large; most of the flesh seemed to have been digested, but the skins and bones were intact. After about a week, the body of a fourth mole, which must have burrowed in and been swallowed, was found in the cage. It is suggested that this apparent inability to digest moles, when other animals, such as mice, are digested bones and all, is strange; but in the case of the first three found the disturbance of the snake's system caused by recapture no doubt caused them to be disgorged when half-digested. The case of the fourth specimen is more difficult to understand, but though moles are eaten by the common adder and by the four-rayed snake (*Coluber quatuor-radiatus*) of the Continent, it may be that lowering of the digestive powers caused by captivity was just enough to prevent any digestion of a new prey by a snake the natural diet of which is rodents and birds; and one is reminded of the belief of falconers that the eating of a moorhen puts the trained goshawk out of working condition, though it is not likely that the free bird abstains from such prey. But in any event, it is interesting to find that a reptile coming from a country where the summer is so much warmer than that of Great Britain can not only do well in an outdoor cage, but have sufficient energy to escape and find prey for itself, in such a poor summer for warmth as we have had this year.

THE strange acquirement of a Central Australian parrot, the Corella (*Kakatoa sanguinolenta*), is described by A. W. Mullen in the *Australian Museum Magazine* for July. The individual in question is now twenty-six years old. When it was a year old, the owner's children were firing off crackers close to the bird's cage, when in terror it seized its loose drinking tin (a shallow preserved-meat tin) and placed it over its head—the writer says, "to hide what was to the parrot a terrifying scene". The action in itself was curious, but it is more extraordinary to learn that ever since then the parrot has placed the tin can on its head every night. "He places the tin on his head before falling asleep, and keeps it on like a night-cap until the first streak of dawn awakens him." When by day he had to be transported by rail, he clapped the tin over his head whenever he encountered the strange sights and sounds of the railway station. During his quarter of a century he has worn out at least four tins. We fear to speculate as to the thought which originated and continued this curious action, but remembering the imitativeness of parrots (this one talks and calls the children by name, as well as mimicking dogs and fowls), we wonder if his master ever wore a night-cap.

A STRIKING example of human concern for the well-being of wild fauna, apart from mere prevention of cruelty, has recently been set by the Viennese Society for the Protection of Birds. Owing to the very inclement weather in Austria at present, thousands of swallows have been stranded on their migration southwards. The Society has taken the problem into its hands and has collected the stranded birds, giving them sanctuary and food. The birds are then being sent over the Alps either by specially heated coaches attached to the night express train or in cases, which each hold 1000 birds, by aeroplane. The first consignment of 2000 birds was sent to Venice on Sept. 25, and, landing in a suitable climate, took to their wings, finally making their way south. On Sept. 26, 25,000 birds were sent by aeroplane. The weather was unsettled on Sept. 27, so 35,000 were sent to Venice by train. Thousands more are being dealt with, and after resting in Vienna will in due course be sent to Venice.

A LARGE number of visitors availed themselves of the invitation of Sir Joseph Petavel to attend a reception at the National Physical Laboratory on Sept. 24, arranged in connexion with the Faraday celebrations and the centenary meeting of the British Association. Each visitor was provided with a programme of exhibits, members of the staff were present to explain the various investigations being made, and by an excellent system of signs and numbers it was a simple matter to find any particular exhibit. Tea was served in the great building housing the new duplex wind tunnel. This tunnel is 14 ft. by 7 ft. in section, and in it models up to 7 ft. or 8 ft. span can be tested with air speeds up to 75 miles an hour. Another notable aeronautical exhibit was the compressed air tunnel, now nearing completion, in which models will be tested under an air pressure of 300 lb.

per sq. in., the air jet being 6 ft. in diameter. Whereas the other wind tunnels are built of wood, this tunnel has a steel shell 2½ in. thick and weighs 250 tons. It has been tested hydraulically to 500 lb. per sq. in. By the use of this tunnel, scale effect is eliminated, and the results of experiments are immediately applicable to the full-scale machine or component. In the William Froude Laboratory visitors were shown a model ship under test, and the methods of making the models. The demonstrations of flashover tests at 350 kv. on a porcelain insulator string in the High Voltage Laboratory also attracted many visitors. Throughout the laboratory every facility was afforded for learning what was being done, and the efforts of the members of the staff were much appreciated.

The extensive new laboratories of the Lancashire and Cheshire Coal Research Association were opened on Sept. 22 by Mr. R. A. Burrows, the first president of the Association. The Association was formed in 1918, the funds being provided voluntarily by eight of the large colliery firms in Lancashire. The organisation is now supported by the Lancashire and Cheshire Coal Owners' Association, which includes substantially all the collieries in the coalfield. The programme of work of the Research Association embraces the physical and chemical survey of the seams of the coalfield, the investigation of problems connected with safety in mines, and the study of coal mining. The coal survey work forms part of the National Coal Survey, and in 1922 the fuel research organisation of the Department of Scientific and Industrial Research provided grants to enable the work on the survey aspects of the Association's work to be expedited.

Dr. F. S. Sinnatt, of the Department of Scientific and Industrial Research, who was the first director of research to the Lancashire and Cheshire Coal Research Association, outlined its early history and development, and said that the staff has been favoured by the enthusiastic support of the coal owners of the district, and has been helped by the fact that there has been continuity of direction by the Council. Originally the Association was largely concerned with the problems of the utilisation of coal, but now its investigations embrace questions of safety and coal winning. Prof. J. S. Haldane, who is especially interested in the investigations connected with the Safety in Mines Research Board, welcomed the establishment of the new laboratories, and said that he regretted it had not been possible for him to come to Lancashire more frequently to help them in the work they were doing. A very large number of coal owners from the Lancashire coalfield and fuel technologists from every part of the country inspected the laboratory, the details of which were explained by the director of research, Mr. Simpkin.

The report presented by the Seismological Committee to the British Association contains, besides references to the death of the late chairman, Prof. H. H. Turner, the revision of the seismological tables, and work on deep-focus earthquakes, an interesting note on recent earthquakes by Messrs. A. W. Lee, R. Stoneley, and F. J. W. Whipple. A map of the North Sea earthquake of June 7, depending on about 400 observations, has been prepared by Dr. H. C. Versey and Mr. Stoneley. The shock was felt at Waterford, in the Channel Islands, the north of France, in Belgium, Holland, and Denmark, and so far east as Hamburg and Brunswick. The epicentre indicated by the map agrees closely with the position assigned to it by the Rev. J. P. Rowland, *S.J.* (see Nature, vol. 128, p. 147, July 25, 1931). It lies under the North Sea, near the Dogger Bank, and about 60 miles from the coasts of Yorkshire and Norfolk. The spacing of the isoseismal lines suggests that the focus was decidedly deeper than in most British earthquakes. The seismograph records show, however, that it was not below the granitic layer.

A representative party of twenty members of the University of St. Andrews, officially accredited by the University Court and travelling under the auspices of the Overseas Education League (see Nature, Aug. 1, p. 196), returned to Southampton on Sept. 26 from an enjoyable and highly successful visit to the provinces of Quebec and Ontario. Throughout their tour the visitors were cordially welcomed by civic and educational authorities and in private homes, and special facilities were placed at their disposal so as to enable them to see as much as possible, in a limited time, of Canadian life, institutions, activities, and resources. The group was officially entertained by the cities of Montreal, Toronto, and Hamilton, by McGill, McMaster, and Queen's Universities, and by the Universities of Toronto and Western Ontario. In Quebec, the members were received by the Lieutenant-Governor at 'Spencer Wood', and were the guests of the Provincial Department of Public Instruction at Kent House, Montmorency Falls. At Montreal, visits were also made to Macdonald College and the Université de Montréal; at Toronto, to the Canadian National Exhibition and Lake Simcoe; at Ottawa, to the National Research Laboratories and the Gatineau district; at Hamilton, to Queenston and Niagara Falls; and at Kingston, to the Royal Military College and the Thousand Islands.

At a farewell dinner, given to the visitors from St. Andrews, at the Chateau Frontenac, Quebec, by Mr. E. W. Beatty, president of the Canadian Pacific Railway and Chancellor of McGill University, Prof. John Read, leader of the party, stressed the importance of such tours as a factor in education and in promoting understanding between Great Britain and the overseas Dominions. He expressed the hope that similar tours will follow this initial venture, and commented on the value of an interchange of teachers, as well as of an increasing number of post-graduate students, between Canadian and British universities. As one means to this end, he advocated the gradual establishment of non-resident lectureships in universities throughout the Empire. The Rev. Father Cannon, of Laval University, in giving the young Scots a glimpse of educational history in Quebec, explained the main factors which have enabled the French- and English-speaking Canadians to live together in harmony. At the conclusion of the evening, according to the *Chronicle-Telegraph*, Quebec, "the score of braw lads and lasses frae the auld grey toun, rose and sang 'Ygorra, Beatty', a version of their University song, in honour of the C.P. president".

THE *Polar Record* (Scott Polar Research Institute, Cambridge), in its July issue, maintains the high standard of usefulness shown in its first issue. There is again a full record of the activities of all exploring expeditions in both north and south polar regions and a great deal of material that is otherwise difficult of access. It is of interest to note that the Russian Academy of Sciences has been exploring the Indigirka region in eastern Siberia and has established several meteorological stations: also that a new research station is functioning in the little-known New Siberian Islands in lat. 73° 11′ N., long. 143° 15′ E. Stations have also been started in Franz Josef Land and, to the east, in the newly discovered Kamenev Islands. In an article on the Second Polar Expedition, 1932–33, Dr. G. C. Simpson gives a list of the many stations which various States propose to establish as their contribution to that international project.

IN discussing, in the issue of *Scientiarum Nuncius Radiophonicus* for July 30, the hypothesis that the penetrating rays originate in the 'annihilation of matter', Prof. Gianfranceschi points out that this expression is not readily acceptable by all. Annihilation of matter, in the sense applied to this process by Jeans and others, would give rise to energy in the form of photons, these being nuclei of radiant energy, which is a state of matter. It seems, therefore, preferable to say that the positive or negative corpuscles are transformed into primigenic matter, with liberation of a certain quantity of radiant energy, of which photons are composed. In this form the hypothesis is capable of wide extension. Electrons and protons are a special form of the universal primigenic matter, and both the formation of corpuscles within this matter and their dissolution to re-form the primigenic matter are possible. This universal primigenic matter is what constitutes space-ether, since, even in the hypotheses of the most advanced relativists, real space has physical properties and is hence a primigenic form of matter.

THE annual Henry Herbert Wills Memorial Lecture in physics at the University of Bristol will be given in the Wills Physical Laboratory by Prof. Niels Bohr on Oct. 5, at 5.15 P.M. Prof. Bohr will speak on "Space-Time Continuity in Atomic Physics".

THE 1931 award of the Ferranti Scholarship of the Institution of Electrical Engineers (annual value £250, tenable for two years) has been awarded to W. G. Thompson, of Armstrong College, Newcastle-on-Tyne.

THE inaugural sessional address of the Pharmaceutical Society of Great Britain will be delivered by Prof. G. E. Gask, dean of the Faculty of Medicine in the University of London, on Oct. 7. The presentation will also be made of the Pereira Medal of the Society.

THE Foreign Work Committee of Leplay House is arranging to take a group to Italy during the coming Christmas vacation. Rome and Naples will be the centres from which Oetia, Tusculum, Herculaneum, Pompeii, Paestum and other places of interest from the archæological, historical, and sociological point of view will be visited. For full particulars application should be made to Miss Tatton, Director, Foreign Work Committee, Leplay House, 65 Belgrave Road, Westminster, S.W.1.

MESSRS. Ernst Leitz, of Wetzlar (London Branch, 20 Mortimer Street, W.1), have recently completed their 300,000th microscope, which, in accordance with their usual custom of dedicating each 50,000th microscope to a well-known scientific worker or institution, has in this instance been presented to Prof. Ludwig Aschoff, of the Pathological Department of the University of Freiburg. This microscope, in addition to having valuable apochromatic objectives, is equipped with the new Ultropaque illuminator (working in incident light) and the complete set of fifteen new objectives specially constructed for this illuminator. The Ultropaque arrangement, which is a recent innovation, has already proved of value in cancer research and in the investigation of living tissues in general. Previous gifts of Leitz microscopes, each marking the completion of 50,000 instruments, have been made to the German Sanatorium for Consumptives, Davos, Switzerland; Robert Koch; Paul Ehrlich; Prof. M. Heidenheim; and the Institut für Schiffs- und Tropenkrankheiten, Hamburg.

MESSRS. W. and G. Foyle, Ltd., 119 Charing Cross Road, W.C.2, have just circulated a comprehensive catalogue (Dept. 7) of second-hand and new books on technical subjects and applied science. In many cases both the published price and that asked for second-hand copies is given—a useful feature.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A chemist-bacteriologist in a margarine factory in St. John's, Newfoundland—The Trade Commissioner, Newfoundland Government Offices, 58 Victoria Street, S.W.1 (Oct. 8). An honours graduate in chemistry at the Wolverhampton Municipal Secondary School—The Director of Education, Wolverhampton (Oct. 10). A London representative of the New Zealand Fruit-Export Control Board—The Secretary, New Zealand Fruit-Export Control Board, Box 882, Wellington, New Zealand (Nov. 30). A lecturer in chemistry at the Handsworth Technical College—The Principal, Handsworth Technical College, Handsworth, Birmingham. A lecturer in the building trades department of the Cape Technical College—Chalmers and Guthrie (Merchants), Ltd., 9 Idol Lane, E.C.3. A chief mathematical master at the Swansea Grammar School—The Director of Education, Dynevor Place, Swansea.

ERRATUM.—In the announcement of Messrs. G Bell and Sons' standard and new science books in last week's issue of NATURE, the title of Prof. E. N. da C. Andrade's "The Structure of the Atom" was incorrectly printed as "The Mechanics of the Atom", and that of his "The Mechanism of Nature" as "The Mechanics of Nature".

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Isolated Quantised Magnetic Poles.

IN the last number of the *Proceedings of the Royal Society,* Dirac has come to the conclusion that the quantum theory requires the existence of discrete magnetic poles of a strength equal to 137÷2 times the electronic charge. If such objects were common one might expect the universe to be a good deal different from what experimenters have found it to be, so far.

There seems no a priori reason why the whole theory of atom building which has been built up for electrons and nuclei—an electrostatic problem apart from details—should not be carried over bodily into the corresponding magneto-static problem of the attractions of the oppositely charged poles. In this way we might, at first, expect to get a set of 'magnetic' atoms, similar to the electric atoms of which matter is generally supposed to be built up. These atoms would be a good deal different from those we think we are familiar with. How much different depends to some extent on what the mass of a magnetic pole is. The quantum theory does not tell this, but I think its value, if it exists, can be fixed by an argument based on classical ideas at about 500 times that of the corresponding electronic object. Following this general line of argument, the dimensions of these magnetic atoms come out at 10^{-14} cm. to 10^{-15} cm. compared with 10^{-7} cm. to 10^{-8} cm. for the atoms of the periodic table. The frequencies of the 'spectral' lines emitted by these magnetically constructed atoms would run about 10^{10} times those of the corresponding lines of the electronic spectra; for example, the first line of the Lyman series would be raised from $\nu = 2{\cdot}5 \times 10^{15}$ to $\nu = 3{\cdot}1 \times 10^{25}$ sec.$^{-1}$ if the corresponding states are capable of existence. Even if quite large changes are made in the mass of the magnetic poles, which is the doubtful element, the corresponding numbers will still remain quite wide apart.

Dirac has suggested that the reason these magnetic poles have not been observed may be that the forces between them are so much larger than those between electrons and protons that they cannot be separated. There is reason for believing they could not get together to the extent indicated by the preceding numbers. The number of kinds of atoms with azimuthal quantum number 1 which can be formed from these magnetic units is much less than unity. This follows from Dirac's formula for the spectral terms for hydrogen, or alternatively, from the principle of minimum time. This may be forcing the required atoms too much into the pattern of those with which we are familiar. In any event, no atom with azimuthal quantum number less than 34½ can be made out of these elements. Otherwise the time factors in the wave functions involve real exponentials and become infinite with lapse of time. However, even with such high quantum numbers the forces would still be enormous compared with those in corresponding electronic structures and the frequencies would still be quite high.

There may be an application of these products of the quantum theory in the field of 'ultra-penetrating' radiations. I have no first-hand knowledge of the process of creation, but I should suspect it would be relatively difficult to create objects with the intrinsic energy of these magnetic poles. It seems likely, therefore, that their abundance would be very small compared with that of electrons and protons, but there might be enough in the universe to account for such ultra-penetrating radiations as are not capable of being accounted for otherwise. The possible existence of such isolated magnetic poles, with properties so very different from those of electrons and protons, obviously changes the basis for discussion of a good many cosmological questions.

O. W. RICHARDSON.

King's College,
London, W.C.2,
Sept. 18.

Similarity between Cosmic Rays and Gamma Rays.

As heretofore indicated,[1] it was in the fall of 1926 that Millikan and Cameron began to use high pressure electroscopes in order to increase the sensibility of their cosmic ray measurements. They built at first two such electroscopes and filled them to pressures of 8 atmospheres and 30 atmospheres respectively. Their first published results [1] were obtained with the 8-atmosphere filling, and they then assumed that for these hard rays the observed ionisation would be proportional to pressure. By directly comparing, however, a little later, similar spherical electroscopes of 1600 c.c. capacity filled to 1 atmosphere and to 8 and 30 atmospheres respectively, they were surprised to find that the ionisation shown in the 8-atmosphere electroscope was but about five times, and that in the 30-atmosphere electroscope was but 13·8 times that in the 1-atmosphere electroscope. These facts were published in one of their 1930 publications,[2] but since the authors were then interested merely in the *variation* in the ionisation in a given electroscope with depth beneath the top of the atmosphere, they made no attempt to discuss the reasons for these low factors. They did, however, *by direct comparisons find that these factors were the same for the gamma rays of radium and thorium as for the cosmic rays, thus bringing to light another significant similarity in behaviour of these two types of radiations.*[3]

Since Broxon [4] and Hoffmann [5] have both, in recent publications, commented upon these pressure-ionisation relations as measured by them, in entire agreement too with our own measurements, but without directing attention to what we consider to be the correct explanation of the phenomena, we have decided to present it herewith in this brief note. There are two causes of this failure, even for very hard rays, of the expected linear relation between pressure and ionisation. The first and the less important of the two is that mentioned by Hoffmann, namely, the mixture with the hardest beta rays which are formed by Compton-encounters with the original cosmic ray photons, of soft secondary beta rays which may be fully absorbed even within the air of the electroscope at 1 atmosphere, and can contribute no more to the ionisation when the pressure is high than when it is low. We have reasons which, merely for brevity's sake, we omit from this brief note, for thinking this cause of departure from linearity in the pressure-ionisation curve to be relatively small. The main cause of divergence from this relation is the following.

The low energy electrons shaken loose by the original ionising beta ray, if thrown an appreciable distance from the parent positive atom at 1 atmosphere, could be thrown but a small fraction of this distance at 8 atmospheres or at 30 atmospheres. The tendency to recombine then increases very rapidly with pressure. This lack of saturation effect will scarcely be noticed at all when the impressed field is varied from, say, 100 volts to 300 volts as in our own experiments. In other words, for such fields the ionisation currents will give all the usual indications of being saturated, though very strong variations of field rising up to thousands of volts, should bring to light the fact that they are not. *This lack of saturation is then, in our judgment—and we have experimental evidence for it—the real cause of the pressure-ionisation effects discussed otherwise by Hoffmann and Broxon.*

R. A. MILLIKAN.
I. S. BOWEN.

Norman Bridge Laboratory,
California Institute, Pasadena, California,
Aug. 15.

[1] Millikan and Cameron, *Phys. Rev.*, **31**, 922 ; 1928.

[2] Millikan and Cameron, *Phys. Rev.*, **37**, 237 ; 1930.

[3] Hoffmann in (5) below comments upon having also observed this relation in his own earlier work.

[4] Broxon, *Phys. Rev.*, **37**, 1320 ; 1931.

[5] Hoffmann, *Zeit. für Phys.*, **69**, 704 ; 1931.

Graphical Indication of Humidity in the Upper Air.

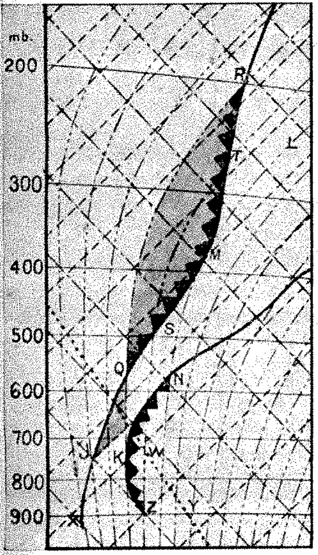

FIG. 1.—Tephigram and estegram: ——, isobars ; – – – –, isentropics ; —·—, isothermals ; . . . . . ., isohygric ; —·–·–·—, saturation adiabatics.

SIR NAPIER SHAW'S representation of upper air temperatures by the method of the T-ϕ or tephigram is, from the thermodynamical aspect, the best that has yet been proposed. The depegram (or graph of dew-point temperatures), which ordinarily accompanies it, is a practical means of representing humidity, yet most meteorologists will agree that it is not as wholly satisfying a method for humidity as the tephigram is for temperature. A thermodynamic indication of humidity along with the tephigram is of importance, especially in the tropics, and further consideration of the mode of representing humidity is therefore desirable.

In the accompanying diagram (Fig. 1), X the dry bulb and Y the dew-point temperatures at the 900 mb. level, are plotted on tephi-paper. The isentropic XW and the isohygric (or line of constant specific humidity) YW are drawn and intersect at W. Through W is drawn the saturation adiabatic WZ, cutting the 900 isobar at Z. We may call Z the 'saturation' temperature or *S.T.*, and direct attention to the following important properties: The *S.T.* is so nearly the same as the ventilated wet bulb temperature that in practice they may be substituted for one another.[1] If a sample of the air at the 900 mb. level is raised adiabatically, the dry bulb temperature of that sample moves along the isentropic XW, the dew-point temperature along the isohygric YW, and the saturation temperature along the saturation adiabatic ZW. The air becomes saturated at W, all the three temperatures coincide there, and further upward displacement causes them to follow the saturation adiabatic WST. Beyond T the saturation adiabatic runs parallel to a dry isentropic; that is, it is associated with, and can be identified by, a definite value on the potential temperature scale. That potential value of the *S.T.* (or wet bulb) is allied to the equivalent potential temperature; it remains an invariant in all adiabatic processes whether the air is saturated or not.

If the saturation temperatures or the wet-bulb temperatures of the upper air be plotted on the appropriate isobars or tephigram paper, the resulting graph of *S.T.*'s, or estegram, proves to be of greater importance thermodynamically than the depegram. We may note the following points:

(1) From any two of the three graphs, tephigram, estegram, and depegram, the third may be readily constructed on tephi-paper without reference to tables.

(2) If we define air of latent instability to be air which, when raised adiabatically, finds at some level above the condensation level an environment in which it is unstable, then all air samples of latent instability are indicated by the points on the estegram that lie to the left of the lowest saturation adiabat tangential to the tephigram. For example, LMN is the lowest saturation adiabat tangential to the tephigram $XQMR$, and to the left of it lies the portion ZN of the estegram; hence the layers of air between the heights represented by Z and N are those which on adiabatic ascent will develop instability in another higher layer.

(3) Superadiabatic gradients being excepted, all layers which form a latent unstable environment for samples of air displaced adiabatically upwards from one or more of the lower layers are indicated by points on the tephigram which lie to the right of the highest saturation adiabat tangential to the estegram. For example, KQR is the highest saturation adiabat that touches the estegram, and to the right of it lies the portion QMR of the tephigram; Q and R therefore represent the limiting heights between which instability may arise on account of the adiabatic ascent of a lower layer.

(4) If the lowest saturation adiabatic tangential to the tephigram lies wholly to the left of the estegram, then no layer possesses latent instability. This is frequently the condition of continental air in India. On the other hand, oceanic equatorial air seems frequently to possess so marked a latent instability that samples of the lower air when raised adiabatically will release more energy during the higher unstable portion of their ascent than is needed to be supplied in the lower stable portion. The point J on the diagram (with *S.T.* at K) represents such an air sample, because the area QRM represents a much greater release of energy than needs to be supplied to raise the sample from J to Q.

A classification of Indian tephigrams, suggested by the above considerations, is being undertaken by a research student.

C. W. B. NORMAND.

Poona, India, July 20.

[1] Cf. *Ind. Met. Mem.*, **23**, part 1.

Activated Adsorption.

THE transition from van der Waal's adsorption to activated adsorption is shown by a minimum on the adsorption isobar,[1] and a similar minimum occurs on the isobar representing the transition from activated adsorption to chemisorption.[2] There is thus a region of temperature over which the amount of adsorption increases with rise in temperature. The experimental work so far published shows that, at least in the case of the first type of transition, the processes are reversible. The positive temperature coefficient must therefore be associated with an increase in the heat of adsorption.

If ϕ be the activation energy of the surface atoms and Q the heat liberated on adsorption, then at constant pressure the number of surface atoms which are covered by gas molecules will be given by $N' = N . e^{(Q-\phi)/RT} . k$, where k is a constant but slightly affected by temperature. In the above transitional regions, $Q - \phi$ must possess at first a negative value, ultimately becoming zero and then positive. It is unlikely that ϕ will decrease with increase in temperature, therefore Q must become larger as the temperature is raised. There are but few experimental data bearing on this point. The heat of adsorption of oxygen on charcoal, for the same amount of gas adsorbed, increases from 70 to 110 k.cal. as the temperature increases from 20° to 110° C.[3] From 100° to 200° C. the heat is practically constant. These values probably refer to a transitional region between van der Waals and chemisorption, but this is somewhat uncertain. The figures, however, lend support to the above view, that the heat of adsorption in the transitional regions increases with rise in temperature. More experimental work is needed on the effect of temperature on the heat of adsorption.

The activated surface atoms will undoubtedly be mainly singlets at low temperatures, but doublets will increase in number as the temperature is raised. The increase in the heat of adsorption may be due to this fact, for the energy liberated on adsorption will probably be the greater the more activated the group of surface atoms by which the adsorbed molecule is held.

W. E. Garner.

The University, Bristol.

[1] Cf. Benton and White, *Jour. Amer. Chem. Soc.*, **52**, 2332; 1930; and Taylor and Williamson, *Jour. Amer. Chem. Soc.*, **53**, 2178; 1931.

[2] Garner and Kingman, Nature, **126**, 352; 1930. *Trans. Far. Soc.*, **27**, 322; 1931.

[3] Garner and McKie, *Jour. Chem. Soc.*, 2455; 1927.

Change of Dielectric Polarisation of Nitrobenzene with Temperature.

Recently one of us (J. M.) has determined the changes of density D and dielectric constant E of nitrobenzene with temperature.[1] In this connexion we would like to repeat here that the freezing point of nitrobenzene lies at 5·5° C. and not at 9° as given in the Landolt-Börnstein tables.

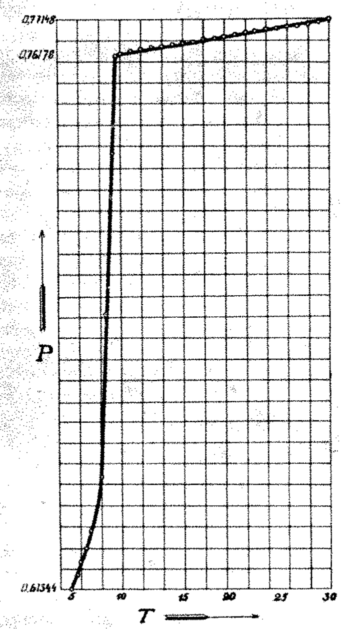

Fig. 1.

On the basis of these data, we have computed the dielectric polarisation P of nitrobenzene, according to the formula of Clausius-Mossotti,

$$P = \frac{E-1}{E+2}\frac{1}{D}$$

The results of this computation for the temperatures between 5·5° C. and 30° C. are represented on the accompanying curve (Fig. 1).

The value of P changes linearly with temperature, varying from 30° down to 9·6°. At 9·6° there appears a sudden drop in the value of P. This suggests that at the point 9·6° (which, as our former studies have shown, is a transition point from one liquid modification of nitrobenzene into another one, also liquid) the structure of the molecule undergoes a change. We have therefore to do here with a phenomenon somewhat different from that appearing in liquid helium, where the structure of the molecule does not undergo a change.[2]

The summary of the results we have obtained with nitrobenzene can be stated as follows: at the point 9·6° there appears to be a jump of the value of dielectric constant; a distinct change of slope in the density curve, and a very distinct change in the value of the refractive index.

M. Wolfke.
J. Mazur.

Physical Laboratory, Technical Institute,
Warsaw, July 20.

[1] J. Mazur, Nature, **127**, 741, 893; 1931.

[2] M. Wolfke and W. H. Keesom, *Comm. Leiden*, No. 192*a*.

Charged Aerosols and Ball Lightning.

Messrs. Cawood and Patterson conclude their extremely interesting account of the behaviour of electrified aerosols with the comment:[1] "The existence of such a spherical highly charged assemblage of particles suggests that globular lightning may owe its origin to an analogous effect, in which particulate matter, either liquid or solid, is charged to a very much higher potential".

Is it advisable to consider only liquid and solid particulate matter in this connexion?

Is it not conceivable that gaseous molecules, if charged to a sufficiently high potential, may mutually repel each other so strongly that the properties of the assemblage cease to be that of a similar one subject only to ordinary Maxwellian thermal movements, forming temporarily an unstable expanded mass, perhaps of considerable tenuity, surrounded by normal gas at ordinary pressure?

Puzzling features of ball lightning are the violent explosions which sometimes occur inside a room, without damage to persons present or furniture.[2, 3]

If an attenuated electrified mass of gas can suddenly collapse, like an evacuated electric light bulb, it would afford an explanation of this mysterious behaviour.

During the explosion of certain gaseous mixtures, charged molecules which are not subject entirely to Maxwellian thermal movements, temporarily, may complicate the phenomena.

Exceptionally high voltages can now be developed in a few research stations; further research may reveal the conditions under which the charged aerosol behaviour can be extended to gases.

William C. Reynolds.

16 Southern Drive,
Anlaby Park, Hull.

[1] Nature, July 25, 1931, p. 150.

[2] Marchant, Nature, Jan. 25, 1930, p. 128.

[3] Reynolds, Nature, March 15, 1930, p. 413.

Resonance Spectrum of Hydrogen.

WHILE we were attempting to photograph the spectrum of arsenic by the Paschen hollow cathode discharge in helium, plates were obtained which revealed with remarkable intensity the Lyman series of hydrogen extending down to the 15th member. The most interesting feature of the series, however, is the peculiar distribution of intensity among its members. Instead of the intensity diminishing steadily to the very last member, it diminishes rather slowly to the 10th member; there is a definite increase in intensity of the 11th and then an abrupt fall, so that the remaining members are only just observable.

Further experiments under varying conditions of pressure of helium and arsenic in the discharge have definitely indicated that the phenomenon must be interpreted as a case of resonance occurring only in the presence of arsenic. With a high pressure of arsenic and a low pressure of helium, the 10th and the 11th members of the Lyman series appear with considerable intensity (the 11th being stronger), while the others show a rapid diminution in intensity, the 8th and 9th being very faint.

It is considered that the energy of excitation of this resonance spectrum is to be sought for in a transfer, by collisions of the second kind, from the excited arsenic atoms. Further investigations are in progress to determine the exact value, from series data, of the first ionisation potential of arsenic, a knowledge of which throws considerable light on the correct interpretation of the phenomenon.

A full report of the results will be published as soon as they are ready.

K. R. RAO.
J. S. BADAMI.

Physikalisch-Technische Reichsanstalt,
Charlottenburg, Berlin,
Aug. 25.

Contraction Constants of Enzyme-Substrate Reactions.

CHANGES of volume accompanying enzyme hydrolysis have been utilised by Sreenivasaya and Sastry[1] to follow the kinetics of enzyme action by means of the dilatometer. The procedure employed in the above investigation does not bring into consideration the substantial volume change occurring in the initial stages of the reaction, and therefore gives no idea of the total contraction resulting from the complete hydrolysis of the substrates. The total contraction given by an enzyme-substrate system depends only on the absolute amount of the substrate in the reaction mixture, and is proportional to it.

The contraction of a few systems has now been investigated by a specially designed dilatometer; the contraction per gram-molecule of the substrate has been calculated, and found to be a constant for each enzyme-substrate system. For urea-urease the constant is 24, while sucrose-invertase has a constant of 6. These constants are of considerable value in the dilatometric estimation of substrates in physiological liquids and plant saps. Constants for other enzyme-substrate systems are being determined.

M. SREENIVASAYA.
H. B. SREERANGACHAR.

Department of Bio-chemistry,
Indian Institute of Science,
Bangalore, July 15.

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[1] *Biochem. Jour.*, **23**, 975; 1929.

The Treatment of 'Gapes' in Chickens.

OUTBREAKS of 'gapes' among chickens usually lead to a very high mortality. The disease is due to the presence of the nematode worm *Syngamus trachealis* Lieb. in the windpipe. Treatment with turpentine in olive oil, applied with a feather, is often successful in skilful hands, but I have only saved one pullet thus. A severe outbreak occurred among my chickens in March 1930, and I treated a number with carbon tetrachloride dissolved in medicinal paraffin, probably about a two per cent solution. Fewer died than I expected, but being otherwise occupied, no records were kept.

In January this year four chickens were hatched out, and all developed gapes when about a month old. Two died, and I started to treat the remaining two cockerels by giving, on three successive nights, about 2 c.c. of carbon tetrachloride solution, administered by means of a pipette with teat. Though one appeared to be very ill at the start, both recovered. Successive outbreaks were similarly treated, fourteen birds in all, with only one death up to about the end of May. The birds were usually a month or six weeks old when attacked. Late in May, however, gapes appeared in two broods, of eight and six, when about a fortnight old. The treatment failed completely, and thirteen died, even though the amount of carbon tetrachloride was increased up to probably about five per cent. One pullet, however, never contracted gapes, though she must have been as heavily infected as the others. This bird is still alive, and might form the starting point of an immune race.

Though unsuccessful among chickens a fortnight old, the treatment has undoubtedly been successful among older birds, and appears to be worth the attention of those engaged in work on poultry. My own trials were rather rough and ready, a cure rather than a definite research being the object. The breeds were Light Sussex and White Wyandotte, including crosses.

W. R. G. ATKINS.

Antony, Torpoint, Cornwall.

A Spark Method of Measuring High Resistance.

A CONDENSER of capacity $c\mu f$ charged through a resistance r megohm by a battery of e volts, has at any instant a charge $q = ec(1 - \epsilon^{-t/cr})$. After a time, t sec., the charge is approximately equal to 2/3 ec. The attainment of this stage in the charging process may be determined by inserting a spark gap in parallel with the condenser, of which the sparking potential is 2/3 e, the spark passing when $t = cr$.

This suggests a method of measuring resistances of a high order (or capacities of a low order), and some preliminary experiments have been made with standard megohms and xylol alcohol resistances of the order of 10^8 ohm. The spark gap consisted of two platinum wires about 1 mm. apart fused into a highly evacuated glass tube, the sparking potential being about 410 volts. The values obtained for the resistances in this manner were about 10-15 per cent too great, but consistent results were obtained in all cases. The large results (that is, large values of t) obtained are probably due to leakage through the condenser insulation or across the glass of the spark tube. The elimination of these defects is under investigation, and it is hoped shortly to publish elsewhere the results of further work.

J. A. C. TEEGAN.

London, Aug. 17.

Research Items.

A Late La Tène Spear-head from the Thames.—In *Man* for September, Mr. T. D. Kendrick describes and figures a remarkable ornamented iron spear-head found in the Thames at London and now in the possession of Captain Ball. It is 11·8 inches long and has a broad triangular blade with rounded base angles. The wings are flat; but the blade itself is bisected on each face by a raised mid-rib, sharp-edged and triangular in section. This extends from tip to base, where it merges into the socket, which is faceted for a short length and then runs on round-sectioned. The forging is excellent and shows no trace of the annealed joint. Bronze plates are affixed to the lower part of the wings on each face—thin strips of metal with bevelled edges about 3½ inches long. They are applied as four separate pieces, being fastened in position by a number of neat little pins, of which two have the heads traversed by the ornament on the plates. No two of the plates are alike, but each is cut into a sinuous form with eccentric leaf-shaped protuberances, and each is ornamented with an incised design in which a disc-ended S-shaped scroll, set off against a basket-work background, is the principal element. The pattern is not in the best tradition of this sort of work. The form of the spear-head would suffice to date it to the La Tène period. A large number of decorated spear-heads have been found abroad and some in Ireland. Yet this single English specimen is unique among all decorated La Tène spear-heads because of the manner of its ornament. Other spear-heads are decorated by inlay or by incised or openwork devices in the iron blade, but here it is in the form of applied plates of a different metal. In richness of decoration it is surpassed by a specimen from Hungary and one from Switzerland; but it is much later than either. It belongs to the middle of the first century A.D., and must be regarded as an important document for the study of 'Celtic' art in Britain, marking the complete disappearance of the fluid elegance of the earlier foliate design.

Speed of Flight of Birds.—An important contribution to our knowledge of the speed of flying birds is made by T. H. Harrisson in *British Birds* (Sept., p. 86). The data were obtained by well-designed methods of using a motor-car and motor-cycle; they cover 103 records for thirty-six species, and they refer only to normal daily flight. Comparison of the figures here with those which have been published by other observers suggests that in some species at least (for example, rook, swallow, and lapwing) there may be a difference between the speed of migratory and of normal daily flight. But it is evident also that speed for a species is not a constant: ten sets of records for the starling give speeds ranging from 48 to 24 miles an hour, the non-migratory speeds ranging from 32 to 24 m.p.h.; and eight readings gave the ring-dove a range from 51 to 27 m.p.h. The speeds of different species show striking differences: the fastest speed recorded by the author was 59 m.p.h. for a stock-dove, the slowest 17 m.p.h. for a herring-gull, and the seemingly slow tawny owl gave speeds of 45 and 41 m.p.h., while the swallow (eleven observations) yielded no better than a range from 23 to 32 and an average of 27·3 m.p.h.

Japanese Nematodes.—Dr. Shigemoto Imamura in his paper "Nematodes in the Paddy Field" (*Journal of the College of Agriculture*, Imperial University of Tokyo, vol. 11, No. 2; 1931) investigates the nematodes of the rice fields and their numbers before and after irrigation. This is an exceedingly interesting and important subject. Forty-eight species belonging to twenty-five genera are described and figured. The Anguillulidæ are by far the most numerous, amounting to more than seventy-five per cent of all those found in the fields before irrigation. The worms belonging to this family are more or less injurious to the higher plants, and it is found that after irrigation their numbers are reduced to less than one-third. The whole nematode population after irrigation was reduced to about half as many as before, but whereas before irrigation they were chiefly those which were injurious to the crops, after irrigation they were chiefly those which fed on other animals, including the Anguillulidæ, the predatory genus *Mononchus* being much to the fore. The results of these investigations suggest that the irrigation either causes the injurious nematodes to be drowned or to be devoured by other nematodes such as *Mononchus*. Most of the nematodes both before and after irrigation occurred in the layer of soil in which were the roots of the rice plants.

Duration of the Pleistocene Period.—An address to the American Association for the Advancement of Science by G. F. Kay on the classification and duration of the Pleistocene is published in the *Bull. Geol. Soc. Amer.*, **42**, pp. 425-466, 1931. Reasons are given for the interpretation that Pleistocene history involves four cycles from the time of advance of the first ice-sheet, the Nebraskan, to the retreat of the last, the Wisconsin, each being recorded in the deposits laid down during the early glacial stage and in the changes which those deposits underwent during the interglacial stage. New names have been chosen for the four epochs so defined: *Grandian* (Nebraskan and Aftonian), *Ottumwan* (Kansan and Yarmouth), *Centralian* (Illinoian and Sangamon), and *Eldoran* (Iowan, Peorian, and Wisconsin). The evidence used in estimating the durations of the interglacial stages was gained from field studies in Iowa of the relative depths of the leaching of calcium carbonate in similar materials which throughout their times of leaching were similarly situated topographically and climatically. The results in years are: post-late Wisconsin, 25,000; post-Iowan, 55,000; Sangamon, 120,000; Yarmouth, 300,000; and Aftonian, 200,000. The *minimum* duration of the times of actual glaciation is estimated at 30,000 years. The combined estimates give for the whole of the Pleistocene in Iowa a minimum of about 700,000 years. In so far as the rate of downward leaching may well have decreased as the depth increased, it is judged that the Pleistocene deposits may actually represent a much longer time, possibly up to two million years.

A Connexion between Electricity and Magnetism.—It is invariably found in experimental investigations that magnetic poles have to be dealt with in quantities equal in amount and opposite in sign. With the usual method of formulation, this fact is taken over into quantum mechanics, which is thus applicable only when there are no isolated magnetic poles. In a paper in the September number of the *Proceedings of the Royal Society*, Dr. P. A. M. Dirac shows that this restriction can be removed by a natural development of quantum mechanics. The new theory leads to a simple formula $hc/2\pi e\mu_0 = 2$, where μ_0 is a quantum of magnetic pole strength and the other symbols have their conventional significance. Comparing this with the well-known relation $hc/2\pi e^2 = 137$, which is known to be closely true from experiment independently of any theory, shows that $\mu_0/e = 137/2$. In other words, the attractive forces between two one-quantum poles of opposite sign is almost 5000 times that between electron and proton, a result which may explain why a separation of poles of opposite sign has never been effected.

Estimation of Dissolved Metals.—In the September number of the *Proceedings of the Royal Society*, F. Twyman and C. S. Hitchen describe an improved spectrophotometric method for the estimation of metals in solutions. It consists in principle in the measurement of the intensity of a line from its length in the spectrum photograph obtained when a disc of special contour is rotated in front of the slit of the spectrograph during the exposure. Much attention has to be paid to details of procedure, such as the operation of the spark source of light and the development of the plate, but it appears that the necessary operations, which are described in full detail, are neither unduly laborious nor intrinsically difficult. The method, as given for minor constituents in solutions of metals, seems to have as great advantages as the corresponding method for the analysis of alloys; it is rapid, sufficiently accurate, and often superior in many respects to a chemical analysis, whilst the spectrogram gives a permanent record of the analysis.

Constitution of Cyanidin Chloride.—In a communication to the *Journal of the Indian Chemical Society*, vol. 8, p. 329, Dr. M. Nierenstein discusses the constitution of cyanidin chloride, a substance which is of interest both to chemists and to botanists on account of its relationship to the anthocyanidin pigments of flowers. Since cyanidin chloride breaks down on hydrolysis to phloroglucinol and protocatechuic acid, it is necessary to ascertain the mode in which the two nuclei of these products are linked in cyanidin. Willstätter ventured in 1914 to assign a definite structure to the latter compound, since it was supposed that it could be produced from the anthoxanthone quercetin by reduction. The fact that this reduction theory, though strongly favoured by Everest, Willstätter, and other chemists, appears to conflict with botanical evidence led Malkin and Nierenstein to reinvestigate the matter. These authors (*Jour. Amer. Chem. Soc.*, **52**, 2864; 1930) were able to show that reduction of quercetin leads to a dimolecular product, quercetylene chloride, and not to the monomolecular pentahydroxyflavylium chloride, which has the structure assigned by Willstätter to cyanidin chloride. It appears that both quercetylene chloride and pentahydroxyflavylium chloride have been identified with natural cyanidin chloride, but the evidence on which identity of composition is based is stated to be inconclusive. Furthermore, X-ray analyses of the natural cyanidin chloride and the synthetic product have revealed their dissimilarity. Thus there appears to be some doubt about the actual structure of cyanidin chloride. A possible solution of the problem, based on the fact that Freudenberg has reduced the compound to epicatechin, is tentatively suggested in the paper.

Astronomical Topics.

Detection of Neujmin's Comet, 1913 III.—Search for this comet has been going on for some months. A telegram from the U.A.I. Bureau, Copenhagen, on Sept. 26 announced that Dr. Nicholson, at Mount Wilson, had found it in the following position:

Sept. 17^d 12^h 18·0^m U.T., R.A. 4^h 43^m 48^s,
N. Decl. 38° 29′, Mag. 15. Daily motion +40^s, N. 9′.

It was stated that there was no nebulosity; this was frequently the case in 1913.

This position and the motion are satisfied within 1′ by the following elements, which are from the B.A.A. Handbook for 1931, with adjustments to period, eccentricity, and date of perihelion:

$$\begin{array}{rl} T & 1931\ \text{April}\ 29{\cdot}98\ \text{U.T.} \\ & \left.\begin{array}{llll} \omega & 346^\circ & 57' & 48'' \\ \Omega & 347 & 18 & 10 \\ i & 15 & 9 & 3 \end{array}\right\}\ 1931{\cdot}0 \\ & \begin{array}{llll} \phi & 50 & 47 & 54 \end{array} \\ \log q & 0{\cdot}18415 \\ \text{Period} & 17{\cdot}689\ \text{years.} \end{array}$$

EPHEMERIS FOR 0^h U.T.

	R.A.	N. Decl.	log r.	log Δ.
Oct. 2.	4^h 49^m 43^s	40°40′	0·3712	0·2566
10.	4 49 32	41 45	0·3828	0·2514
18.	4 46 31	42 42	0·3942	0·2475
26.	4 40 58	43 27	0·4054	0·2460

This comet must be ranked as belonging to Saturn's family; its orbit makes a close approach to that of Saturn in the region passed by the comet after aphelion. It is the second member of the family to be observed at a second apparition. Tuttle's comet has been observed at seven apparitions.

Collapsed Stars and Novæ.—Prof. E. A. Milne suggested, in the *Observatory* for May, that novæ are the result of the collapse of a star of ordinary density. This collapse may produce rotational instability and cause the star to split into two portions. These may then re-expand, which would give an ordinary binary star. A system like that of Sirius might result if the larger star re-expanded, while the smaller one retained its high density. The very great disparity in state of the components of Sirius, both presumably of the same age, might thus be explained.

Incidentally, Milne concludes, from the observed frequency of novæ, that every star is a nova at least once in its history. This suggests the question: Has the sun had the disease yet? The appulse of another star, which is the current explanation of the birth of the planetary system, would produce conditions in the sun that would bear some resemblance to an outburst of a nova. Milne ranks the nuclei of planetary nebulæ, also ex-novæ, and possibly the ordinary Wolf-Rayet stars, as collapsed stars that have a high density and a high temperature.

Velocity of Light from the Spiral Nebulæ.—Some months ago Prof. Perrine made the suggestion that the positions of the distant spirals with reference to stars in their vicinity should be observed at different times of the year, as a test whether they indicated the same velocity of light as that from bodies in our own galaxy. It was not anticipated that any difference would be shown, as ever since the Michelson-Morley experiment it has been generally accepted that light from any source gives the same measured velocity. It was, however, of considerable interest to make the experiment. This has been done by Mr. Gustaf Strömberg, using plates obtained with the 60-inch reflector at Mt. Wilson; the results are given in *Pubs. Astr. Soc. Pacific*, August 1931. They give the same aberration constant for the stars and the nebulæ within 0·006″, which is far below the limits of probable error. Hence the velocity of light from the nebulæ is not influenced by the large recessional speed (11,000 km./sec.) which Humason found for the nebulæ that were observed by Strömberg.

The International Illumination Congress.

THE International Illumination Congress, which took place on Sept. 1–19, was the first conference of this kind to be held in Great Britain. Something like twenty different countries were represented and the number of names on the official membership list exceeded 500. It may be recalled that the Congress consisted of two distinct sections: the initial period during which members visited in succession London, Glasgow, Edinburgh, Buxton, Sheffield, and Birmingham; and the subsequent stage, on Sept. 13–19, which took place at Cambridge and was devoted to the proceedings of the International Commission on Illumination. During the first period more than a hundred different papers on varied subjects were presented and discussed; at Cambridge, reports from the various national committees surveying progress in different fields or making suggestions for international action were presented, and in some cases effect was given to these suggestions by suitable resolutions.

The programme in London (Sept. 1–3) was mainly social. Such institutions as the National Physical Laboratory, the E.L.M.A. Lighting Service Bureau, the G.E.C. Research Laboratories at Wembley, and the training centre for gas engineers at Watson House were visited. At a luncheon given by the Gas Light and Coke Co. and the leading London electric supply undertakings on Sept. 2, the toast of the Congress was proposed by the Rt. Hon. George Lansbury, M.P., who, on behalf of H.M. Office of Works, had taken a keen interest in the floodlighting arrangements. On the evening of the following day there was also a dinner at the Dorchester Hotel, at which the president (Mr. C. C. Paterson) presided. There were also motor trips round the streets of London by night and a visit to the Croydon aerodrome, where night-flying by artificial light could be witnessed. But the most interesting event of the London programme was undoubtedly the steamboat trip from Westminster to the Port of London, the return journey of which was designed to enable visitors to inspect the floodlighting.

Much has been written regarding the floodlighting, which aroused extraordinary popular interest. It is stated that the crowds on the evening of Sept. 2, the opening day, were the greatest in London since Armistice night. It is impossible to describe this lighting in detail, but there were several features of exceptional interest. The most brilliant illumination (estimated at 20 foot-candles) was attained on Buckingham Palace, which received light from 183 projectors, each rated at 1500 watts; but the treatment of other buildings was artistic and successful, such as the floodlighting, by rose-coloured light, of Somerset House and the pleasing 'local lighting' of Thames House, which enabled its architectural features to be 'picked out' and the roof to be revealed by special strip reflectors. Considerable enterprise was shown in two examples of gas-lighting, the special treatment of Whitehall (bringing the illumination up to Class "A" standard, that is, a minimum of 2 foot-candles, which is attained in no other street in Great Britain) and the floodlighting with gas of St. James's Park. The latter, whilst very effective pictorially, is of considerable technical interest because of the novel gas-lighting projectors designed specially for this scheme. During September there were, however, more than fifty towns throughout the country where floodlighting installations were arranged; Edinburgh Castle may be mentioned as a most noteworthy and effective example of floodlighting.

The party left for Glasgow on Sept. 3. On the following morning, a civic welcome was extended to them by the Lord Provost at the Royal Technical College, where the sessions took place. At Glasgow there were three simultaneous sessions, devoted respectively to lighting developments, photometric precision, and daylight. The papers grouped under lighting developments were mainly descriptive. Miss C. Haslett and Miss Nora E. Millar put in a plea for better domestic lighting. Mr. C. W. Sully emphasised the importance of good lighting to electric supply undertakings, which should set up well-staffed 'lighting service' departments. Sig. C. Clerici reviewed recent progress in illuminating engineering in Italy. Mr. C. A. Atherton presented an informative paper surveying educational methods throughout the world and illustrating (by reproductions of posters, etc.) the effect of national characteristics.

In these three sessions twenty-seven papers were presented, so that one cannot do more than briefly indicate a few salient points. The chief item in Section 2 (Photometric Precision) was a comprehensive survey of photometry by the National Dutch Committee, in which reference was made to the unsatisfactory nature of the various existing photometric standards. There appear to be two alternative possibilities, either a standard based on physical photometry or one based on the use of tungsten lamps of known dimensions. The latter seems the more practical method. Other papers were designed to show the degree of precision possible in laboratory and commercial photometry. Thus R. Kovesligethy and P. Selenyi and also L. Simek (Czechoslovakia) indicated the possibility of confining errors to within 0·25 per cent. A useful contribution by B. P. Dudding and G. T. Winch led to the interesting conclusion that the error in visual photometry consists of two approximately equal portions, arising respectively from imperfect visual judgment and inaccuracies in establishing the standard electrical pressure at which lamps operate. A further inference may be made that, if suitable precautions are taken, laboratory photometry based on the use of photoelectric cells gives greater consistency than is attainable by visual methods. Of special interest was the analysis by A. K. Taylor (G.B.) and by J. Wetzel and A. Gouffé (France) of errors in portable photometers. In the discussion, the importance of accurate control of the current taken by the lamps in such photometers was emphasised; it is regarded as doubtful whether adequate precision can be obtained from customary types of ammeters or voltmeters, and more sensitive methods (based on the use of null-points and bridges, etc.) have been suggested by J. T. MacGregor Morris.

There were no less than ten papers included in the Section on Daylight Illumination, the authors of which were drawn from seven different countries. Of the three British papers, that by P. J. Waldram contained an informative survey of the development of legal aspects of access of natural light, and the corresponding photometric methods that have been evolved in Great Britain. There appears to be good basis for the suggestion that in buildings a minimum daylight factor of at least 0·2 per cent should be adopted. With the normal sky-brightness of 500 lux already approved by the International Commission on Illumination, this factor would correspond to a minimum of 1 foot-candle.

On the evening of Sept. 4 there was a civic reception in the City Chambers by the Lord Provost, followed by a tour of inspection of the lighting of streets in

Glasgow and its environs. The following day was devoted to a pleasant excursion on the Firth of Clyde, and on Sept. 6 the party travelled on to Edinburgh, breaking the journey at Gleneagles. It had been remarked that in Glasgow there was little or no floodlighting, whilst at Edinburgh attention had been concentrated on the illumination of the Castle, which on account of its commanding site is an ideal subject. Although the degree of brightness in this case was less than in some London installations, the effect was very fine, the inequalities in the illumination of the extensive surface of the walls operating as a positive advantage.

At Edinburgh also there was a very full programme of papers, no less than 34 being presented in the four sections dealing with public lighting, diffusing materials, aviation lighting, and physiological problems. The outstanding session, however, was that devoted to public lighting. This was undertaken jointly with the Association of Public Lighting Engineers, the eighth annual conference of which was being held simultaneously. The morning papers were mainly statistical. Contributions reviewing progress in gas and electric street lighting were presented by Sir Francis Goodenough and Mr. W. J. Jeffery. Of considerable scientific interest was the account by Mr. W. S. Stiles ("Mass Experiments in Street Lighting") of impressions of degree of glare, visibility, etc., gathered in Sheffield and Leicester by an appeal to a considerable number of observers.

The afternoon session resolved itself largely into a discussion of the British Standard Specification for Street Lighting, which was ably dealt with by the president (Mr. C. C. Paterson) and others. Modifications in the original specification were explained and the difference between 'methods of grouping' and 'criteria of excellence' illustrated. These papers gave rise to a good 'international' discussion, and the chairman (Dr. N. A. Halbertsma, of Holland) excited general admiration by his interpretations in three languages and his skilful guidance of the discussion. An informative contribution was that of C. Clerici (Italy), who described the lighting of the arterial road from Rome to Ostia, by means of 60 watt fittings 'staggered' at intervals of only 25 ft.—an example of remarkably close spacing. In the section on aviation lighting, the papers by H. N. Green ("The Light Distribution from Navigation Lamps") and the British National Committee ("Ground Lighting Equipment for Aviation") were of special merit. In Section 2, J. W. Ryde and B. C. Cooper were responsible for two papers dealing with the theory of opal glasses. Japan was responsible for three papers in this section. On Sept. 8, visitors left for Buxton, where the next sessions were held.

(*To be continued.*)

Photographic Analysis of Explosion Flames.*

IN principle the method usually employed for the photographic analysis of explosion flames is the same as that originally designed by Mallard and Le Chatelier fifty years ago. It consists in photographing the movements of the flame along a horizontal glass tube on a sensitised plate or film moving vertically at a suitable known velocity, thus obtaining (*inter alia*) a graph compounded of the two velocities, from which that of the flame at any point can be deduced. Mallard and Le Chatelier employed horizontal tubes of diameter between 1 and 3 centimetres in sections, each 1 metre long, connected in series by means of caoutchouc rings. The whole was focused, by means of a wide aperture lens, on a plate moving vertically with a known uniform velocity of about 1 metre per second.

As the plates used by Mallard and Le Chatelier were not sufficiently sensitive to give satisfactory records with feebly luminous flames, such as those of hydrogen-oxygen explosions, they employed explosive mixtures of carbon disulphide with either oxygen or nitric oxide, the flames of which are much more actinic, believing them to be typical of all explosive 'oxygen' or 'air' mixtures respectively. The behaviour of these mixtures on explosion was found to differ according as they were ignited at or near (*a*) the open, or (*b*) the closed end of a tube. In the former case the flame always proceeded for a certain distance along the tube at a practically uniform slow velocity, which was regarded as the true rate of propagation 'by conduction'. This initial 'uniform movement' was usually succeeded by an 'oscillatory period', the flame swinging backwards and forwards with increasing amplitude, and finally *either* dying out altogether *or* giving rise to 'detonation', according to circumstances. With some 'oxygen'-mixtures the initial period of uniform velocity was short, and appeared to be succeeded abruptly by 'detonation', without passing through any intermediate oscillatory period. When, however, the mixtures were ignited near the *closed* end of the tube, the forward movement of the flame was continuously accelerated until finally 'detonation' was set up. In 'detonation', where the explosion is propagated from layer to layer by 'adiabatic compression', the flame velocities are both uniform and high, usually of the order 2000 to 3000 metres per second.

The experimental method was developed and improved by the late Prof. H. B. Dixon and his collaborators in Manchester during the nineties of last century. They used a highly sensitive film rotating vertically on the periphery of a drum with a constant velocity (which, however, varied between 25 and 50 metres per second in different experiments), the explosion tube being placed at such a distance from the camera that the size of the image was about one-thirtieth of the flame. In this way they analysed the progress of an explosion from its origin up to the final attainment of its maximum force and velocity in 'detonation'. They also discovered (i) the wave of 'retonation', which is thrown back through the still burning or chemically active medium from the point where detonation starts (a phenomenon also independently discovered by Le Chatelier in 1900), (ii) the effects of collisions between two explosion waves, as well as of the passage of 'reflected waves' through the hot products of combustion behind the flame front.

Within recent years the experimental method has been further developed and improved in the laboratories at the Imperial College, South Kensington, chiefly by means of the new high-speed photographic machines designed by Mr. R. P. Fraser, which have so increased its analysing power that it is now possible to photograph and measure movements in explosive flames occurring periodically with frequencies up to 250,000 per second. With a new type of camera embodying the principle of a mirror revolving *in vacuo* at high constant velocity (16,000 r.p.m.) and projecting the image of the explosion flame on to a stationary film, we hope soon further to increase the analysing power four- or five-fold. So that in the near future we hope to be able to photograph and measure periodic flame-movements occurring with frequencies of a million per second.

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* Substance of an evening discourse delivered before the British Association on Sept. 24 by Prof. William A. Bone, F.R.S.

The results already obtained have modified and corrected many of our former ideas concerning the nature of the initial phase of slow uniform flame-movement in gaseous explosions, and (*inter alia*) completely disproved the supposed 'law of flame speeds'. Indeed, it now seems probable that what Mallard and Le Chatelier visualised as flame propagation 'by conduction' is an ideal condition perhaps realisable only when a stagnant explosive mixture is ignited without impulse at the centre of a spherical vessel of infinite radius.

Important new information has been obtained regarding the influences of 'compression' and 'shock' waves upon the speeding up of combustion and flame movements during explosions; and it is now proved that the speed can be abruptly raised from a lower to a higher uniform value when a flame is overtaken by a 'shock' wave travelling in the same direction. Indeed, it has been shown that in such manner the flame-speed can be successively raised *per saltum* many times, and that it may assume any uniform value between the limits of that theoretically corresponding with propagation by 'conduction' and that due to propagation 'by adiabatic compression'.

Much new light has been thrown on what may be termed the 'pre-detonation' phase of explosion, when the flame is advancing at a speed greater than that of any 'shock' wave through the unburnt medium, and is therefore overtaking any such shock waves which are ahead of it. 'Detonation' is ultimately set up when a rapidly moving flame on the verge thereof is just about to overtake a shock wave immediately in front of it. Thereupon an 'ignition ahead' of the flame-front occurs, and immediately afterwards 'detonation' is set up. Indeed, during the 'pre-detonation' phase a series of successive such 'ignitions ahead' may occur, detonation being set up immediately after the last one.

We have obtained photographs analysing the phenomenon of 'spin' in detonation, which was first observed five years ago in detonations of moist $2CO + O_2$ mixtures by C. Campbell and D. W. Woodhead, working in the late H. B. Dixon's laboratory, and later confirmed in our laboratories at South Kensington. 'Spin' has also been observed in detonations of methane-oxygen, pentane-oxygen, undiluted acetylene, and other media, and apparently is caused by the helical rotation of a luminous 'head' of detonation in the flame front together with a long luminous 'tail' behind it. The pitch (L) and frequency (f) of such rotation in detonations of a given medium varies with the internal diameter (D) of the tube, so that, while the ratio L/D for diameters up to about 1 inch is constant, and nearly equal to 3·0, the helical velocity of the rotating 'head' of detonation is approximately of the same order, irrespective of the medium or of the tube diameter. Thus, in the case of a moist $2CO + O_2$ medium, which exhibits the phenomenon most markedly, $f = 44{,}000$ per sec., and $L = 3{\cdot}95$ cm. in a tube of 1·3 cm. internal diameter, the velocity of the 'head' of detonation along its helical path being 2500 metres per second.

These discoveries have necessitated revision of the old classic conception of 'detonation' and opened up new lines of inquiry concerning it.

Within recent years the photographic method has also been used for the purpose of analysing (i) ignition phenomena, including the 'induction' period of explosions, (ii) the influence of moisture upon explosions of carbonic oxide-oxygen mixtures, and (iii) the influence of strong electrical fields upon gaseous explosions.

The Construction of Man's Family Tree.*

SOMEWHERE about the year 1865 Ernest Haeckel drew a family tree to represent man's relationship to the rest of the animal kingdom. Neither Darwin nor Huxley were so daring. In 1871 Darwin went no further in his "Descent of Man" than to infer that "a member of the anthropomorphous subgroup gave birth to man". In 1863 the utmost Huxley adventured was the opinion that man had arisen by "the gradual modification of a man-like ape or from the same stem". Haeckel saw life as a great tree rooted deeply in the geological past with only the end-twigs peering through the surface of the earth into the present as living forms. The terminal twig on the extreme right of his tree represents humanity (*Homo sapiens*). Man, the gorilla, and the chimpanzee are made to emerge from the same terminal stem. Following this human-gorilla stem to the left downwards, we find shooting from it the orang twig, then at a still longer interval, the gibbon branch, then the old world monkeys, then those of the new world, and ultimately this primate stem merges with the stem of the prosimiæ or lemurs.

The facts which guided Haeckel were the multitude of structural points in common which could be explained only as an inheritance from a common ancestor. To convert his hypothesis into true history it was necessary to find the fossilised remains of his missing links; but very few of these were known in his day—Neanderthal man and Dryopithecus and Pliopithecus from the Miocene deposits of Europe. Haeckel depicted the human stem as breaking away from that leading on to the gorilla and the chimpanzee rather more than half-way through the Tertiary period. On Osborn's estimation in years, Haeckel thus gives man's antiquity at 20 or 25 millions of years.

In 1895 Dr. Eugen Dubois, in order to incorporate his newly discovered Pithecanthropus, showed the central stem as represented at first by a proceropithecus, the ancestor of the old world monkeys, then the prothylobates, the ancestor of the gibbons, then the prototype of the great anthropoid apes, followed by the Pithecanthropus type and finally the stem ending in the human form.

Some years previously Sir Arthur Keith was engaged with the dissection of some 300 specimens, gorillas, chimpanzees, etc., and the collection of records of human dissections, in the hope of arriving at a clear-cut explanation of the distribution of anatomical characters. In 1900 he drafted a chart to show the mass of data thus collected. He arrived at the conclusion that the evolution of posture gives the clue not only to the evolution of man but also to that of all the higher primates. There are only two main ways in which an animal can climb a tree—either with the body horizontal (pronograde) or upright (orthograde). Sir Arthur Keith concluded that an arboreal orthograde anthropoid had first diverged in a humanward direction in specialisation of spine, leg, and foot. It was on the trees and not on the ground that man first came by the initial stages of his posture and carriage.

What has happened in the last thirty years confirms the conviction that in the study of the gibbon is the key to the evolution of the great anthropoids and man. In 1910 the discovery of Propliopithecus in the older oligocene of Egypt extended the antiquity of what is apparently an ancestor of the gibbons, and presumably orthograde, for a good many million years. It affords a fixed point for speculation concerning the evolution of the orthograde posture. Prof. Osborn and Prof. Wood Jones, who exclude the other anthropoids from the ancestry of man, are prepared to accept Propliopithecus as an ancestor from which both man and the chimpanzee may have arisen.

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* Substance of an evening discourse delivered before the British Association on Sept. 26 by Sir Arthur Keith, F.R.S.

Sir Arthur Keith's census showed so many anatomical characters in common in the big-bodied group, gorilla, chimpanzee, and orang, that he postulated a common ancestor for the big-bodied group. The discoveries of Dr. Foutan in the lower Miocene of Egypt (1920) of two orthograde primates, one the size of a gibbon, the other half-way between the gibbon and man, support his contention that the great orthograde primates evolved at the beginning of the Miocene. It was at this period, evidently one of great plasticity, that Sir Arthur Keith supposes the human line to have separated from the great anthropoids. Dr. W. K. Gregory also brings the human stem from the anthropoids at the beginning of the Miocene. They both give the human stem an antiquity of about 20 million years.

The human posture was completely evolved before the end of the pliocene period. Allowing two geological periods, the Miocene and the Pliocene, this represents about 18 million years for the evolution of the human characteristics of foot, leg, thigh, and pelvis. Beside Pithecanthropus we now know two other forms of early Pleistocene man, Eoanthropus and Sinanthropus. By the end of the Pleistocene, then, the human stem had been in existence long enough to have broken up into many divergent branches; but we are uncertain whether they represent the ancestors of any race now living. Hence in our tree we trace the living races to an early pleistocene ancestor not yet discovered.

It is not claimed that this formula explains all the facts. Prof. Wood Jones points out that the human body preserves many primitive features which have disappeared from those of anthropoids and of monkeys—features which Sir Arthur Keith thinks are to be explained not by modifying the family tree but by a fuller understanding of the laws of inheritance. In the United States, Dr. W. K. Gregory assigns a place to Australopithecus, the Taungs skull, nearest to man. Dr. A. H. Schultz, of Johns Hopkins University, has drafted a tree in which the gibbon and man are opposed as contrasted forms, while Prof. H. Fairfield Osborn excludes the anthropoidal stage from human ancestry.

Sir Arthur Keith concludes by giving his support to the form of man's family tree which was drafted by Haeckel sixty-five years ago. All are agreed that anthropoid and man have a common ancestry; it is merely the degree of relationship which is in dispute.

A Retrospect of Wireless Communication.*

SIR OLIVER LODGE said that, looking back over his connexion with wireless telegraphy, the first paper which had attracted his attention was one by Lord Kelvin in 1853 on "Transient Currents", which gave the theory of electric oscillations in a masterly manner considering that the idea of self-induction was not then born. Kelvin knew that electric energy could be stored in and released by a condenser in a manner analogous to that in which energy could be stored and released by a coiled spring, and, moreover, that the current resulting from the condenser discharge possessed properties akin to inertia or momentum. The discharge would consequently be of an oscillating character unless the circuit resistance exceeded a certain critical value, and the resulting spark a beaded band instead of a continuous band.

With a large enough condenser, oscillations should be slow enough to give a musical note. The frequency of the note depends on the capacity of the circuit and on its self-induction, which Kelvin spoke of as the "electrodynamic capacity of the discharging circuit". Such a musical note was exhibited by Sir Oliver at the Royal Institution in what was called a 'whistling spark', the pitch of which could be brought down to reach the tones of the human voice.

One factor the theory did not take into consideration was possible loss of energy by radiation, in the same way as a tuning-fork mounted on a sounding-board loses energy to the surrounding air, thus diminishing the time during which the charge would oscillate. At the time, such radiation was unsuspected, and in any case there were no means of detecting it.

The first to show that an electric discharge would generate radiation was Fitzgerald, who discussed the problem mathematically in a paper read before the British Association in 1880. In a further paper in 1883, he calculated the actual energy lost per second by a given condenser and self-induction and showed that it was proportional to the fourth power of the frequency. To obtain an efficient radiator it was necessary to work with a frequency of not less than one million cycles. Fitzgerald took as the basis of his research the results of Maxwell's investigations on electromagnetic theory

In 1865, Clerk Maxwell had attempted to treat mathematically what Faraday had long brooded over as the 'electric field', regarding it as distinct from matter and existing in the ether of space round the charged body. Maxwell evolved two sets of equations, one for the electrostatic field and another for the magnetic field surrounding a current. These he combined in an endeavour to discover the nature of the electromagnetic field. His result, which is now familiar to scientific workers, was the differential equation expressing wave motion. Fortunately, the separate electric and magnetic constants of the ether, which are immeasurable, did not enter into the expression except as a product, which experiments in Germany had shown to be capable of determination.

Maxwell set to work to determine experimentally the rate of propagation of the electromagnetic waves predicted by his theory, and obtained the surprising result that it was equal to the velocity of light.

Theories of light up to this time had treated the ether as an elastic solid capable of transmitting vibrations at a tremendous speed. No single theory had been able to account for all the phenomena of light, and Maxwell's theory, published in 1873 and representing a complete departure from accepted ideas, came as a revelation. His equations have formed the basis of all subsequent work on electromagnetic waves.

Attempts were soon made to verify Maxwell's theory experimentally by the production of ether waves by electro-magnetic means. In 1887 or 1888, Sir Oliver Lodge, working with closed condensers, obtained evidence of their existence in the form of nodes or loops characteristic of ether waves reflected back on themselves at the end of a wire attached to such condensers.

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* Substance of an evening discourse delivered before the British Association on Sept. 26 by Sir Oliver Lodge.

At the same time, Hertz in Germany was making experiments on the way in which electric forces streamed out from a discharging conductor. Using an oscillatory circuit consisting of two widely separated plates joined by a wire, he was able to generate waves as Fitzgerald had predicted. These waves were generated in space and had such energy that they caused little sparks to be emitted by a conductor on which they fell. Hertz showed that Maxwell's theory would account for his radiation in every detail, and he made maps of the lines of force during each phase of the oscillation. These maps were published in NATURE in 1889, in a translation of Hertz's paper by Sir Oliver Lodge.

Other means of detecting the waves than by the scintillæ they produced were soon developed. Sir Oliver Lodge discovered the principle of the coherer which was afterwards improved by Branly, and in 1894 he showed that Hertz's waves combined with a Branly detector could be used for the sending and receiving of messages in Morse code.

At the same time, Marconi in Italy was studying the application of Hertzian waves to telegraphy, and in 1896 he came to England and was able to interest Sir William Preece, chief engineer to the Post Office, and to secure his co-operation. Marconi persevered with his experiments, and to him must be attributed the great success of wireless telegraphy.

About the same time Sir Oliver Lodge had realised the importance of selectivity and had taken out a patent for a receiver incorporating capacity and self-induction and capable of being tuned.

The next step, also to be attributed to Marconi, marked the beginning of trans-Atlantic wireless communication. Marconi made use of an elevated aerial connected through a spark gap to earth. The waves generated were consequently in a vertical plane and could travel great distances before becoming attenuated by the earth's resistance. He arranged for a powerful series of signals to be sent out from a station in Cornwall and he himself went to Newfoundland to try to detect them. The experiment was a complete success, and demonstrated that the waves would follow the contour of the earth, a fact which was afterwards explained by the theory of the Heaviside layer. This acts as a kind of whispering gallery and reflects the waves impinging on it.

So far, signalling had been confined to discontinuous trains of waves generated by spark transmitters, but it was realised that there would be a distinct improvement if the signals could be made to consist of modulations in amplitude of a continuous wave of definite frequency, the modulations recurring with a frequency of their own.

The first experimenter to achieve this was Duddell, using an electric arc as part of a circuit containing capacity and inductance. So long as the circuit was not interfered with, the note emitted by the circuit was of uniform tone, but it could be varied by alteration of the self-induction or capacity by means of a key. Duddell's arc responded only to low frequency vibrations and was not applicable to the extremely high frequency vibrations needed for effective transmission. Poulsen improved the arc by immersing it in hydrogen under various pressures, and finally obtained an arc of really high frequency, which he patented in 1903.

There still remained the problem of detecting such waves. In 1904, Fleming perceived that the rectifying action of the two electrode valve could be adapted for the detection of ether waves, and he patented the vacuum valve as a detector. At first the valve was only used for the discontinuous system of spark signalling. Later, Fessenden devised the heterodyne system of reception, in which he superimposed on the received wave another of nearly the same frequency, producing low frequency beats which could be detected by the valve and made to operate a telephone. It was now possible to superimpose on a continuous wave the modulation of the human voice, applied by a microphone, and to detect the resulting vibrations at a distant station. This was the beginning of wireless telephony.

The amount of energy received at a station was small and the signals therefore feeble. De Forest conceived the idea of introducing the grid into a valve and supplying the latter with energy from a local high-tension battery. The pulsations of the received wave were applied to the grid, which therefore acted as a regulator, sometimes assisting the flow of current in the valve and sometimes retarding it. The energy of the signals received was supplied by the local battery, the grid merely acting as a relay, putting energy into the disturbance, but not otherwise interfering with it. It was soon found that the three electrode valve could be used for generating continuous waves, at the same time enhancing their power enormously. Thus in 1913 it became feasible to transmit speech and music to great distances.

In 1917 there was further development when the remarkable property of quartz was utilised to control the frequency of transmitted waves. If a crystal of quartz is compressed it becomes polarised, while on the other hand if it is electrified it constricts. This reversible action renders quartz a natural intermediary between mechanical and electrical vibrations. Eccles uses the vibrations of quartz as a transmitter for electrical waves of steady frequency. This frequency is regulated by a tuning-fork adjusted to the frequency desired and operating on a piece of quartz so as to generate waves of the same frequency. After amplification, signals of enormous power can be sent out with a precision of tuning hitherto unequalled. Broadcasting on a large scale was thus made possible. It was initiated in the United States in 1920 and in Great Britain in October 1922.

Beyond the Milky Way.*

THE star-system best known to us is the Galactic system, which is bounded by the Milky Way. About two million such systems of stars can now be observed; they are known as extra-galactic nebulæ. A random collection of extra-galactic nebulæ seems at first to show a bewildering variety of size, shape, brightness, and constitution, but a scientific study soon reduces them to law and order. Rejecting all those which are not seen edge on, we find that by far the greater number of the remainder can be arranged in a single continuous sequence, beginning with spheres and ending with flat discs. Since the speed of rotation of a body increases as it shrinks, it seems likely that we may interpret this sequence of nebulæ as one of different stages of development or evolution. If this conjecture is sound, a nebula starting with little rotation at first and shrinking in size would gradually increase its speed of rotation as it shrank, and would move steadily along the sequence as it did so.

The way to test this conjecture is to calculate for ourselves how a mass of rotating gas would change in shape as it condensed and shrank. Although the mathematical analysis is not simple, and cannot be absolutely precise, it is fairly conclusive; we find that the evolution of a mass of rotating and shrinking gas would be represented exactly by passage along the sequence.

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* Substance of an evening discourse delivered before the British Association, London, on Sept. 29 by Sir James Jeans, F.R.S.

How did the nebulæ themselves come into being? The conjecture which at once jumps to the mind is that the nebulæ may have been formed by the same process as the stars; just as the stars came into being as condensations in a tenuous uniformly spread gas—the outer fringes of the nebulæ—so the nebulæ may themselves have previously come into being as condensations in an earlier mass of uniformly spread tenuous gas. This can never be more than a conjecture, but there are strong arguments in its favour.

Differences in size and brightness between nebulæ of the same shape are almost entirely due to a distance effect. This makes it possible to estimate the distances of all nebulæ, even the very faintest, with fair accuracy. The faintest which can be observed photographically in the 100-inch telescope prove to be at the amazing distance of about 140,000,000 light-years. Dr. Hubble finds that the two million nebulæ which lie within this distance are fairly uniformly spaced at about 1,800,000 light-years apart. We can construct a model, by taking apples and spacing them at about 10 yards apart, until we have filled a sphere a mile in diameter. This will use about 300 tons of apples. This sphere is the part of space we can see in the 100-inch telescope; each apple is a nebula containing matter enough for the creation of several thousand million stars like our sun: each atom in each apple is as big as Betelgeux, with a diameter equal to, or slightly larger than, that of the earth's orbit.

The circumstance that the nebulæ are fairly uniformly distributed through space certainly supports the conjecture that they may have originated out of a primeval gas spread uniformly through space. Moreover, it can be proved that such a gas would not stay uniformly spread through space but would break up into condensations; and that each condensation would have something like the same mass as the observed nebulæ.

The general breaking-up process of which this is the beginning is in operation throughout the universe. It might be thought that the attractive forces of gravitation would continually draw all the broken pieces together again. The exact reverse appears to be the case. Not only is the substance of the universe for ever being broken into smaller pieces, but these pieces for ever tend to scatter farther and farther apart. Every ray of sunlight that enters our eye carries mass with it; eight minutes previously this mass was part of the mass of the sun. Every second the sun loses more than four million tons of mass in the form of sunlight and sun-heat. As the result of this continual loss of mass the sun's gravitational hold on its family of planets for ever weakens, and these are driven further off into space. The earth's orbit round the sun is not so much like a circle or ellipse as like a coiled watch-spring—a spiral for ever receding into the cold and dark of space.

The same tendency affects the galactic system as a whole. Throughout the universe, all the smaller broken pieces, satellites, planets, stars, are scattering away from one another in apparent opposition to the laws of gravitation.

Still more surprising and sensational is the recent discovery that the largest pieces of the universe—the great extra-galactic nebulæ we have been discussing—are to all appearances engaged in a similar scattering. They, too, appear to be running away from us and from one another. Until recently it was thought that on the whole the nearer nebulæ were approaching the galactic system, while the more remote were receding. We now know that the nearer nebulæ appeared to be approaching merely because they happen to lie mostly in the direction towards which the sun is being carried by the rotation of the galaxy; actually we are approaching them. After the sun's motion in the galaxy has been taken into account, all, or nearly all, of the nebulæ appear to be receding from the galaxy. The nearer nebulæ have small speeds, and the more remote nebulæ have greater speeds; in general, speed is approximately proportional to distance. This simple law seems to hold to the very farthest of the nebulæ—Hubble finds that for every million light-years of distance there is a speed of recession of about 105 miles a second. The last nebula to be investigated at Mount Wilson shows a speed of recession of 12,300 miles a second; its distance, as estimated from its faintness, being about 105 million light-years.

On the face of it, this looks as though the whole universe were uniformly expanding, like the surface of a balloon while it is being inflated, with a speed such that it doubles its size every 1400 million years.

There is one strong theoretical argument in favour of regarding the apparent speeds as real. Einstein's original cosmology regarded the universe as being as full of matter as a universe of its size could possibly be without violating the theory of relativity. Recently, Lemaître, of Louvain, has shown that a universe of this type would not be static—there would be an unstable quality about it. The condensation of the primeval gas into distinct nebulæ, and the imprisonment of a large part of the free energy of the universe in these nebulæ, would cause it to start expanding, in which case it would continue to expand, its radius finally increasing exponentially with the time, until it ended up as an empty universe—finite matter spread through infinite space. Throughout the motion the relative speed of recession of any two nebulæ would be exactly proportional to their distance apart, so that, at first glance at least, this theory seems exactly to fit the observed facts. It not only provides a suggestion as to why the nebulæ may be receding. It goes much further, and predicts that they must be receding; if Einstein's relativity cosmology is sound, the nebulæ have no alternative—the properties of the space in which they exist compel them to scatter.

Yet various circumstances suggest a need for caution. For one, the speeds of the nebulæ are not strictly proportional to their distances. Again, the very magnitude of the apparent speeds casts doubt on their reality; they would reduce the whole existence of the universe to a mere flash—at any rate in comparison with what we have recently believed. If they are real, Eddington has calculated that the universe must have started from a radius of about 1200 million light-years, and that its total mass must be about $2 \cdot 3 \times 10^{55}$ gm. which is the mass of $1 \cdot 4 \times 10^{79}$ protons and an equal number of electrons. So far as we can tell from the masses of the extra-galactic nebulæ, the present average density of matter in space appears to be not less than 10^{-30} gm. per c.c., which, with the same amount of matter, would assign a radius of 13,200 million light-years to the universe—only eleven times its initial value. If the motions are real, the universe is only at the beginning of its career; as it appears at present to be doubling in size every 1400 million years, the few doublings which these figures permit cannot have occupied more than 10,000 million years at most.

General calculations on the ages of astronomical bodies point to far longer periods of time than this. The mere act of condensation of the nebulæ was probably a matter of hundreds of thousands of millions of years. Perhaps there is no real difficulty here; it might well take this long to get the doubling process really going. The real difficulty is that the stars carry intrinsic evidence of having lived through far longer periods than this.

Spectroscopic binaries provide further evidence. Observation reveals a complete sequence; it begins with systems which appear to have just broken into two as the result of rotation—pairs of stars describing circular orbits, and almost in contact—and ends with systems in which the two stars are far apart and describing elliptical orbits. Theory suggests that this observational sequence exactly depicts the evolution of a star which has broken into two as the result of excessive rotation. The outstanding importance of this sequence to our present discussion lies in the fact that the stars at the beginning of the sequence are undoubtedly many times more massive than those at the end. It seems likely that those which are now at the end must have begun at the beginning and lost the greater part of their mass in the form of radiation, and to do this would take millions of millions of years.

Considerations such as these make it very difficult to believe that the universe can be such an ephemeral concern as the apparent speeds of recession of the nebulæ would suggest.

Birthdays and Research Centres.

Oct. 5, 1861.—Sir THOMAS HEATH, K.C.B., K.C.V.O., F.R.S., honorary fellow of Trinity College, Cambridge, Joint Permanent Secretary to the Treasury, 1913–19, and Comptroller-General of the National Debt Office, 1919–26.

Having published my "Manual of Greek Mathematics" in the early part of this year, I am continuing my life-study of Greek mathematics and astronomy, with the view of keeping pace with the new discoveries in that and allied fields which are continually being made. Thus it is that I was able to include in the "Manual" some interesting things that have come to light since the publication in 1921 of the "History of Greek Mathematics"; for example, an investigation by Archimedes of the problem of inscribing a regular heptagon in a circle (preserved in an Arabic treatise) and some very remarkable results of the study of Babylonian cuneiform inscriptions of 2000–1800 B.C.

I have long wished to write upon the mathematical passages of Aristotle, and hope to proceed with that work if circumstances permit.

Oct. 9, 1863.—Prof. A. C. SEWARD, F.R.S., professor of botany in the University of Cambridge.

Since the publication in 1925 of two papers on Cretaceous plants collected in Greenland by Mr. Holttum and me ten years ago, I have been working through a large consignment of fossils sent to me through the courtesy of colleagues from the museums of Copenhagen and Stockholm. With the help of the additional data thus obtained, I hope to complete in the near future a supplementary account of the rich Cretaceous floras of western Greenland. In this work much assistance has been received from junior co-workers.

Other lines of work are: a more systematic consideration of the bearing of palæobotanical data on the general problem of evolution; and a more critical study of the geographical distribution of plants during the several geological periods.

One of the subjects which I would recommend for treatment is a careful revision of European collections of Tertiary plants.

Oct. 10, 1893.—Prof. M. SAHA, F.R.S., University professor of physics, Allahabad.

The Physical Laboratory of the University of Allahabad is one of the oldest and smallest laboratories in India, having been established about thirty years ago, but little research work was done before I took charge in October 1923. Since then, my colleagues and I have been trying our best to organise the laboratory for research work, but I must confess that I am not satisfied with the progress so far made. Research work is being carried on chiefly in spectroscopy and X-rays. At present we are engaged in studying the absorption spectrum of saturated halides of multivalent elements, and on the modification of quanta by photo-ionisation. The work on thermal ionisation has been temporarily suspended owing to lack of space and time. Research students are engaged in the classification of spectral lines. There is a wireless section, with a good broadcasting station, and it is planned to undertake work on propagation of radio in India, but nothing has been achieved, in so far as the co-operation of other universities could not be secured. The staff (total strength, nine) is heavily overworked, as there are about 200 undergraduate and 25 advanced students, and the laboratory is too much congested, for there has been practically no extension since its foundation.

Societies and Academies.

LONDON.

Institute of Metals, Sept. 15* (Annual Autumn Meeting, Zurich).—**W. E. Alkins**: Experiments in wire-drawing. (2) Notes on the relation between reduction of area by cold-drawing and tensile strength of H.-C. copper. Annealed copper rod 0·435 in. diameter was drawn through straight-sided tapering dies at single drafts of slowly increasing amount. The resulting 'primary' tensile strength reduction of area curve consists of an approximately rectilinear portion up to about 15 per cent reduction and of a smooth curve concave to the reduction axis from 15 per cent upwards. Below 15 per cent, results are consistent with the view that drawing takes place by simple elongation under tensile stress; above 15 per cent the curve has the form of a rectangular hyperbola, and one asymptote appears to lie suggestively near the limiting tensile strength to which copper can be cold-drawn.—**Clement Blazey**: Brittleness in copper. The experiments described are a continuation of those described in two other papers already published under the title of "Brittleness in Arsenical-Copper". It has been found that the brittleness is not restricted to arsenical-copper, but may be produced in copper free from arsenic.—**Edward J. Daniels**: The attack on mild steel in hot-galvanising. Experiments have been carried out in the laboratory to determine the rates of attack on mild steel strip when immersed in different brands of zinc at various temperatures between 432° C. and 540° C. The influence of the addition of small percentages of aluminium, antimony, and tin has been investigated, and the action of alloys of zinc and cadmium has also been studied.—**J. S. Dunn**: The oxidation of some copper alloys. The zinc-copper alloys fall, so far as their behaviour under oxidation is concerned, into two classes, fairly sharply separated. Those with copper contents below about 80 per cent all oxidise at essentially the same rate, and all give rise to an oxide which is almost pure zinc oxide.

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* Continued from p. 554.

Those with copper above about 86 per cent oxidise at approximately the same rate as copper, and the oxide contains the metal in the same proportion as the original metal. The rate of oxidation increases exponentially with temperature, doubling itself approximately for every 75° C. rise in temperature.—**W. R. D. Jones**: The copper-magnesium alloys. (4) The equilibrium diagram. Magnesium and copper form solid solutions to a limited extent. At the ordinary temperature 0·02 per cent copper is soluble in magnesium and 2–2·2 per cent magnesium in copper. Two compounds, Mg_2Cu and $MgCu_2$, exist which do not form solid solutions, but form eutectic series with each other and with the solid solutions of copper with magnesium, and of magnesium in copper. The compound MgCu is not formed in the solid state.—**Hugh O'Neill**: Note on the diameter measurement of certain Brinell indentations in cold-rolled metal. Diameter measurements of the indent may differ by 3-4 per cent according to whether vertical or oblique illumination is used with the measuring microscope.—**Hugh O'Neill and J. W. Cuthbertson**: The work-hardening capacity and elongation properties of copper. So far as they go, the results indicate that (*a*) the Tetmajer 'uniform elongation' value, and (*b*) the 'extensibility', that is $(1+a)$, where a is the index in the Bertella-Oliver elongation equation, are reliable measures of the work-hardening capacity of a metal.—**C. J. Smithells, S. V. Williams, and E. J. Grimwood**: Melting nickel-chromium alloys in hydrogen. Sound ingots can be produced by this method, provided that all the oxides present in the melt are reduced by hydrogen before casting. Alloys prepared from commercial materials give better resistance to oxidation than those prepared from pure materials. The probability that the presence of certain impurities has a beneficial effect was confirmed by making deliberate additions of elements known to be present as impurities in the raw materials. The process of hydrogen melting of nickel-chromium alloys is being applied on a commercial scale. The process has also been used with success for the preparation of other metals and alloys in a ductile state without the use of the usual deoxidisers.

ROME.

Royal National Academy of the Lincei, Feb. 15.—**U. Cisotti**: Circulations about regions of dead water limited by a polygonal wall and by a free surface.—**L. Cambi and A. Cagnasso**: A new series of nitrososulpho-salts of iron: nitrosodithiocarbamates. Treatment of a solution containing $Fe(NO)SO_4$ with the aqueous solution of a dithiocarbamate results in the immediate formation of an emerald-green nitroso-salt of the general formula $(R_2N.CS.S)_2Fe.NO$. These compounds, several of which have been prepared and analysed, appear to be ferric nitrosodithiocarbamates, but their constitution has not yet been definitely established.—**G. Dantoni**: The definition of integrals.—**R. Caccioppoli**: Linear functionals in the field of analytic functions.—**R. Calapso**: A theorem on Green's angle.—**E. Gugino**: The behaviour of the forces of reaction in the motion of any material system acted on by positional forces.—**G. B. Bonino and L. Brüll**: Raman spectrum and chemical constitution of certain chloroethylenes. In a recent study of the ultra-red molecular spectrum of ethylene, Mecke classified the frequencies of the oscillations characteristic for the molecule of this hydrocarbon into valency and deformation oscillations. For tetrachloroethylene, the symmetry of which is similar to that of ethylene, the ratios between these frequencies are calculated to be

$$\sqrt{\frac{2}{\mathrm{C}+2\mathrm{Cl}}}:\sqrt{\frac{1}{2}\left(\frac{1}{2\,\mathrm{Cl}}+\frac{1}{\mathrm{C}}\right)}:\sqrt{\frac{11}{2\,\mathrm{Cl}}}=1{\cdot}31:1{\cdot}85:1,$$

the values obtained by Pringsheim and Rosen being 1·45 : 1·91 : 1. The cis- and trans-isomerides of 1 : 2-dichloroethylene are also considered.—**A. Quilico and M. Freri**: Azopyrrole blacks (3). For certain of the black products formed from pyrrole and diazo-compounds as the result of a complicated process of oxidation and coupling, attempts are made to establish the number of pyrrole and phenyl nuclei taking part in the condensation, and a hypothesis concerning the general lines of their structure is advanced.—**A. Debenedetti**: Determination of the optic axial angle of biaxial minerals by means of Fedorow's plate.—**G. Tallarico**: The biological value of the products of manured or artificially fertilised soil. Experiments with turkeys show that the birds given a vegetable diet grown on manured land are more resistant to disease than those fed on material grown on soil artificially fertilised.—**Ada Bolaffi**: Certain lipoidal fractions of the adenocarcinoma of the rat.—**G Armellini**: Memorial notice of P. G. Hagen.

SIDNEY.

Linnean Society of New South Wales, July 29.—**W. J. Dakin**: On a new bopyrid parasite from the coast of New South Wales. Description of a new genus allied to the group *Orbione*, *Parapenæon*, and *Epipenæon*, the type species being an ectoparasitic branchial parasite under the branchiostegites of a penæid prawn, *Aristeus foliaceus*.—**J. R. Malloch**: Notes on Australian Diptera (28). Data on the occurrence of the family Rhagionidæ in Australia. A key is given to the genera of the family.—**G. H. Cunningham**: The Gasteromycetes of Australasia (12). The genus *Scleroderma*. The genus is represented in this biological region by five species, of which *S. australe* and *S. radicans* are confined to Australia, *S. flavidum* extends to Africa and North America; and the other two species, *S. Bovista* and *S. verrucosum*, have a general distribution. A general account is given of the morphology and development of the genus, as well as an artificial key to the species.

Official Publications Received.

BRITISH.

New Zealand: State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1931. Pp. 14. (Wellington, N.Z.: W. A. G. Skinner.)

The Technique of Field Experiments: being the Report of a Conference held at Rothamsted on May 7, 1931, under the Chairmanship of Sir A. D. Hall. Pp. 64. (Harpenden: Rothamsted Experimental Station.) 1*s.* 6*d.* net.

Mines Department. Ninth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1930. Pp. 86+12 plates. (London: H.M. Stationery Office.) 2*s.* net.

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1930. Part 2. Pp. v+90+4 plates. (London: H.M. Stationery Office.) 2*s.* net.

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931. Vol. 43, No. 7, August. Pp. 305-344+xxxviii. (London.)

Observations made at the Royal Observatory, Greenwich, in the Year 1929 in Astronomy, Magnetism and Meteorology, under the Direction of Sir Frank Dyson. Pp. vii + A110 + B2 + Cix + C131 + D65 + E46 + 19. (London: H.M. Stationery Office.) 37*s.* 6*d.* net.

Photographic Magnitudes of Stars brighter than $14^{m}.0$ in 40 of Kapteyn's Selected Areas, determined at the Royal Observatory, Greenwich, under the Direction of Sir Frank Dyson. Pp. 69. (London: H.M. Stationery Office.) 6*s.* 6*d.* net.

East London College (University of London.) Calendar, Session 1931–1932. Pp. 206. (London.) 1*s.*

Battersea Polytechnic. Technical College for Day Students, and Day School of Art and Crafts. Calendar, Session 1931–1932. Pp. 50+16 plates. 3*d.* Domestic Science Department and Training College. Full-time Day Instruction, Afternoon and Evening Classes, Session 1931-1932. Pp. 35+9 plates. 3*d.* Department of Hygiene and Public Health, Session 1931–1932. Pp. 24+6 plates. 3*d.* Calendar of Evening and Afternoon Courses and Classes for Session 1931–1932. Pp. 32+14 plates. Free. (London.)

The Botanical Society and Exchange Club of the British Isles. Report for 1930 (with Balance-Sheet for 1929). By Dr. G. C. Druce. Vol. 9, Part 3. Pp. 247-504+30. 10*s.* Report for 1930 of the Botanical Exchange Club. By C. E. Britton. Vol. 9, Part 4. Pp. 505-534. 4*s.* (Arbroath: T. Buncle and Co.)

Report of the Progress of the Ordnance Survey for the Financial Year 1st April 1930 to 31st March 1931. Pp. 29+6 plates. (London: H.M. Stationery Office.) 4*s.* net.

The Hundred and Ninth Report of the Commissioners of Crown Lands. Pp. 38. (London: H.M. Stationery Office.) 2*s.* net.

Ceylon. Part 4: Education, Science and Art (F). Administration Report of the Director of the Colombo Museum for the Year 1930. By Dr. Joseph Pearson. Pp. F9. (Colombo: Government Record Office.) 10 cents.

Journal of the Chemical Society. August. Pp. vi+1877-2228+xii. (London.)

Supplement to the Journal of the Indian Mathematical Society, Vol. 18: Report of the Seventh Conference of the Indian Mathematical Society held at Trivandrum in April 1931. Pp. iv+54. (Madras.)

Foreign.

Smithsonian Institution: United States National Museum. Bulletin 104: The Foraminifera of the Atlantic Ocean. Part 8: Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporettidae, Globorotaliidae, Anomalinidae, Planarbulinidae, Rupertiidae and Homotremidae. By Joseph Augustine Cushman. Pp. ix+179+26 plates. (Washington, D.C.: Government Printing Office.) 65 cents.

Smithsonian Miscellaneous Collections. Vol. 85, No. 5: Infra-Red Absorption Bands of Hydrogen Cyanide in Gas and Liquid. By F. S. Brackett and Urner Liddel. (Publication 3123.) Pp. 8. (Washington, D.C.: Smithsonian Institution.)

Proceedings of the United States National Museum. Vol. 79, Art. 1: Three New Species of Polychaetous Annelids from Chesapeake Bay. By Aaron L. Treadwell. (No. 2867.) Pp. 5. Vol. 79, Art. 2: Revision of the Species of Beetles of the Genus Trirhabda North of Mexico. By Doris Holmes Blake. (No. 2868.) Pp. 36+2 plates. Vol. 79, Art. 4: Four New Species of Trematode Worms from the Muskrat, *Ondatia zibethica*, with a Key to the Trematode Parasites of the Muskrat. By Emmett W. Price. (No. 2870.) Pp. 13. Vol. 79, Art. 6: Two New Species of Nematode Worms of the Genus Ostertagia from the Virginia Deer, with a Note on *Ostertagia lyrata*. By G. Dikmans. (No. 2872.) Pp. 6+2 plates. Vol. 79, Art. 11: The Two-winged Flies belonging to Siphosturmia and Allied Genera, with Descriptions of Two New Species. By H. J. Reinhard. (No. 2877.) Pp. 11. Vol. 79, Art. 14: Descriptions of Thirteen New American and Asiatic Ichneumon-Flies, with Taxonomic Notes. By R. A. Cushman. (No. 2880.) Pp. 16. Vol. 79, Art. 15: Descriptions of New Marine Mollusks from Panama, with a Figure of the Genotype of Engina. By Paul Bartsch. (No. 2881). Pp. 10+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. Fishes obtained by the Barber Asphalt Company in Trinidad and Venezuela in 1930. By Henry W. Fowler. Pp. 391-410. (Philadelphia.)

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 12, Livraison 1. Pp. 168. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

Report of the National Committee on Calendar Simplification for the United States, submitted to the Secretary of State, Washington, August 1929. Pp. 119. Supplementary Report of the National Committee on Calendar Simplification for the United States, submitted to the Secretary of State, Washington, May 1931. Pp. 112. Religious Aspects of Calendar Reform. Second edition. Pp. 37. (Rochester, N.Y.)

League of Nations. Fourth General Conference on Communications and Transit. Preparatory Documents, Vol. 1: Calendar Reform. (Official No. C.G.C.T.1.) Pp. 28. (Geneva.) 1*s.* 3*d.*

U.S. Department of Agriculture. Technical Bulletin No. 252: Two Citrus Leaf Miners of the Far East. By C. P. Clausen. Pp. 14. (Washington, D.C.: Government Printing Office.) 5 cents.

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sappora, Japan. Vol. 26, Part 2: Flora of Hokkaido and Saghalien. II. Monocotyledoneae. Typhaceae to Cyperaceae. By Kingo Miyabe and Yushun Kudo. Pp. 81-277. (Tokyo: Maruzen Co. Ltd.)

Catalogues.

A Complete Catalogue of Heffers Publications, 1931–1932. Pp. 62. (Cambridge: W. Heffer and Sons, Ltd.)

Catalogue of Books on Natural History. (No. 65.) Pp. 24. (London: R. S. Frampton.)

Carotene B.D.H. Pp. 6. (London: The British Drug Houses, Ltd.)

Catalogue of Chemical and Industrial Laboratory Apparatus. Ninth edition. Pp. 1471. (London: A. Gallenkamp and Co., Ltd.)

Diary of Societies.

FRIDAY, October 2.

Institution of Chemical Engineers (at Chemical Society), at 6.—N. E. Rambush and F. F. Rixon: The Gas Generator as a Direct Producer of Metallurgical Products.

Society of Chemical Industry (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. T. Callan: Selected Chapters in Organic Analysis (Lecture).

Junior Institution of Engineers, at 7.30.—R. P. Mears: Submersible Bridges on Indian Roads.

SATURDAY, October 3.

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.—Dr. P. Flemming: Harley Street, Historical and Topographical Notes (Lecture).

Institute of British Foundrymen (Lancashire Branch) (at College of Technology, Manchester), at 4.—W. West: Low Total Carbon Cast Irons and their Service to the Foundryman.

MONDAY, October 5.

Society of Engineers (at Geological Society), at 6.—Major C. K. Cochran-Patrick: Present Practice in Aerial Survey.

British Psychological Society (Education Section) (at London Day Training College), at 6.—H. A. Simmonds: Vocational Guidance and Education.

Institution of Automobile Engineers (at Queen's Hotel, Birmingham), at 7.30.—W. A. Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

British Kinematograph Society (in Gaumont British Theatre, Wardour Street), at 7.45.—T. Thorne-Baker: The Spicer-Dufay Colour Process.

Society of Chemical Industry (London Section) (at Chemical Society), at 8.—Sir Daniel Hall: Recent Applications of Science to Agriculture.

TUESDAY, October 6.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—C. S. Bayne: Humbug in Ornithology and Entomology.

Iron and Steel Institute (jointly with Lincolnshire Iron and Steel Institute) (in Modern Schools, Scunthorpe), at 7.—B. Matuschka: Solidification and Crystallisation of Steel Ingots: the Influence of the Casting Temperature and the Undercooling Capacity of the Steel.—A. Robinson: Melting Shop of the Appleby Iron Co., Ltd.—Dr. W. Rosenhain and A. J. Murphy: Accelerated Cracking of Mild Steel (Boiler Plate) under Repeated Bending.

WEDNESDAY, October 7.

Pharmaceutical Society of Great Britain, at 3.—Prof. G. E. Gask: Inaugural Address and Presentation of the Pereira Medal.

Institute of Fuel (jointly with other Societies) (at Institution of Electrical Engineers), at 7.—Dr. W. R. Ormandy: Coal: Smokeless Fuel and Oil from the National Standpoint.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—J. C. Maby: The Identification of Wood and Wood Charcoal Fragments.—Dr. T. Callan and N. Strafford: The Examination of Dyed Leathers in Cases of Alleged Dermatitis.—Dr. W. L. Davies: The Determination of Chlorides in Dairy Products and Biological Material.

THURSDAY, October 8.

Institution of Automobile Engineers (at Merchant Venturers' Technical College, Bristol), at 7.—W. A. Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

Institute of Marine Engineers (Junior Section), at 7.—J. R. Douglas: The Running and Maintenance of Marine Turbines.

Institute of Metals (London Local Section) (at 83 Pall Mall), at 7.30.—W. T. Griffiths: Chairman's Address.

Royal Aeronautical Society.—Prof. Piccard: Experiences in his Balloon Ascent.

FRIDAY, October 9.

Institute of Metals (Sheffield Local Section) (jointly with Sheffield Society of Engineers and Metallurgists) (in Applied Science Department, Sheffield University), at 7.30.—Dr. W. Rosenhain: Gases in Metals.

Institution of Production Engineers (at Society of Motor Manufacturers and Traders, 83 Pall Mall), at 7.30.—Annual General Meeting.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—D. M. Wilson: The Manufacture and Testing of Asphalt Paving Material.

PUBLIC LECTURES.

MONDAY, October 5.

Royal Institute of Public Health, at 4.—Dame Louise McIlroy: Recent Researches in the Prevention of Maternal, Fœtal, and Neo-natal Mortality (Harben Lectures). (Succeeding Lectures on Oct. 6 and 7.)

University of Bristol (in Wills Physical Laboratory), at 5.15.—Prof. Niels Bohr: Space-Time Continuity in Atomic Physics (Henry Herbert Wills Memorial Lecture).

TUESDAY, October 6.

King's College, London, at 5.—Dr. J. W. Pickering: Blood Plasma and Platelets. (Succeeding Lectures on Oct. 13, 20, and 27.)

Gresham College, at 6.—Sir George Newman: Physic. (Succeeding Lectures on Oct. 7, 8, and 9.)

SATURDAY, October 10.

Royal Institute of British Architects, at 3.—C. Williams-Ellis: Architecture? What's the Use?

Horniman Museum (Forest Hill), at 3.—Miss M. A. Murray: Egyptian Beliefs in the Hereafter.

Mathematical Association (London Branch) (at Bedford College for Women), at 3.—B. C. Wallis: Arithmetic from the Examiner's Point of View.

CENTENARIES.

Friday, October 2.

James Clerk Maxwell Centenary Celebration (at Cambridge).

Friday, Oct. 2 (*morning*).—Addresses by Prof. Max Planck, Sir Joseph Larmor, and Prof. Niels Bohr.

(*Afternoon*).—Addresses by Dr. William Garnett, Sir Ambrose Fleming, and Sir Oliver Lodge.

Friday, October 9.

Michael Faraday Centenary Celebration (in City Hall, Newcastle-upon-Tyne), at 7.—Dr. W. M. Thornton: Faraday and his Successors—the Growth of an Idea.

CONGRESS.

October 5 to 10.

Congress on Tuberculosis (at Davos).—*Principal Subjects for Discussion*:—Development and Course of Tuberculosis of the Lungs; Extra-Pulmonary Tuberculosis; Collapse Therapy.

SATURDAY, OCTOBER 10, 1931.

CONTENTS.

PAGE
International Aspects of Agriculture 597
The Biological Nature of the Viruses. By Dr. H. H. Dale, C.B.E., Sec.R.S. 599
Eels and Conger Eels of the North Atlantic. By Prof. Johannes Schmidt 602
The Clerk Maxwell Centenary Celebrations . . . 604
Henry Cavendish, 1731–1810 608
Obituary :
  Sir Howard Grubb, F.R.S. 609
News and Views 610
Letters to the Editor :
  Doppler Effect in Light-Scattering.—Sir C. V. Raman, F.R.S. 636
  Activated Adsorption of Hydrogen by Zinc and Chromium Oxides.—Prof. Hugh S. Taylor . 636
  Origin of Chromosome Linkage in *Œnothera*.—Prof. R. Ruggles Gates, F.R.S., and D. G. Catcheside 637
  Magnetic Resolution and Nuclear Moment of Rhenium.—Prof. P. Zeeman, For.Mem.R.S., J. H. Gisolf, and T. L. de Bruin 637
  Infra-Red Absorption Spectrum of Carbonyl Sulphide.—C. R. Bailey and A. B. D. Cassie . 637
  A Method of Obtaining Air Currents of Different Humidities.—Prof. J. B. Seth 638
  Structure of the Azides, from their Electric Dipole Moments.—L. E. Sutton 639
  Raman Spectra of Liquid Mixtures.—P. Krishnamurti 639
Research Items 640
Astronomical Topics 641
International Illumination Congress 642
International Congress for the Testing of Materials . 643
Association of Special Libraries and Information Bureaux 644
Birthdays and Research Centres 645
Societies and Academies 646
Official Publications Received 647
Diary of Societies 648
SUPPLEMENT.
  Paul Tannery and the History of Science. By Prof. F. S. Marvin 613
  Ethnological Survey of a South African Tribe. By C. W. H. 614
  Astronomy for All. By H. D. 615
  Strength of Materials 617
  Extinct Volcanoes of Western Scotland. By J. W. G. 619
  Formal Logic. By Dr. Norman R. Campbell . 620
  Plant Biochemistry. By Prof. Arthur R. Ling . 621
  The Chemical Engineer. By E. F. A. . . . 622
  Modern Views on Magnetism. By Prof. W. Peddie 623
  Short Reviews 624
  Forthcoming Books of Science 631

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International Aspects of Agriculture.

IT is sometimes said that agriculture is no subject for internationalism. Indeed, this dictum was not infrequently hurled at those who, after the War, made the first tentative attempts to start or to revive the international handling of agricultural problems. Oblivious of the fact that the produce markets of the great countries were becoming, with a decisive rapidity which was leaving all arguments in the rear, scenes of the most bitter struggles of international competition, the old-fashioned agriculturist was still arguing up to a few years ago—and in a few cases even continues so to argue to-day—that the knowledge and practice of each country are all-sufficient for that country. This point of view has not been without its influence on the research side of the subject. It has certainly affected in no small degree the study of the best means of getting the results of the experiment stations adopted in practice.

The doctrine of national self-sufficiency in matters agricultural has wrought deep havoc particularly on the social side of agricultural life. It is greatly delaying the fruitful interchange of social experience between the agriculture of different parts of the world. Wherever it has been broken down the results bid fair to be beneficial, and it is to the advantage of European agriculture that it has been able to revive and to place on a hopeful basis a body which even before the War stood for the international idea among research workers and also among practical farmers. The Fifteenth International Agricultural Congress recently held at Prague under the auspices of the International Commission of Agriculture went with a swing, and reflected great credit on a body which seems genuinely representative of large sections of European agriculture, even if it has not yet managed to secure adequate representation from Great Britain, Australia, or the Americas.

The International Commission of Agriculture stands for independence from government action. It is of course accustomed to work in friendly relations with the great State organisations which handle agriculture on an international footing, such as the League of Nations, the International Labour Office, and similar bodies. Indeed, one of its most important functions is to help in conveying the opinions of the research and of the farming world to these and other official organisations, in which effort it has been singularly successful of recent years, as all can testify who have followed its activities since 1927, the year of the World Economic

Conference convened by the League of Nations at Geneva. But it does not profess to resemble these official institutions, and guards most jealously its essential prerogative of opinion and action independent of all government influences.

Men of science can only view with sympathy ideals such as these. What the International Commission of Agriculture is now trying to accomplish from the practical farmers' point of view—to focus and to harmonise world opinion on world problems—pure science has always tried to do in its own magnificent field. It has had one great advantage. If practical agriculture has too frequently been wrongly argued to be a national craft, then science, as has always been admitted, is from its very nature international. Even popular opinion now endorses this view; elementary textbooks do homage to it.

Nor has science in any way improperly disowned its world character when joining hands with agriculture. However frankly and rightly agricultural experiment stations and demonstration farms have been financed and controlled by national authority and for national ends, their results have been yielded up for the good of all. No trade secrets are possible for the investigator of agricultural science so long as that profession follows in the footsteps of the workers in pure science.

There is, however, a shadow side to this free trade in intellect; it leaves the intellectual, after years of labour, with an empty purse. No government and no institution responsible for experimental work in the sciences bearing on agriculture can afford to pay salaries on so handsome a scale as to be at all commensurate with those massive rewards which sometimes accrue to the authors of mechanical and other inventions capable of being patented and then exploited by private enterprise. While this does not deter the man with a genius for biological investigation, it undoubtedly affects adversely the recruitment of biological students. Prof. T. G. Hill admitted this difficulty in his presidential address to Section K (Botany) of the British Association in referring to the present dearth in the British Empire of trained botanists for administrative and technical services when he said the work must be its own reward.

Such disadvantages are met with in the whole profession of science, but apply with particular force to the biological scientific career. While, however, in other departments of science some alternative reward, principally of reputation, fame, and distinction, comforts the soul of the investigator, the agricultural investigator appears to share very markedly neither in the honours which fall to academic science nor in the material rewards of commerce. The irony of the position is that successful work of the kind which he undertakes may spell not merely thousands to a few individuals but positively millions to a whole country. In his recent presidential address to Section M (Agriculture) of the British Association, Sir John Russell stated that, by using improved methods of cultivation, the farmers of Victoria, Australia, now obtain one bushel of wheat for each inch of rain falling during the season, whereas forty years ago they obtained only half a bushel. In Java the Dutch have produced a new sugar cane which has quadrupled the output of sugar. The production and use of artificial fertilisers in the past thirty years have changed completely the problem of the world's food supply, while the figures as to the great national wealth created by new agricultural strains of wheat, such as Marquis in Canada and the United States, run into sums of astronomical dimensions.

It would, therefore, seem a simple act of justice and of wise policy to arrange that some encouragement should occasionally be held out to the agricultural inventor. That such reward should be international in character would also appear to be thoroughly appropriate when we remember the universal application of most great agricultural advances. It thus becomes pertinent to direct attention to a recent highly interesting suggestion put forward by the Secretary-General of the Czechoslovak Academy of Agriculture, Dr. Edouard Reich, which might serve the end contemplated. Simultaneously with the Fifteenth International Congress of Agriculture already referred to, though not directly in connexion with it, the Czechoslovak Academy of Agriculture, which is a research and educational institution serving the needs largely of countries in eastern and central Europe, held a meeting of its corps of foreign members. At this meeting, Dr. Reich put forward various suggestions designed to further international co-ordination of scientific and intellectual effort applied to the agricultural domain. Among these suggestions was one for the foundation of a prize in agriculture. It was estimated that an endowment fund of about £10,000 would have to be collected by subscription. It is much to be hoped that the organising committee of distinguished men of science and other workers who were elected to deal with the proposals put forward at the meeting will be able to work out the details and carry them into practical effect.

The Biological Nature of the Viruses.[*]

By Dr. H. H. DALE, C.B.E., Sec.R.S.

THE viruses are a group of agents, the existence of which would certainly be unknown to us but for the changes produced by their presence in the bodies of higher animals and plants. They seem to have one property at least of living organisms, in being capable, under appropriate conditions, of indefinite reproduction. We know nothing of their intrinsic metabolism : it has even been asserted that they have none. Few of them have yet been rendered visible by the microscope ; it is, indeed, a question for our discussion whether any of them have yet been seen or photographed. It is a question, again, whether any of them, or all of them, consist of organised living units, cells of a size near to or beyond the lowest limits of microscopic visibility ; or whether, as some hold, they are unorganised toxic or infective principles, which we can regard as living in a sense analogous to that in which we speak of a living enzyme, with the important addition that they can multiply themselves indefinitely. Some, however, would attribute this, not to actual self-multiplication, but to a coercion of the infected cells to reproduce the very agent of their own infection.

The problems presented by the nature and behaviour of the viruses cannot fail to raise questions of the greatest interest to anyone concerned with general physiological conceptions. What is the minimum degree of organisation which we can reasonably attribute to a living organism ? What is the smallest space within which we can properly suppose such a minimum of organisation to be contained ? Are organisation, differentiation, separation from the surrounding medium by a boundary membrane of special properties, necessary for the endowment of matter with any form of life ? Or is it possible to conceive of a material complex, retaining in endless propagation its physiological character, as revealed by the closely specific reaction to it of the cells which it infects, though it is not organised into units, but uniformly dispersed in a watery medium ? Among those who study the viruses primarily as pathogenic agents, these questions provide matter for debate ; I suggest that they are questions with which the physiologist may properly be concerned.

I cannot deal with the history of the subject ; but it is of interest to note that Edward Jenner was dealing, in small-pox and vaccinia, with what we now recognise as characteristic virus infections, long before there was any hint of the connexion of visible bacteria with disease. Pasteur himself was dealing with another typical case of a virus infection in the case of rabies. The clear recognition, however, of the existence of agents of infection, imperceptible with the highest powers of ordinary microscopic vision, and passing through filters fine enough to retain all visible bacteria, begins with Ivanovski's work in 1892 on the mosaic disease of the tobacco plant, brought to general notice and greatly developed by Beijerinck's work on the same infection some seven years later ; and with Loffler and Frosch's demonstration, in the same period, that the infection of foot-and-mouth disease is similarly due to something microscopically invisible, and passing easily through ordinary bacteria-proof filters. Since those pioneer observations the study of viruses has spread, until they are recognised as the causative agents of diseases in an imposing and still growing list containing many of the more serious infections of man, animals, and plants.

If we are to discuss the biological nature of the viruses, it is obvious that we should begin by attempting some kind of definition. What do we mean by a virus ? And what are the tests by which we decide that a particular agent of infection shall be admitted to, or excluded from, the group ? But a few years ago I think that we should have had no difficulty in accepting three cardinal properties as characterising a virus, namely, invisibility by ordinary microscopic methods, failure to be retained by a filter fine enough to prevent the passage of all visible bacteria, and failure to propagate itself except in the presence of, and perhaps in the interior of, the cells which it infects. It will be noted that all three are negative characters, and that two of them are probably quantitative rather than qualitative.

Such a definition is not likely to effect a sharp or a stable demarcation. We shall see that its failure to do so is progressive. Nevertheless it would still be difficult to refuse the name of virus to an agent which fulfils all three criteria ; and we must therefore, in consistency, apply it, on one hand, to the filtrable agents transmitting certain tumours, and, on the other hand, to the agents of transmissible lysis affecting bacteria, and now widely known and studied as bacteriophages. But the strict application of such a definition, based on negative characteristics, must obviously narrow its scope with the advance of technique. We may look a little more closely at the meaning of these different characters.

Microscopic visibility is obviously a loose term. Rayleigh's familiar formula, in which the lower limit of resolution is equal to one-half the wavelength of the light employed, divided by the numerical aperture of the objective, only gives us the smallest dimensions of an object, of which, with the method of transmitted illumination habitually used in former years, a critical image can be formed. There can be no doubt that the separate particles of practically all the agents to which the term virus would be applied fall below this limit of size. To put it in plain figures, their diameter is less than 0·2 micron. On the other hand, progress has recently been, and continues to be, rapid in the direction of bringing into the visible range minute bodies associated with a growing number of viruses. This has been effected, on one hand, by improvement in staining technique, which probably owes its success largely to increase of the natural size of the particles by a deposit of dye on their surface; and, on the other hand, by forming visible diffraction images of the unstained particles with wide-aperture dark-ground condensers, and by photographing the images formed of them with shorter invisible rays. Mr. Barnard has obtained such sharp photographic images of the bodies associated with one virus, measurements of which give their natural size by simple calculation.

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[*] From the presidential address introducing a discussion on the subject in Section I (Physiology) of the British Association in London on Sept. 28.

The reaction of a cautious criticism to such a demonstration seems to have taken two different directions. There has been a tendency, on one hand, to exclude an agent from the group of viruses as soon as the microscope could demonstrate it with some certainty. Many have for years thus excluded the agent transmitting the pleuro-pneumonia of cattle, though the status of this organism has been compromised even more by the success of its cultivation on artificial media. Visibility seems to have rendered doubtful the position of the Rickettsia group of infections, and, if the test is logically applied, the process of exclusion can scarcely stop before the agents transmitting psittacosis, fowl-pox, infectious ectromelia, and even vaccinia and variola, have been removed from the group of viruses into that of visible organisms.

In discussing the biological nature of viruses as a whole, however, we can scarcely begin by accepting an artificial and shifting limitation of that kind. The real task before us, rather, is to discuss to what extent the evidence of these recent developments, which appear to show that some of the agents, known hitherto as viruses, consist of very minute organisms, can safely be applied to other viruses which are still beyond the range of resolution. Do these also consist of organisms still more minute, or are any of them unorganised? Another line of criticism, sound in itself, while not excluding from the virus group these agents for which microscopic visibility has been claimed, demands more evidence that the minute bodies seen or photographed are really the infective agent, and not merely products of a perverted metabolism which its presence engenders.

It is obvious that complete evidence of identity cannot be obtained until a virus has been artificially cultivated in an optically homogeneous medium. Meanwhile it is a question of the strength of a presumption, on which opinions may legitimately differ. Let us recognise that the evidence is not perfect, but beware of a merely sterilising scepticism. I suspect that the attitude of some critics is coloured by past history of the search for viruses and especially by that part of it concerned with the curious objects known as 'inclusion bodies', which are readily demonstrated with relatively low powers of the microscope, in the cells of animals and plants infected with certain viruses. From the earlier and admittedly hasty tendency to identify them as infective protozoa, opinion seems to have swung too quickly to the opposite extreme, of dismissing them as mere products of the infected cell. It is so comparatively simple, in some cases, to separate these bodies, that it is surprising that so few efforts have been made to test their infectivity. However, the power of such a body to convey at least one virus infection has been demonstrated; and since they have further been shown, in several cases, to consist of a structureless matrix packed with bodies looking like minute organisms, the burden of proof in other cases seems to me, for the moment, to rest on those who suggest that they consist wholly of material precipitated by the altered metabolism due to the infection.

The physical evidence, obtained by filtration through porous fabrics and colloidal membranes, and by measuring rates of diffusion, is, of course, purely concerned with the size of the units of infective material, and must be taken in conjunction with the evidence provided by the microscope. The crude qualitative distinction between the filterable and non-filterable agents of infection has long since ceased to have any real meaning. There is no natural limit of filterability. A filter can be made to stop or to pass particles of any required size. It is now realised that the only proper use of a filter in this connexion is to give a quantitative measure of the maximum size of the particles which pass it. Evidence from failure to pass must always be subject to correction for the effects of electrostatic attraction and fixation by adsorption on the fabric of the filter. A large amount of filtration evidence has, further, been vitiated by reliance on determinations of the *average* pore size of the filter. In dealing with an infective agent, the test for the presence of which depends on its propagation under suitable conditions, it is obviously the maximal pore size which is chiefly significant.

For these reasons a good deal of the evidence showing that certain viruses can be detected in the filtrates, obtained with filters which will not allow hæmoglobin to pass in perceptible quantities, must be regarded at least with suspicion. Dr. Elford has recently succeeded in preparing filter-membranes of much greater uniformity, with a small range of pore-diameters. His measurements, with these, of the sizes of the particles of different viruses, show a range approaching the dimensions of the smallest recognised bacteria, on one hand, and falling as low, in the case of the virus of foot-and-mouth disease, as about three or four times the size of the hæmoglobin molecule; the latter being given not only by filtration-data, but also by other physico-chemical measurements, such as those obtained by Svedberg with the ultra-centrifuge. It should be noted, as illustrating the difficulties of the problem and the uncertain meaning of some of the data, that Elford has regularly found a bacteriophage to be stopped by a membrane which allows the foot-and-mouth virus to pass; while, on the other hand, recent determinations of the rate of diffusion of bacteriophage, made by Bronfenbrenner, put the diameter of its particles at 0·6 of a millimicron, that is, only about one-fifth of the accepted dimensions of the hæmoglobin molecule. If we accepted such an estimate, we should be obliged to conclude, I think, not merely that the bacteriophage is unorganised, but that its molecules are something much simpler than those of a high-molecular protein. It has even been suggested, though on very imperfect evidence, that it may be a moderately complex carbohydrate. Are we, then, to suppose that the foot-and-mouth virus is a similarly unorganised and relatively simple substance ? It is difficult to do so, in view of the series of other agents, all conforming in many aspects of their behaviour to the classical type of the foot-and-mouth virus, and yet showing a range of dimensions up to that at which their units are apparently becoming clearly visible by modern microscopical methods.

It will be clear, indeed, that, if we accept the lowest estimates for the size of the units of some viruses, such as the bacteriophage and the agents transmitting some plant diseases, we cannot by analogy apply the conception of their nature, thus presented, to viruses consisting of organisms which are ceasing to be even ultramicroscopic ; and we should be led to doubt the identity with the virus of the bodies which the microscope reveals. If, on the other hand, we regard the still invisible viruses, by analogy with those already seen, as consisting of even much smaller organisms, we can only do so by rejecting the conclusions drawn from some of the physical evidence. It is, of course, possible that some of the agents called viruses are organisms and others relatively simple pathogenic principles in solution ; but to assume at this stage such a fundamental difference, among members of a group having so many properties in common, would be to shirk the difficulty.

The third negative characteristic of a virus, namely, its failure to propagate itself, except in the presence of living cells which it infects, may obviously again provide an unstable boundary, shifting with the advance of our knowledge and skill. We may regard it as not only possible, but even likely, that methods will be found for cultivating artificially, on lifeless media, some of those viruses at least which have the appearance of minute organisms. It would be playing with nomenclature to let inclusion in the virus group depend on continued failure in this direction. On the other hand, the dimensions assigned to the units of some viruses, representing them as equal in size to mere fractions of a protein molecule, might well make one hesitate to credit them with the power of active self-multiplication. Experience provides no analogy for the growth of such a substance by self-synthesis from the constituents of a lifeless medium ; the energetics of such a process might present an awkward problem. To account for the multiplication of such a substance at all, even in cells infected by it, we should be driven, I think, to the hypothesis which has been freely used to account for the propagation of bacteriophage, on one hand, and of typical viruses like that of herpes, on the other ; namely, that the presence of the virus in a cell constrains the metabolism of the cell to produce more.

Bordet has used the reproduction of thrombin by the clotting of the blood as an analogy for the suggested reproduction of bacteriophage in this manner. Another, and perhaps closer, analogy might be found in recent evidence that a culture of pneumococcus, deprived of its type-specific carbohydrate complex, can be made to take up the carbohydrate characteristic of another type, and then to reproduce itself indefinitely with this new, artificially imposed specificity. The response of the cells of the animal body to even a single contact with a foreign protein, by the altered metabolism producing immunity, and often persistent for the lifetime of the individual, may suggest another parallel ; but here the protective type of the reaction is in direct contrast to the supposed regeneration by the cells of the poison which killed them.

Boycott, again, has emphasised the difficulty of drawing a sharp line of distinction between the action of normal cell-constituents, which promote cell-proliferation for normal repair of an injury, and the virus transmitting a malignant tumour, or that causing foot-and-mouth disease. I do not myself find it easy, on general biological grounds, to accept this idea of a cell having its metabolism thus immediately diverted to producing the agent of its own destruction, or abnormal stimulation. It is almost the direct opposite of the immunity reaction, which is not absent, but peculiarly effective in the response of the body to many viruses. It is difficult, again, to imagine that a virus like rabies could be permanently excluded from a country if it had such an autogenous origin. The phenomena of immunity to a virus, and of closely specific immunity to different strains of the same virus, are peculiarly difficult to interpret on these lines.

This conception, however, of the reproduction of a virus by the perverted metabolism of the infected cell has been strongly supported by Doerr, in explanation of the phenomena of herpes. There are individuals in whom the epidermal cells have acquired a tendency to become affected by an herpetic eruption, in response to various kinds of systemic or local injury. From the lesions so developed, an agent having the typical properties of a virus can be obtained, capable of reproducing the disease by inoculation into individuals, even of other species, such as the rabbit, and exciting, when appropriately injected, the production of an antiserum specifically antagonising the herpes infection. Such phenomena have a special interest for our discussion, in that they can be almost equally well explained by the two rival conceptions. One regards the herpes virus as a distinct ultramicroscopic organism, and the person liable to attack as a carrier, in whom the virus can be awakened to pathogenic activity and multiplication by injuries weakening the normal resistance of his cells to invasion. The other regards it as a pathogenic principle produced by cells in response to injury, and awakening other cells to further production when transmitted to them.

This forms a good example of the central difficulty in dealing with the group of agents at present classed together as viruses. They seem to form a series ; but we do not know whether the series is real and continuous, or whether it is formed merely by the accidental association, through a certain similarity in effects, and through common characteristics of a largely negative kind, of agents of at least two fundamentally different kinds. If we approach the series from one end, and watch the successive conquests of microscopical technique, or if we consider the phenomena of immunity over the whole series, we are tempted to assume that all the viruses will ultimately be revealed as independent organisms. If we approach from the other end, or consider analogies from other examples of a transmissible alteration of metabolism, we may be tempted to doubt the significance of the evidence provided by the microscope, and to conclude that all viruses are unorganised, autogenous, toxic principles. If we take the cautious attitude of supposing that both are right, and that viruses belonging to both these radically different types exist, where are we going to draw the line? Is the test to be one of unit dimension? If so, what is the lower limit of the size of an organism? Are we to suppose that inclusion bodies can only be produced by viruses which are independent organisms? And if so, does this conclusion also apply to the 'X' bodies associated with the infection of plant cells by certain viruses?

If we try to form an estimate of the lower limit of size compatible with organisation, I think we should remember that particles which we measure by filters of known porosity, or by photomicrographs, need not be assumed to represent the virus organisms in an actively vegetative condition. They may well be minute structures, adapted to preserve the virus during transmission to cells in which it can resume vegetative life. Attempts to demonstrate an oxidative metabolism in extracts containing such a virus, separated from the cells in which it can grow and multiply, and to base conclusions as to the non-living nature of the virus on failure to detect such activity, must surely be regarded as premature.

Our evidence of the vitality of its particles is, as yet, entirely due to their behaviour after transmission. They may accordingly contain protein, lipoid and other molecules in a state of such dense aggregation that comparisons of their size with that of the heavily hydrated molecules of a protein in colloidal solution may well give a misleading idea of their complexity.

Apart from their known function as the agents transmitting many of the best known among the acute infections, it is impossible, to anyone having even a slight knowledge of the recent developments which began with the work of Rous and Murphy, to doubt that in the advance of knowledge concerning the nature of the viruses in general lies the brightest hope of finding a clue to the dark secret of the malignant tumours. In unravelling what is still such a tangle of contradictions, the animal biologist needs all the help that can be given by concurrent study of the analogous phenomena in plants.

Eels and Conger Eels of the North Atlantic.

By Prof. Johannes Schmidt.

In the course of the Danish investigations on the life-histories of the fresh-water eels (1904–1931) important data about the congers have been obtained. I hope it will be possible some time to give a more detailed picture of the history and distribution of the fresh-water eels and congers of the various oceans. Referring to my earlier publications,[1-8] I propose here to deal with the relation between the European and the American conger, which is generally referred to the same species as the European one. The investigation is mainly based upon a study of the larvæ and their distribution.

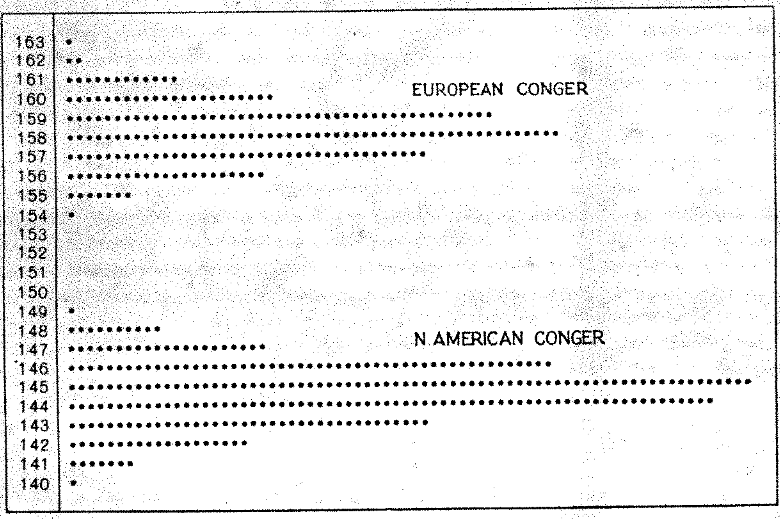

Fig. 1.—European and North American Conger (*Conger vulgaris* and *Conger oceanicus*). Number of myomeres in larvæ: *Conger vulgaris* (top graph), average of 201 specimens, 158·16; *Conger oceanicus* (lower graph), average of 288 specimens, 144·63. (Countings by Miss Esther Hansen.)

In the North Atlantic area, we obtained about 2500 larvæ belonging to the genus *Conger s. str.* By counting the myomeres we found that the material falls into two distinctly separate groups (Fig. 1). In the former, the number of myomeres varies between 154 and 163 with an average of 158·16, in the latter between 140 and 149 with an average of 144·63. So there is no overlapping of the two groups.

On marking the distribution of the larvæ of the two groups upon a chart, we find that the larvæ with the high myomere number occupy quite another and a much larger area than those with the smaller number. As shown by the charts (Figs. 2 and 3), the distribution is much like the one I have found in the case of the larvæ of the European and the American fresh-water eel respectively. Similarly, there is in both cases an overlapping of the areas.

We have determined the number of vertebræ in several hundred adolescent and adult specimens of the European conger (*Conger vulgaris*) and have found values between 153 and 161 (average between 157 and 158), which corresponds well with the above-mentioned values of myomeres in the group of larvæ with the higher number, the number of myomeres of the larvæ being a little higher than the number of vertebræ of the adult fish. This fact also holds good of the fresh-water eels and other murænoids.

As to the number of vertebræ in adult specimens of congers from North America, my material is much smaller than that for the European conger. Through the kindness of the United States Bureau of Fisheries, however, I received in 1922 four adult specimens originating from Woods Hole, Mass. A determination of their number of vertebræ gave the following figures: 143, 144, 144, 145, which is in complete agreement with the values of the group of larvæ with the smaller number.

In the circumstances, it is clear that the American conger is a species differing from the European one, and that it ought to be given a specific name. For want of types, I have applied for advice to American colleagues, namely, Prof. H. B. Bigelow and Mr. A. E. Parr, who think that the name used by Mitchell (*Jour. Ac. Nat. Sci. Phila.*, p. 407; 1818), namely, *Anguilla oceanica*, should be chosen. The fish in question being stated by Mitchell to occur "off New York", there is scarcely any doubt that he really had before him the American species with the smaller number of vertebræ. So we name the North American species *Conger oceanicus* as distinct from the European *Conger vulgaris*. However, I wish to direct attention to the fact that the name does not apply to the conger occurring in South America (Argentine), which by our investigations has proved to be different from the North American species.

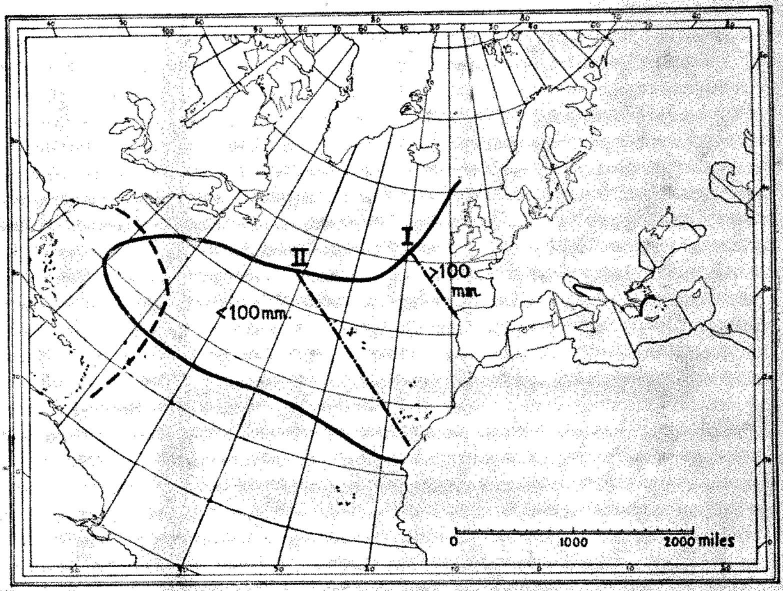

Fig. 2.—Distribution of unmetamorphosed larvæ of the European and North American species of congers (*Conger vulgaris* and *Conger oceanicus*). *Conger vulgaris*: East of line I all larvæ were more than 100 mm. long, west of line II all were less than 100 mm. in length, according to Danish investigations, 1904–1931. The American species indicated by *broken*, the European by *unbroken* curves. In contrast to the fresh-water eel, *Conger vulgaris* breeds in the Mediterranean and in the Eastern Atlantic.

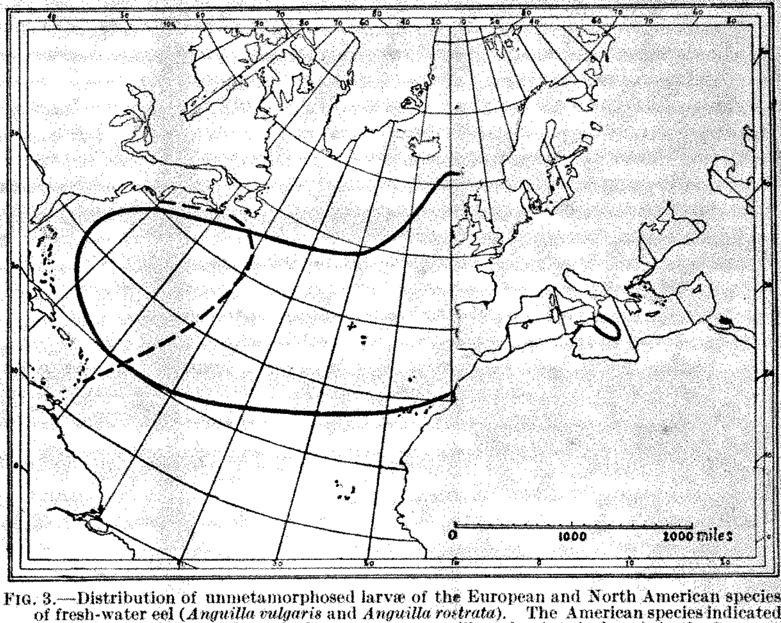

Fig. 3.—Distribution of unmetamorphosed larvæ of the European and North American species of fresh-water eel (*Anguilla vulgaris* and *Anguilla rostrata*). The American species indicated by *broken*, the European by *unbroken* curves. *Anguilla vulgaris* only breeds in the Sargasso Sea west of long. 50° W.

The distribution of *Conger oceanicus* is not nearly so wide as that of *Conger vulgaris*. We know that it occurs off the Atlantic coast of the United States, but we know little more. In the West Indies we have found quite tiny larvæ, a fact that permits us to conclude that here is the breeding place of the species. The appearance of these tiny larvæ agrees with the corresponding stages of development of *Conger vulgaris* described and pictured by me in 1912[4] and 1913.[6] The tiny stages, however, which Eigenmann (1902) hatched from pelagic eggs taken by the schooner *Grampus* south of Nantucket lightship, do not belong to *Conger* but to an *Ophichthys* or a closely related form, a fact to which I have already directed attention.[5]

I have already mentioned that there is a striking agreement between the distribution of the larvæ of the two *Conger* species and those of the two *Anguilla* species. It is especially interesting to compare the two European species, *Conger vulgaris* and *Anguilla vulgaris*, which, as shown by the maps (Figs. 2 and 3), are both distributed over a zone across the North Atlantic and the Mediterranean, a distance of about a quarter of the circumference of the globe. But while the fresh-water eel breeds only in the western Atlantic, from which place its larvæ, increasing in age and size, spread towards the north-east and the east over an area similar to the one taken up by the conger larvæ, matters are different as to the conger. For our investigations have shown that the European conger must have breeding places along the whole extent of the area from the Sargasso Sea to Egypt, because throughout this extent—always over great oceanic depths—we have found tiny larvæ, only 10 mm. in length.

The full-grown larvæ measure about 140–160 mm. in length. If we make a closer examination of the distribution of the larvæ of *Conger vulgaris* according to size, we find :

1. In the south-eastern part of the larvæ area, that is, from the Azores and eastwards between about lat. 30° and 40° N. to Gibraltar and onwards through the Mediterranean to Egypt, all sizes of larvæ from tiny to full-grown ones were found. This fact shows that we are dealing here with local conger populations.

2. From Cape Finisterre a line has been drawn on the map (Fig. 2) in a north-westerly direction (I) ; north of this line, that is, in the north-eastern part of the larvæ area, only older larvæ more than 100 mm. in length have been found. From this fact we may conclude that the conger populations of north-western and northern Europe, including the British Isles, are *not* of local origin, but originate from more distant regions of the Atlantic situated to the south and west.

3. From a point a little south of the Canary Islands a line has been drawn in a north-westerly direction passing a little west of the Azores and limiting the western part of the larvæ area (II). West of this line, that is, in the Sargasso Sea, we only found tiny (10 mm. in length) or half-grown larvæ, but none attaining a length of 100 mm. As the adolescent conger lives in shallow water, these larvæ must be the offspring of conger populations that have undertaken very long migrations to the breeding places. The origin of the *Conger vulgaris* breeding in the Sargasso Sea cannot be determined for certain at present. Since the tiny larvæ of *Conger vulgaris* occur in the Sargasso Sea together with the tiny larvæ of our European eel, and the larvæ, like those of the eel, increase in size from this place towards the north and north-east, I think it very probable that they migrate along the same routes to north-western and northern Europe, and that they are the offspring of the conger populations living there.

I can sum up as follows : it is a common feature of the eels and conger eels of the North Atlantic that both genera have an eastern (European) and a western (American) species, *Anguilla vulgaris* and *Conger vulgaris*, and *Anguilla rostrata* and *Conger oceanicus*, respectively. Both the eastern species have a higher number of vertebræ and a far wider distribution of the larvæ than the two western species. (Fig. 1.)

The adolescent European eel and European conger have, in the main, the same distribution, and this also holds good of their larvæ, when no account is taken of the age (size) of the latter. (Figs. 2 and 3.)

The European eel breeds in the western Atlantic and only there, in a limited area of the Sargasso Sea. The European conger has a much wider breeding area, as it breeds in the Mediterranean, in the eastern Atlantic between the Azores and Gibraltar, and in the west Atlantic (the Sargasso Sea).

So *Conger vulgaris* is not a biological unity like the fresh-water eel. It comprises different populations with different breeding places, breeding time, and migratory tendencies.

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[1] *Rapp. Proc. Verb. Conseil perm. intern. l'Explor. de la Mer* Copenhagen, 1906.

[2] *Med. Komm: Havunders., Fiskeri*, Bind 3, No. 3, Copenhagen, 1909.

[3] NATURE, March 9, 1911.

[4] *Vidensk. Medd. Dansk naturh. Foren.*, Copenhagen, Bd. 64, 1912.

[5] *Intern. Revue Hydrobiol. Hydrogr.*, Bd. 5, Leipzig, 1912.

[6] *Med. Komm. Havunders., Fiskeri*, Bind 4, No. 2, Copenhagen, 1913.

[7] British Association, Hull Meeting, 1922.

[8] *C.R. Acad. Sci.*, Paris, t. 179, Oct. 20, 1924.

The Clerk Maxwell Centenary Celebrations.

THE University of Cambridge celebrated, on Oct. 1–2, the centenary of the birth of the first Cavendish professor of experimental physics, James Clerk Maxwell.

On Sept. 30, before the celebrations opened in Cambridge, memorial tablets to Faraday and Maxwell were unveiled in Westminster Abbey. The tablets are of the same size as that which marks Kelvin's resting-place, and they lie on the opposite side of the Newton floor-slab. There could be no more appropriate site. The short service was conducted by the Dean, and was attended by about four hundred members and delegates from the Royal Institution, delegates of the Maxwell celebration, and members of the University of Cambridge. The Master of Trinity unveiled the memorial, and in a short address emphasised the links between Faraday and Maxwell and their claims to such memorials.

The celebrations opened in Cambridge on Oct. 1, with the old Maxwell wing of the Cavendish Laboratory as its headquarters. About eighty official delegates had been nominated by the principal academies and learned societies of the world and by the home universities. Capt. J. Wedderburn Maxwell represented Maxwell's family, and there were present also some fifty guests, including at least twelve of those who had worked with Maxwell or sat at his lectures in the first days of the Cavendish Laboratory and many of those who have since helped to build up the school of experimental physics in Cambridge. A luncheon to the official delegates was given by the newly appointed Vice-Chancellor, the Master of Corpus, who in an introductory speech said that he counted himself fortunate in having this amongst the first of his new duties. The toast of the delegates, proposed by Lord Rutherford, was replied to by the Marchese Marconi and also by Prof. Max Planck, who said:

> "Maxwell's centenary is indeed a festive day—a day of honour for the physicists of all countries. In his personality we see not only the erudite savant mastering every domain of physics, but also the imaginative artist, who, like no other, knew how harmoniously to combine the separate material of investigation and thus to further its development. It is pre-eminently with Maxwell that this interweaving of sober intellectual activity with artistic intuition plays a particularly characteristic part.
>
> "In physics, intuition is a peculiar thing. Nowadays it has somewhat fallen into discredit, having really recently done a deal of harm: first in the province of relativity, where the seemingly evident conception of the simultaneousness of two events occurring in different places proved a gross delusion; then again in the province of the quantum theory, where it has proved absolutely impossible with the common forms of intuition completely to grasp the connexions between corpuscular and undulatory motion.
>
> "And yet those are wrong who wholly reject intuitions by asserting that theoretical physics is only concerned in the mathematical working out of the results of measurements. For he who quite forgoes tentative flights of imagination will never be struck by a new idea which can be made fruitful for experiments. Yet a careful distinction must be made between the operations of the intellect and those of fancy. Here Maxwell sets us a classic example. His theory of electrodynamics was originally founded on quite special ideas of the mechanical nature of the ether, in accordance with the fact that in his time the mechanical conception of Nature was considered nearly a matter of course, having received strong support through the discovery of the principle of conservation of energy. But after, by the aid of such mechanical notions, Maxwell had found his electromagnetic differential equations and had recognised the extent of their efficiency, he did not hesitate in pushing aside as a negligible accessory the mechanical interpretations of the differential equations, in order to make them independent and to give his theory its pure and sublime shape. Perhaps this most clearly characterises Maxwell's physical manner of thinking.
>
> "Thus to-day, when we are beset by more difficult problems, Clerk Maxwell can still teach us a good deal, and it is with the expression of sincere thanks and warm wishes that we greet the home of his activities: the University of Cambridge and particularly the Cavendish Laboratory."

After this impressive opening, the Vice-Chancellor and delegates proceeded in procession to the Senate House, where, after the welcome and presentation of delegates, the Master of Trinity delivered the memorial lecture, dealing first with Maxwell's life and personality and finally with his work. This address forms the first of the essays in the commemoration volume which has been published by the University Press.

After the ceremony in the Senate House, the guests were entertained by the Master and Fellows of Peterhouse, the college where Maxwell spent his first days in Cambridge. In the evening the reception given by the Master and Fellows of St. John's College filled the hall and combination room with a brilliant assembly.

Three of the main scientific addresses were given in the Arts School on the morning of Oct. 2. Prof. Planck's address on "The Influence of Maxwell on Theoretical Physics in Germany" will remain long in the memory of those present. Sir Joseph Larmor charmed the assembly with personal reminiscences of the celebrities who formed the scientific environment of Maxwell; he told in particular of a visit from Ludwig Boltzmann, who through misfortune had arrived penniless and without luggage in Cambridge, in search of models which he was sure Maxwell must have made to illustrate his electrodynamic field theory, and which he hoped to find in the lumber of the Cavendish Laboratory. After this, Prof. Niels Bohr gave an address on the influence of Maxwell's work on modern theoretical physics.

In the afternoon, under the presidency of Sir Richard Glazebrook, Sir James Jeans gave an address on Maxwell's methods, and Dr. William Garnett, the first demonstrator in the Cavendish Laboratory, related many new and delightful Maxwell stories. Some of his address may be quoted:

> "Perhaps to see Maxwell at his best was to see him at play. Few things could give him more pleasure than a new toy, whether designed by himself or anyone else, provided it showed some ingenuity in its design or construction; and to exhibit these toys to his friends at home in the evenings was a great delight. Maxwell's improved Zoetrope with its concave lenses and his real image stereoscope afforded much interest to visitors, but perhaps his favourite toys on these occasions were the flying butterflies with their revolving antennæ which he made to fly about the drawing-room at Scroops Terrace.
>
> "But if one looks for Maxwell's most characteristic feature, it is to be found in his sympathy with and love for every creature. Though very fond of country life, he would never hunt or shoot. In Cambridge and in London he nursed friends who were seriously ill, at the cost of much time taken from his work. During his last two years his work at the laboratory was greatly interrupted by the illness of Mrs. Maxwell, in whose room he would frequently sit all night. It is an interesting speculation whether, if his time had not been occupied by his wife's serious illness and the Cavendish papers, he would not have followed up his electromagnetic theory and experimentally produced long electric waves.
>
> "It was during the visit of the comet in 1874, when unfortunately the comet's tail was a subject of general conversation, that Maxwell's terrier developed a great fondness for running after his own tail, and though anyone could start him, no one but Maxwell could stop him until he was weary. Maxwell's method of dealing with the case was, by a movement of the hand, to induce the dog to revolve in the opposite direction and after a few turns to reverse him again, and to continue these reversals, reducing the number of revolutions for each, until like a balance wheel on a hair spring with the maintaining power withdrawn, by slow decaying oscillations the body came to rest.
>
> "I have been asked what Maxwell did when he wanted an experimental test of a theory and had not thought of one, or when a piece of apparatus behaved quite unexpectedly. According to his own statement

he 'dreamt over it properly', which he considered 'the best method of resolving difficulties of a particular kind which may be found out especially by the laws of association'."

Sir Ambrose Fleming spoke of his work at the laboratory during the last few years of Maxwell's life, and of Maxwell's lectures, attended only by three students. He presented to the laboratory the notes he took of Maxwell's last lectures. He thought it strange that Maxwell never lectured or spoke of his theory of electromagnetic waves. He had never heard any proposal for an experiment on electromagnetic radiation, and although there is in existence a letter from Maxwell to Garnett where he promises to write down for Fleming "a scheme for a radiating wire experiment", one is driven by the absence of any later development to conclude that this referred to the thermal radiation for the oil-cooled coils which were then being used for the B.A. experiments.

After Sir Oliver Lodge had wound up the addresses with an account of the development of wireless from Maxwell's equations to Marconi and the B.B.C., the proceedings were transferred to the Cavendish Laboratory, where, in the old rooms designed so carefully by Maxwell, were laid out for the first time since Maxwell's death the treasures which were bequeathed by Mrs. Maxwell.

The laboratory can count itself fortunate in Maxwell's characteristic of saving everything of interest from his toys, manuscripts, and apparatus. In one group were assembled the relics of his childhood and adolescence. The models of the regular solids made at the age of thirteen showed Maxwell's early geometrical interests; the strained pieces of glass and gelatine used in his early investigations on the optical properties of elastic solids when placed in the polariser showed the now familiar coloured strain figures, which could be compared with the same figures sketched out by Maxwell eighty years ago. The improved form of Zoetrope referred to by Dr. Garnett, with its clearly executed drawings of vortex rings in motion, and the drawings of more elaborate operations, in which his imagination was aided by the clear brush of Jemima Wedderburn, proved a great attraction. There was also his real image stereoscope which he constructed for the teaching and study of solid geometry, and the ophthalmoscope which he used for the study of the eyes of his friends.

In the next group could be seen the development of Maxwell's scientific interests; the colour-top with its sectors of different colours which he constructed whilst a graduate of Trinity College in 1854, and which was used to establish his colour equations and for the investigation of colour blindness; here also was the more perfect instrument of his last years in Aberdeen—the colour-box with its slits and prisms for combining different components of white light in any desired proportion. To illustrate his work on the dynamics of rigid bodies were three models of his dynamical top; the original wooden top used to entertain and mystify his undergraduate friends in Trinity College and the more perfect instrument of his Aberdeen days with its screws for the adjustment of the principal moments of inertia and devices for showing the motion of the instantaneous axis of rotation. One of the important applications of this top has been to show the connexion of the figure of the earth with a periodic variation in latitude. As a reminder of Maxwell's first excursion into statistical theory was shown the model of Saturn's rings constructed to illustrate two of the possible methods of propagation of waves amongst the particles of the rings; by it stood the original oscillating disc apparatus used for the measurements on the viscosity of gases which were carried out in his King's College days in his home in Kensington. There was also the small note-book with its record of swings and 'log decs.', and the triumphant letter to Tait announcing the independence of viscosity and pressure.

The activities of Maxwell as a member of the British Association Committee on Electrical Standards were fully illustrated by the spinning coil lent by the Science Museum to its old home, the apparatus used for the determination of the ratio of the units by balancing the electrostatic attraction of two discs against the electromagnetic repulsion of two coils, and the great B.A. electrodynamometer constructed in 1867 and used later by Lord Rayleigh for the determination of the ampere.

Most interesting of all, perhaps, were the manuscripts and letters of Maxwell. The delegacy of King's College, London, had kindly lent three of the small note-books in which Maxwell used to write down his examination questions, and in one of which are the first chapter headings of the "Electricity and Magnetism". Practically the whole of the manuscript of the first edition of the "Electricity and Magnetism" is in the possession of the laboratory, and various parts were exhibited, together with Maxwell's copy of the first edition. Here also were the manuscripts of his later papers, the note-books of his undergraduate days, and the notes of his lectures taken by Sir Ambrose Fleming. With the original plans of the Cavendish laboratory was a letter to Thomson asking for advice and giving his idea of what a laboratory should contain:

> "A place on the ground floor with solid foundations for things requiring to be steady. Access to the roof for atmospheric electricity. A place with good ventilation to set up Grove or Bunsen's batteries without sending fumes into the apparatus.
>
> "A good clock in a quiet place founded on masonry, electric connexion from this to other clocks to be used in the experiments, and from here connexion to machines for making sparks, marks on paper, etc.
>
> "A well-constructed oven, heated by gas to get up a uniform high temperature in large things.
>
> "A gas engine (if we can get it) to drive apparatus; if not, the University men in good training in four relays of two, or two relays of four, according to the nature of the experiment.
>
> "We should get from the B.A. some of their apparatus for the Standards Committee. In particular, the spinning coil and the great electrodynamometer."

Here also were letters to Tait announcing the discovery of the law of distribution of radiation and the famous catechisms to Thomson "concerning demons".

If one sought evidence for the unchanging perversity of scientific writers, there was Maxwell's letter written in October 1876:

> "How vile are they who quote newspapers, journals, and translations by number of vol. and page, instead of the year of grace, as if one should refer to the standard No. 16240 instead of Oct. 10, 1876. Lockyer always alters a reference to NATURE for Sept. 7, 1876, into vol. ?, p. ?, as if all promoters of natural knowledge counted everything from the epoch when NATURE first began."

Most interesting pictorial records of Maxwell's early life were provided by Jemima Wedderburn's sketch-book, very fortunately saved from the recent fire at Glenlair and lent by Capt. Wedderburn Maxwell for the celebration. There one could see the child of three years of age gazing in awe at the fiddler at the servants' dance, wondering, no doubt, 'what was the go of it'; there, too, his escape from his unsympathetic tutor by paddling himself into the middle of a pond, together with other charming sketches of early life at Glenlair. The Institution of Electrical Engineers lent its portrait of Maxwell, and Dr. William Garnett sent the original of the well-known photograph of his later years.

As a final entertainment, the guests were shown the connexion of Maxwell's colour work with modern work on colour photography.

In 1861 Maxwell prepared for a Royal Institution lecture three lantern slides of a bow of ribbon taken through solutions of sulphocyanide of iron, chloride of copper, and ammoniated copper. The slides were projected on to a screen by means of three lanterns. Mr. Thorne Baker, of Messrs. Spicer, Ltd., reconstructed the projection, using the original slides, and then showed a colour film of the procession of delegates from Corpus Christi College to the Senate House which had been taken the previous day. The projection was very successful, the brilliant blue of Prof. Cabrera's robes being particularly well reproduced.

The proceedings closed by a banquet in Trinity College.

THE addresses presented on the occasion of the Clerk Maxwell centenary celebrations have been brought together and issued as a single volume.[*] The book forms a most fitting permanent memorial of Maxwell's achievements and personality, linking certain aspects of his work with that of Faraday, placing it against the background of his time, and showing its influence on those great movements in scientific thought which have completely revolutionised our outlook.

It is no easy matter either to review or to summarise adequately a volume dealing with a life which has touched and dominated so many activities of our modern world. Planck puts the matter in a nutshell when he points out that Maxwell's work has materially influenced two great regions of conceptual thought, the regions which deal with the physics of particles and with the physics of continuous media. In half a dozen masterly pages, Planck sketches the development of the kinetic theory, shows how Maxwell's great discovery of the velocity distribution law roused the interest and enthusiasm of Boltzmann, and how these two masters, marching along different ways, one attempting "to find the statistical laws of a complicated mechanical structure by considering the structure simultaneously in a number of different states, while Boltzmann, on the other hand, preferred to follow over a long period of time a single structure through its manifold changes of state", laid the foundations of the modern science of statistical mechanics.

There is no more fascinating chapter in the history of kinetic theory of gases than that which describes the difficulties encountered by the theory when dealing with certain irreversible processes. Here again these two pioneers followed very different routes, and Maxwell's artifice of looking on a collision as a rapid and continuous transition from the initial to the final state governed by a repulsive force which varied according to the inverse fifth power of the distance, roused Boltzmann to a high pitch of enthusiasm. His famous comparison of Maxwell's work to a musical drama is unique in the literature of science:

"At first are developed majestically the Variations of the Velocities, then from one side enter the Equations of State, from the other the Equations of Motion in a central field; ever higher sweeps the chaos of formulæ; suddenly are heard the four words 'put $n=5$'. The evil spirit V vanishes and the dominating figure in the bass is suddenly silent; that which had seemed insuperable being overcome as if by a magic stroke. . . . Result after result is given by the pliant formulæ till, as unexpected climax, comes the Heat Equilibrium of a heavy gas; the curtain then drops."

Sir J. J. Thomson's essay tells the story of Maxwell's greatest contribution to science—the theory of the electric field—with all the force and authority of one of whose influence on post-Maxwellian physics it can with literal truth be said, *pars magna fuit*. It is difficult in these days, when the concept of lines of force is a school commonplace, to realise the state of electrical science in 1855, when Maxwell's first paper appeared. An imposing mathematical superstructure had been built on the inverse square law and the notion of action at a distance, and, indeed, if we endeavour not to be wise after the event, we see that there is a measure of justification for Sir George Airy's dictum when he says that he "can hardly imagine anyone who knows the agreement between observation and calculation based on action at a distance to hesitate an instant between this simple and precise action on the one hand and anything so vague and varying as lines of force on the other."

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[*] James Clerk Maxwell: a Commemoration Volume, 1831–1931. Essays by Sir J. J. Thomson, Max Planck, Albert Einstein, Sir Joseph Larmor, Sir James Jeans, William Garnett, Sir Ambrose Fleming, Sir Oliver Lodge, Sir R. T. Glazebrook, Sir Horace Lamb. Pp. vi+146+2 plates. (Cambridge: At the University Press, 1931.) 6s. net.

Nevertheless, although the exponents of the theory of action at a distance took little account of the properties of space, Faraday's fundamental experiments show that this neglect is erroneous. After all, it is necessary to take cognisance of such elementary results as those shown on rotating a coil (*a*) when a magnet is in the neighbourhood of the coil, (*b*) when the magnet is removed. Faraday expressed the difference by saying that space traversed by magnetic lines of force is in the electro-tonic state.

Maxwell's physics was that of the Scottish school, and he had a passion for exhibiting and explaining his views by means of a model. In his model of the magnetic field he represents "the lines of magnetic force . . . by cylinders rotating round these lines as axes, the magnitude of the force being represented by the velocity of rotation and its direction by that of the axis of rotation". The cylinders, in order that they may rotate in the same direction, must not be geared directly, but something of the nature of idle wheels must be introduced. The part of the idle wheels is played by electric particles, symbolised as small spheres. It is not difficult to see that changes in the magnetic field (that is, in the velocity of rotation of the cylinders) will produce motion of the spheres—that is, will give rise to an electric current; and it is the great virtue of the model that it suggests that changes in the electric force will give rise to motion of the cylinders—that is, will create a magnetic field. There is no need to labour the matter further. We may leave it here with Sir Joseph Thomson's comment that "the introduction and development of this idea was Maxwell's greatest contribution to Physics".

We have remarked on Maxwell's partiality for a model; and it is difficult, based as our mechanical views are (or were) on laws deduced from observation of large-scale phenomena, not to extrapolate our macroscopic conceptual world into the region of the infinitely small. So we obtain a concept of a gas based on billiard-ball mechanics; so we give the realities of elasticity and density to a luminiferous ether. Maxwell ran no such danger. His model was never confused with the physical reality (whatever that may be), and could be cheerfully discarded when it had done its work. "The changes of direction which light undergoes in passing from one medium to another are identical with the deviations of the path of a particle in moving through a narrow space in which intense forces act. This analogy was long believed to be the true explanation of the refraction of light; and we still find it useful in the solution of certain problems, in which we employ it without danger as an artificial method. The other analogy, between light and the vibrations of an elastic medium, extends much farther, but, though its importance and fruitfulness cannot be over-estimated, we must recollect that it is founded only on a resemblance *in form* between the laws of light and those of vibrations."

It is of this passage that Sir James Jeans remarks that it reads almost like an extract from a lecture on modern wave-mechanics.

In these two great divisions of physical science Maxwell's influence has been supreme. But any memorial of Maxwell which did not include some account of his wonderfully attractive personality would suffer seriously. Fortunately a few personal friends are still with us, and Dr. Garnett, Sir Ambrose Fleming, Sir Richard Glazebrook, and Sir Horace Lamb have added some precious details to that store from which many of us have been wont to glean—Campbell and Garnett's "Life".

Perhaps not enough has been made of Maxwell's remarkable genius as a writer of light verse. His mind was nimble, versatile, and scholarly; he had, moreover, that sympathetic understanding of an author which is the first essential for a successful parodist; and hence results the production of a volume of verse, small in itself, but of remarkably high quality. Much of his verse is technical, and its appeal is to a narrow audience; but such a parody of Tennyson as is seen in the well-known stanzas beginning

> "The lamplight falls on blackened walls"

is not unworthy of Calverley.

The autumn of 1931 has been a memorable period in the history of the physical sciences in Britain; it has seen the centenary of the British Association; it has seen the centenary of one of Faraday's fundamental discoveries; in celebrating the centenary of James Clerk Maxwell, we honour one whose life in its gentleness, its geniality, its single-hearted devotion to a lofty ideal is, equally with his contributions to science, a κτῆμα ἐς ἀεί—a treasure for all time.

ALLAN FERGUSON.

Henry Cavendish, 1731–1810.

OF all the many members of the Cavendish family who have made the name famous, none will probably be remembered longer than the distinguished eighteenth-century natural philosopher, the Honourable Henry Cavendish, the bicentenary of whose birth falls on Oct. 10. The founder of the fortunes of the family was the fourteenth-century judge, Sir John Cavendish, who was murdered in Jack Straw's rising in 1381, but from whose descendants came both the first dukes of Newcastle and the earls and dukes of Devonshire. William Cavendish, the fourth Earl of Devonshire, the statesman of the reigns of Charles, James, and William and Mary, became the first Duke of Devonshire, and it was from him Henry Cavendish traced his descent, being the son of Lord Charles Cavendish, son of the second duke.

Cavendish was born on Oct. 10, 1731, at Nice, where his mother, Lady Anne Grey, daughter of Henry, Duke of Kent, had gone for the sake of her health. He was educated at the school of Dr. Newcombe in Hackney, and in 1749, at the age of eighteen, entered Peterhouse, Cambridge. Four years later he left the University without, however, taking a degree. Little is known of his early manhood, but in 1760, three years after his father had been awarded the Copley Medal of the Royal Society for his "Very Curious and Useful Invention of making Thermometers", he, too, became a fellow of the Society, and six years later, after reading his first scientific paper, was also awarded the Copley Medal, "for his Experiments relating to Fixed Air".

Already deeply absorbed in scientific research, thence onward his study and laboratory claimed practically every moment of his life. His published papers were by no means numerous, but they firmly established his reputation, and as time went on he came to be regarded both at home and abroad as the foremost British natural philosopher of his age.

Cavendish occupied himself with many branches of physical science, including chemistry, meteorology, heat, magnetism, electricity, mathematics, and astronomy, but it was in the realm of chemistry that he first made his mark. He proved the elementary nature of hydrogen, he established the practical uniformity of atmospheric air, he was the first to show that water is not an elementary body but a compound of hydrogen and oxygen, and he discovered the composition of nitric acid. When sparking a mixture of common air and oxygen over potash he made observations which were not properly explained until Rayleigh and Ramsay in 1894 discovered argon. His great contemporaries included Black, Priestley, Scheele, Bergmann, Lavoisier, and others, whose work created a revolution in chemical science. A tremendous controversy for long raged around the question of who first discovered the composition of water, but it would probably never have occurred had Cavendish acted on Faraday's advice to investigators to "work, finish, publish".

The chemical researches of Cavendish were well known to his contemporaries; it has remained for the last two generations to learn of his many discoveries in electricity. Only two of his electrical papers were published in his lifetime, but he left behind him a mass of manuscripts and note-books which, though containing many 'pearls of scientific truth', were allowed to remain hidden for nearly a century. After the opening of the Cavendish Laboratory at Cambridge, the princely gift of the Chancellor, William Cavendish, seventh Duke of Devonshire, and the appointment of Clerk Maxwell as Cavendish professor of experimental physics, these manuscripts were placed in Maxwell's hands, and after much study were published in 1879. A further and enlarged edition of Cavendish's papers was issued in 1921, edited by Sir Joseph Larmor, Sir Edward Thorpe, and others. They showed that Cavendish had made electrical condensers and had measured their capacity, that he had anticipated Faraday's work on specific inductive capacity, and had completed an inquiry amounting to an anticipation of Ohm's law.

In another branch of science, geophysics, Cavendish is remembered for his capital experiment for determining the density of the earth. The plan adopted and apparatus used for the experiment were devised by the Rev. John Michell, rector of Thornhill, Yorkshire. He died before he could carry out the investigation, but his apparatus passed to the possession of Wollaston of Cambridge, and was given by him to Cavendish. The results obtained by Cavendish in 1784 were not far different from those obtained by later investigators working with more refined apparatus, and are a tribute to that care and exactness which characterised all his researches.

The character of Cavendish has baffled many inquirers. His habits were more those of a recluse than of a scion of a noble house. At first given an allowance of £500 a year by his father, after his fortieth year he was a man of immense wealth, and Biot after his death spoke of him as "le plus riche de tous les savants, et probablement aussi le plus savant de tous les riches". All his life he was shy, reserved, and taciturn, Brougham saying that "he probably uttered fewer words in the course of his life than any man who ever lived to four score years, not at all excepting the monks of La Trappe". Yet, from his bachelor home on Clapham Common, he would come to attend the weekly dinners of the Royal Society Club, and his library, housed in Dean Street, Soho, was available for all men of science. His life was written by Prof. George Wilson, who had to admit that Cavendish was singularly passionless: "An intellectual head thinking, a pair of wonderfully acute eyes observing, and a pair of skilful hands experimenting and recording, are all that I realise in reading his memorials". Of such a man anecdotes were sure to be told, and among them was the strange one of the manner of his death. Feeling his end was near, he said to his servant, "Mind what I say—I am going to die. When I am dead, but not till then, go to Lord George Cavendish and tell him—go!" He died on Feb. 24, 1810, at his house at Clapham, and on March 8 his remains were removed to Derby and interred in the family vault in All Saints' Church.

Obituary.

Sir Howard Grubb, F.R.S.

For more than sixty years, Sir Howard Grubb, who died at Kingstown, Co. Dublin, on Sept. 16, at the age of eighty-seven, was actively engaged in the design and manufacture of astronomical and other optical instruments. He was born in Dublin in 1844 and educated at a private school and at Trinity College, Dublin, as a civil engineer. His father, the late Thomas Grubb, F.R.S. (1800–1878), who was engineer to the Bank of Ireland, founded a small works near Charlemont Bridge early in the nineteenth century, where he manufactured for the

Bank some ingenious machines for engraving, printing, and numbering the bank notes. He took up practical optics as a hobby and quickly acquired great skill in the art of lens and mirror making. One of his first reflectors, equatorially mounted, was the Armagh 15-inch, in 1835. In 1865 he undertook, at the request of the president and council of the Royal Society, to design and manufacture a 4-foot reflecting telescope for Melbourne, Australia, which he completed in 1868. This instrument was the largest in the southern hemisphere until quite recently.

Thomas Grubb retired from business in 1868 and was succeeded by his son Howard, who had left Trinity College two or three years previously, in order to assist his father with the Melbourne telescope. In 1878 Howard Grubb contracted to build the 27-inch refractor and three domes for the Vienna Observatory. This telescope, at that time the largest existing refractor, was completed in 1881. Among other large instruments which he built were the 24-inch photographic refractors for Cape Town and the Radcliffe Observatory, Oxford, the 26-inch 'Thompson' refractor, and the objective of the 28-inch refractor for Greenwich, the 26½-inch refractor for the Union Observatory, Johannesburg, and the 40-inch reflector for Simeis, Crimea.

One of Sir Howard Grubb's most difficult undertakings was the construction, about 1890, of the 13-inch photographic refractors for the International Photographic Survey of the Heavens, of which he made seven. The conditions were exacting, the objectives requiring to be of the same focal length within very small limits, and the clock driving much more accurate than had hitherto sufficed for visual observations. In this connexion he perfected a means of controlling the driving mechanism by an independent pendulum, so that an error of a fraction of a second in the movement of the telescope was immediately detected and corrected. Numerous other improvements in telescope and revolving dome construction are due to him, and he is credited with being the first to suggest the rising floor, that at the Lick Observatory being partly of his design.

About 1905 Sir Howard Grubb invented and patented the submarine periscope, which was adopted by the British Navy. During the War he supplied about ninety-five per cent of these instruments required for the British submarines, and it was in connexion with these contracts that the Admiralty moved the works from Dublin to St. Albans. He returned to Dublin after the business was taken over by the late Sir Charles Parsons in 1925, but placed his knowledge and experience freely at the service of the new company which Sir Charles formed at Newcastle-on-Tyne, styled Sir Howard Grubb, Parsons and Co. The proprietors of these works are Messrs. C. A. Parsons and Co., Ltd.

Sir Howard Grubb was elected a fellow of the Royal Society in 1883 and knighted in 1887; he was also Hon. M.A.I. (Dublin), senior vice-president of the Royal Dublin Society, honorary member of the Royal Institute of Civil Engineers (Ireland), and was appointed, in 1913, scientific advisor to the Board of Irish Lights, in succession to the late Sir Robert Ball. He received the Cunningham gold medal of the Royal Irish Academy in 1881 and the Boyle medal of the Royal Dublin Society in 1912.

Sir Howard was in the first rank of men of science, and astronomy in particular owes him a great debt. His genial disposition made him a host of friends, and his death will be much regretted. He married in 1871 Mary Hester, daughter of George Hamilton Walker, M.D., of Louisiana, U.S.A., who predeceased her husband by a few months only. He leaves two sons and a daughter.

News and Views.

ON Oct. 14 occurs the centenary of the death of the French astronomer Jean Louis Pons, who in his day was famous as a discoverer of comets. Born at Des Peyres, Hautes Alpes, on Dec. 24, 1761, he entered Marseilles Observatory in 1789, in 1819 became director of a newly founded observatory at Marlia, near Lucca, and in 1825 director of the observatory of the museum at Florence, where he died. Between 1801 and 1827 he discovered no fewer than thirty-seven comets. One of these, discovered on Nov. 26, 1818, when Pons was at Marseilles, now called after Encke, was shown to have a period of only 3¼ years, and its return on May 24, 1822, as Encke predicted, was observed by Dunlop at the observatory of Sir Thomas Brisbane at Parramatta. This was the second instance, Halley's being the first, of the recognised return of a comet. The comet found by Pons on July 20, 1812, was also studied by Encke, who determined its period as 71 years. It was rediscovered by Brooks in America on Sept. 1, 1883.

THE subject of calendar reform is to be discussed in the present month in a League of Nations Conference at Geneva. In preparation for this meeting, the Parliamentary Committee on Calendar Reform has held a card referendum, addressed to a large number of representative people in Great Britain. A summary of the results is given in the *Times* for Oct. 1. It appears that 82 per cent of the voters are in favour of reform, provided that it can be obtained without too much dislocation. The 13-month scheme is evidently unpopular in Great Britain; there is a decisive majority against it. Ninety per cent of the voters favour a stabilised Easter; this, however, apart from public holidays, is an ecclesiastical, not a civil matter, and it will not lie within the scope of the Geneva Conference. The *Times* summary does not give any information on the question of putting certain days outside the normal reckoning of weekdays. This is one of the points that encounters a good deal of opposition, both from religious motives and from reluctance to discontinue a time-unit that has been running without a break for about three thousand years.

ACTING on the discovery of the skeleton of a Bushman on the farm of Mr. Fred. S. Wells in the Zuurberg Mountains, Mr. F. W. FitzSimons, the Director of the Port Elizabeth Museum, excavated the site and obtained four more skeletons. One was buried in a sitting posture, the rest flexed and on their sides. With each skeleton there were bracelets of stone and ivory, necklaces of finely worked ostrich egg-shell beads, pygmy stone implements, and a miscellaneous assortment of the typical larger kinds. The Zuurberg mountains are some fifty-five miles from Port Elizabeth, and the site of the find is on top of a mountain, a mile on the Port Elizabeth side of the Zuurberg Hotel. From the nature of the soil overlying the skeletons and other evidences, Mr. FitzSimons believes the burials were made about a thousand years ago. In 1922, it will be recalled, Mr. FitzSimons, assisted by Mr. Fred Wells, unearthed nine skeletons. This, then, is the second discovery in the Zuurberg of fossil Bushmen of pure lineage totally untainted by any fusion with other races.

A NEW world air speed record of 408·8 miles (657·76 kilometres) per hour was created by Flight-Lieut. G. H. Stainforth at Calshot on Sept. 29. The seaplane used was one of the Vickers-Supermarine *S 6 B*, specially built for the recent Schneider Trophy competition, fitted with a Rolls-Royce *R* engine and a special airscrew to suit the somewhat different conditions that arise in the relatively short bursts of maximum speed. During part of the run a speed of 415·2 miles per hour was recorded. It is estimated that this engine was giving 300 horse-power more than the one used during the Schneider trials, which was rated at 2300 horse-power. A special fuel mixture of petrol, wood alcohol, and tetra-ethyl was used. The wood alcohol was tried for the first time in order to reduce the engine temperature at full power, as the problem of dissipating the heat generated without introducing extra radiating surface with its accompanying head resistance has proved to be the most serious one on these machines. The tetra-ethyl was obviously used for suppressing pre-ignition and engine knock.

THE actual observed straights were flown at a height of 50 metres according to regulation, and Stainforth made the turns by climbing into them and diving out again on to the straight. This manœuvre has the advantage of reducing the speed on the turn and regaining it from the momentum of the dive. Carried out at speeds in the neighbourhood of 400 miles per hour, it is a very real evidence of the extraordinary skill and cool-headedness of the pilot. It was noticeable that after the first run, when once the engine was thoroughly warmed up and the pilot had obtained the ideal throttle setting, there was no further sign of any trail of smoke from the exhaust. The balance between the engine requirements and the amount of fuel forced into it by the supercharger was being maintained so delicately that the engine was just consuming all the fuel supplied to it, thus paying tribute to the accuracy of the work of the engine designer, the blender of the fuel, the mechanics responsible for the final tuning up, and the pilot who was handling it in flight.

A MEETING of the Lord Mayor and Sheriffs' Committee has been held in the Guildhall, London, to take steps in connexion with the festivities on Lord Mayor's Day, Nov. 9, and it is stated (*Times*, Oct. 1) that the Lord Mayor elect, Alderman Maurice Jenks, desires that the Show should contain a pageant designed to illustrate the assistance scientific discoveries have given to industry during the past half-century; and the effect invention and the practical application of invention have had upon the daily life of the people, and especially the Londoner. While the difficulties of turning such an idea into a spectacle suitable for the London streets are obvious, it is hoped that they are capable of being overcome. With regard to this, we think that if the great power companies, the shipping companies, the cold-storage companies, the technical colleges, and similar bodies are asked to co-operate, there should be no difficulty in arranging a very striking display. The adoption of electric light and power, the practice of refrigeration, the use of the internal combustion engine for motor cars and aeroplanes, communication by wireless telegraphy and telephony, are but a few of the gifts of scientific discovery and invention to practical affairs in recent times, and there is probably no side of life in London which has not benefited by modern invention. We wish the promoters of the scheme every success.

AT the annual meeting of the Australian National Research Council, a report by a sub-committee appointed in 1930 to consider a change in constitution was received and adopted. The recommendations were: that the name of the Council be changed to that of Australian Academy of Sciences; that the Academy be incorporated under the Companies Act of New South Wales and registered under the Companies Acts of other States; that the number of members be increased from 100 to 150; that the publication of a journal be undertaken; and that one of the objects of the Australian Academy be to act as the National Research Council. The adoption of the report was unsuccessfully opposed by representatives of a society recently constituted in Canberra under the title of Royal Society of Australia. The action taken in Canberra, without general consultation with leaders in scientific work elsewhere in Australia, was adversely criticised, the majority taking the view that the reconstituted Research Council was the appropriate body to fulfil the functions of a Royal Society for the Commonwealth.

LORD BLANESBURGH, Prime Warden of the Worshipful Company of Goldsmiths, delivered the inaugural address at the formal opening on Oct. 5 of the thirtieth session of the Sir John Cass Technical Institute, London, on Tuesday last. Lord Blanesburgh said that he hopes that the proposals which have been made and are so near fruition for the extension of the Institute will not be indefinitely postponed, and that there will always be secured by the maintenance of its activities a supply of those skilled in applied science to meet the demands made by the future. Swift and unsettling world changes have taken place during the past thirty years. Aviation and wireless are two discoveries of science which alone have revolutionised, and will revolutionise, the world as it was known thirty years ago. Such discoveries, however, have not prevented political unrest nor economic depression, each of which is probably attributable to the fact that, as result of new discoveries, old-established customs pass away and old-established industries are made obsolete. The world to-day needs young minds, ready to face the new situation with fearlessness and courage, and without hesitation if the time comes to destroy the ideals of the market that have had their day. Fortunately, educational help is available for the best young men and women of the land, so that that which has been obtained for humanity by the genius of inventors and discoverers may not be lost by the apathy or ignorance of their successors.

IF the machinery of science, Lord Blanesburgh continued, were withdrawn or went out of gear, and the elaborate structure on which the supplies of comforts, luxuries, and conveniences depend were to fail, mankind would be left defenceless and unable to provide even the barest necessities of life. It is accordingly essential that there should always be those ready to repair the machine when it falls into disrepair, and there must indeed be a new supply of those well qualified to keep the machinery going by themselves being abreast of all new discoveries. Civilisation is on its trial; it could not survive another war. It may even perish without one. The battle for its defence may be fierce and prolonged, but, if human nature remains what it has always been, in the long run it will be to the efficient, to him or her of strong mind and high character. To the young people who have enlisted in this crusade and who have enrolled themselves in a high service to their fellows, Lord Blanesburgh said he would have them be strong and of a good courage, and he would also have them, if need be, to live dangerously. No ideal should be too high, and there should be a healthy contempt for the second-rate.

IN his report as the Entomologist to the U.S. Department of Agriculture, for the year ended June 30, 1928, Dr. C. L. Marlatt summarises the manifold activities of his charge. Owing to the changes authorised in 1927, which led to the establishment of a new organisation designated the plant quarantine and control administration, the work carried out by the Bureau of Entomology in co-operation with the Federal Horticultural Board, in enforcing quarantine measures relating to many of the most important introduced pests, has been transferred to this new body. It had, for a long time, been felt that the growing amount of regulatory work of this kind was handicapping research on the biology and control of insect pests which form the primary function of the Bureau. During the year under review, Dr. L. O. Howard retired from the post of chief of the Bureau, which he had held since 1894. It is, however, gratifying to note that Dr. Howard will remain in the Bureau, under the title of Principal Entomologist, to follow up lines of work bearing upon his special interests. The report, like its predecessors, deals with an immense range of investigations bearing upon agricultural crops and animals, insect-borne human diseases, forest pests, apiculture, and certain domestic troubles, such as furniture pests and the ravages of clothes moths. In addition to work of this character, progress with a general insect-pest survey, and taxonomic investigations carried out in the U.S. National Museum, also come under review.

A FEATURE of particular interest in Dr. Marlatt's report concerns the prevalence of insect life in the upper air. By the adoption of special insect-collecting traps, carried between the wings of aeroplanes, it was found that an unexpectedly large number of insects are present in the upper air. Many of these are species which possess little or no power of flight and are consequently carried involuntarily by air currents. It would seem from the records so far obtained that the stronger flying species are capable of largely controlling their flight so as to be able to confine themselves to relatively low altitudes. On the other hand, species which have never been suspected as being wind-borne have been apparently carried by upward air currents and so caught at great elevations. There is every indication that the problem is one of definite practical importance, particularly in relation to quarantine measures which are solely concerned with restriction of spread on land.

WE are so used to regarding Michael Faraday as a physicist that it comes as a surprise to read an article by Prof. Fraser Harris, in *Discovery* for October, in which he discusses a lecture given by Faraday at the age of twenty-seven to the London City Philosophical Society in 1818. The title of the lecture was "Observations on the Inertia of the Mind". In this lecture he pointed out that apathy represents the inertia of a passive mind, industry that of an active mind. In 1899, Prof. Fraser Harris, unaware of the lecture by Faraday, put forward his hypothesis of 'functional inertia', the functional inertia of rest and the functional inertia of movement. The former is expressed by the latent period, the latter by the phenomena of after-discharge. This principle, Prof. Fraser Harris points out, has been confirmed by Spearman when he says, "Cognitive processes always both begin and cease more gradually than their apparent causes". Even so far back as 1679, Hobbes had said, "Like water troubled, an organ of sense will remain in motion after the removal of the exciting agent". The most recent work in neurology confirms the existence of inertia. Spearman directs attention to the gradual rise and fall of sensory intensity and the latency and after-discharge of reflexes. Blake-Pritchard introduces "inertia of the system" and

(*Continued on p.* 633.)

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Reviews.

Paul Tannery and the History of Science.

Mémoires scientifiques de Paul Tannery. Publiés par L.-L. Heiberg et H.-G. Zeuthen. Tome 10 (Supplément au Tome 6) : *Sciences modernes, généralités historiques, 1892–1930.* Édité avec la collaboration de Joseph Pérès. Pp. xvi + 500. (Toulouse : Édouard Privat ; Paris : Gauthier-Villars et Cie, 1930.)

THE last volume of Tannery's "Mémoires" has a special and immediate interest in view of the recent International Congress of the History of Science and Technology. We have in it the latest views and full evidence of the quality of a man belonging to a class too little known and much needed in England. He was a scholar of the most profound and unquestioned thoroughness, who gave his life to research in a branch of learning which we regard as a side issue but is in fact at the centre of human progress, namely, exactly how men have come to think as they do about scientific questions, especially in the realms of mathematics, physics, and astronomy. On the first of these matters he was at his death probably the most completely informed man in the world. But his special quality, which should commend this volume to English readers, was his constant effort to see the details, which he knew so well, as part of the general process of thought. He was in fact a philosopher as well as a specialist in scientific history. To English students, as a rule, it seems sufficient to know what the particular group of men in the past were working at, and the very idea that there is a general movement of thought is suspect. For this fault the work and temper of Tannery and men like him are a wholesome corrective. They are to be found more abundantly in all other countries than our own. France and Germany lead the way, with Italy as a good third, while America, more open-minded than ourselves, welcomes the spirit and is vigorously following in a more popular way.

It was a tragedy in the life of Tannery that on the occasion when he might have found a large sphere for his views and activity in Paris, personal and sectional interests were allowed to exclude him. A chair had been founded in the Collège de France in the spirit of Comte, for teaching the general history of science, and it was occupied on the first occasion by Pierre Laffitte, who was both Comte's titular successor and also well qualified by his own attainments and influence to fill it. On the death of Laffitte, it was generally expected that Paul Tannery would be chosen, and his name was actually sent up to the Minister by the professors on the committee for appointment. At the last moment, however, pressure was brought to bear by the more orthodox followers of Comte, and a specialist on physics was appointed instead. It was a grievous blow to Tannery and a serious loss to the establishment of a philosophic view of the history of science both in France and throughout the world.

Such men are rare anywhere, and in England we have scarcely yet begun to reckon with their possibility or the desirability of encouraging them. No university in Great Britain has such a chair, though they are to be found in Germany and are frequent in the United States. Nor is there any section of the British Association devoted to the history of science.

The volume before us opens with a pathetic note by Mme. Tannery lamenting the loss of Heiberg, who with Zeuthen had been helping her in the production of her husband's "Mémoires". Others in France have come forward to make possible the completion of the work, and its interest makes one hope that more may be done, especially on the lines of completing the short general history of science up to 1850 which he had sketched and of which several lectures printed here would form part.

Tannery had a strong view that for such a general history no attempt should be made to bring the narrative up to date. We should choose a point at which the sciences have taken a definite and ascertainable shape, and the object of our study would be to show how they had reached it. If we attempt to come later down, the conflict of hypotheses and the complexity of the new matter are so great that no definite impression can be obtained. Time must elapse before the seething mass settles down into a shape that can be visualised. These are all considerations connected with his governing idea of synthesis. We need some distance of vision before science as a whole makes a connected show of its natural articulations, and when that has been gained, we may attempt to go further and see the relations of the scientific side with the other aspects of civilisation. Tannery foresaw that larger synthesis, but had little hope of being able to contribute to it himself.

Everyone, however, who has even the smallest interest or knowledge, would find these scattered papers inspiring. The syllabus he drew up for a course in the history of science for the highest class of a *lycée* is the best that we have seen. It is sane, clear, and well-balanced. He begins himself from the conservative, classical point of view, giving by far the largest place to the Greeks. But he was always ready to modify his preconceptions in view of fuller knowledge or with maturer judgment. His treatment of Comte is an admirable example of this. Starting with the deepest sympathy and appreciation of Comte's work from the philosophical and social point of view, he goes on to re-think and correct the details. In this way the law of the three stages is examined and the truth in it separated from the error. As a correction of the historical evolution of sciences from the most abstract (mathematics) to the most concrete (biology and sociology), he shows the high importance and seniority of medicine.

The book is full of interesting matter of this kind, all based on exhaustive knowledge and expressed with the calm and clarity of a master.

F. S. MARVIN.

Ethnological Survey of a South African Tribe.

The Bavenda. By Dr. Hugh A. Stayt. (Published for the International Institute of African Languages and Cultures.) Pp. xviii + 392 + 48 plates. (London: Oxford University Press, 1931.) 30*s.* net.

IN her able introduction to this work, Mrs. Hoernle points out with regret that no adequate monograph on any of the South African tribes has been written during all the years in which black and white have been in contact in that subcontinent. This regret will be shared by many, and it may, moreover, be considered as remarkable evidence of a failure to realise that the natives of South Africa have been and still are the greatest asset which the country possesses; for it is mainly by the help of their brawn that the present stage of prosperity has been achieved, and thus careful study of their life history is essential. It is true that Callaway wrote of the Zulus, Lagden of the Basutos, and Stow of the native races; but for all that, Mrs. Hoernle's contention is correct. The only two works dealing with the natives of the southern half of the continent which are comparable with Dr. Stayt's monograph are Smith and Dale's "Ba-Ila" and Junod's "Life of a South African Tribe", but the subjects of both of these works live outside the Union of South Africa. Dr. Stayt's work comes as a revelation, for, as an occasional visitor to South Africa, one felt that owing to long-continued disintegration of the tribes it would probably be impossible to gather up the threads and construct a real picture of the indigenous culture of any native tribe in that area. The author has, however, been fortunate enough to discover that the Ba-Venda, living as they do in the valleys of the Zoutpansberg Range of the North Transvaal, have tenaciously preserved their ancient traditions and culture up to present times.

The achievement is all the more remarkable inasmuch as the author suffers from one of the gravest disabilities an anthropologist can experience—blindness. In view of this, it is amazing how he can have accomplished so much; his courage and perseverance command the deepest respect, and the devoted assistance of his wife must not be ignored. It is, moreover, especially fitting that Dr. Stayt should be a South African, and we trust that this admirable piece of research may stimulate many other workers in the Union to emulate his example. Dr. Stayt's monograph covers the field in a very systematic manner, commencing with a description of the terrain, then dealing with the history, unfortunately, however, the author has to confess that the latter is rather vague and fragmentary, and evidence as to the early migrations of this stock will have to be pieced together bit by bit from investigations, yet to be made, farther to the north. He then deals in detail with their daily life, food, and industries, and so on; proceeds to describe the life of an individual from birth to death, their social relationships, form of government, religion, magical beliefs; and so to their folklore—in all, a very complete conspectus.

As is the case in many African tribes, the Ba-Venda are a composite people which have now become a compact entity, and it could not have been easy to disentangle the elements of their culture which were derived from the various components. The problem becomes particularly acute where an effort is made to ascertain which of their physical characteristics belong to the original Venda stock and which are superimposed by comparatively recent intermixture with the Sutho people and others.

The Ba-Venda provide a typical example of Bantu culture. The word 'Bantu', of course, refers only to a language group, but in most cases those who use a Bantu tongue exhibit other affinities which betoken connexion with the same racial stock. Anyone, for example, who is acquainted with the social anthropology of so-called Bantu tribes so far north as Kenya cannot fail to be impressed by the recurrence of social customs, religious beliefs, etc., in spite of the distance intervening; space will not admit of great detail, but these recurrences are so numerous as to preclude the possibility of separate but similar development. The sacred stones erected in the villages as a representation of their ancestors have their parallel in places as remote from each other as North Kavirondo and Kikuyu; the re-burial of the remains of a chief at the ancestral home of the tribe Phaphuli is also a feature of the Awa-Wanga of North Kavirondo; the placing of a stone in a tree, by a traveller, to delay the setting of the sun until his journey is concluded—not Bantu this time, but a custom in vogue among some of the Hamitic tribes of Kenya. These are a few examples taken at random. To find the birthplace of other customs we should probably have to make a comparison with tribes to the north-west of their present habitat.

There is little doubt that when the ethnological survey of Africa is more advanced we shall, by careful analysis of customs and beliefs, be able to trace with considerable accuracy the past migrations of native races and discover the various racial elements which go to make up the assemblages now designated as tribes.

The chapter on "Puberty and Initiation" is an important one, for, owing to the secrecy of the ceremonies attending the latter, it is but rarely that the European investigator is able to make a detailed study. As is usual, there are many features repugnant to European sentiment, but for all that, the importance of these ceremonies as a part of native life should not be under-estimated. The discipline and even suffering undergone by the initiates is a crude form of educational training, and the lesson of obedience to the tribal law learnt at this period is one which leaves its mark for life. It is a potent cement which helps to hold a tribe together. While sympathising to some extent with good-hearted missionaries who strive to induce governments to crush these practices, we would venture to suggest that legislation against a custom is rarely effective; it only tends to drive it underground and to produce a lasting sense of injustice. Rise in culture will in time cause these customs to die, but what will replace them? It is the duty of those responsible to see that the substitute is ethically effective.

The religion of the Ba-Venda conforms to the pattern evolved by the stock. There is the mysterious monotheistic deity called Ralu vhimba, but, as is usual, he has but little appeal to the ordinary man, who is more concerned with placating and giving due service to the spirits of his ancestors. Earth tremors are particularly identified as manifestations of the Supreme Deity.

In connexion with medicine and magic, a careful description is given of certain curious divination bowls used by this tribe. These are of considerable importance, for it is believed that we here have evidence of the native origin of the so-called zodiacal bowls found at Zimbabwe and upon which the school which pleaded for Phœnician origin laid so much stress.

It is only desired to lodge two minor criticisms of this exhaustive monograph: the print is rather small, and the price of the book is high.

C. W. H.

Astronomy for All.

(1) *The Stars in their Courses.* By Sir James Jeans. Pp. xi + 188 + 47 plates. (Cambridge: At the University Press, 1931.) 5*s*. net.

(2) *Astrophysik auf atomtheoretischer Grundlage.* Von Prof. Dr. Svein Rosseland. (*Struktur der Materie,* herausgegeben von M. Born und J. Franck, Band 11.) Pp. vi + 252. (Berlin: Julius Springer, 1931.) 21·20 gold marks.

(3) *The Stars of High Luminosity.* By Cecilia H. Payne. (Published for Harvard College Observatory.) Pp. xiii + 320. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.)

(4) *Flights from Chaos: a Survey of Material Systems from Atoms to Galaxies; adapted from Lectures at the College of the City of New York, Class of 1872 Foundation.* By Harlow Shapley. Pp. vii + 168. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 12*s*. 6*d*. net.

(5) *Man and the Stars.* By Harlan True Stetson. Pp. xiii + 221 + 31 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 12*s*. 6*d*. net.

(1) HERE is astronomy to suit all tastes. We may go even further, for Sir James Jeans's book has the power to create a taste which in large part it satisfies. It embodies all the rare qualities

of exposition for which the author is justly famous, and the treatment, even of subjects with which Sir James's pioneer work is not intimately concerned, bears the stamp of originality. The book is avowedly and actually one to be read for pleasure rather than for profit (although, needless to say, profit inevitably follows from the reading), and we may truthfully add, in the language usually employed in describing literature of this class, that there is not a dull page from start to finish. About fifty of the pages are occupied by excellent reproductions of the finest of astronomical photographs, and, indeed, the book as a whole appeals more to the senses than to the mind. It originated in a series of wireless messages to the ear, and it carries the reader in a magic rocket through space and time, inviting him the while to use his eyes. Maps of the sky, with descriptions of the constellations and tables of simple data, are added as souvenirs of the journey.

Regarded in this light the book is almost beyond criticism, but we cannot quite shake off an awkward suspicion that theoretical astronomy is scarcely a legitimate subject for a novel. Seeing is believing, and because of its vividness the pageant which passes before our eyes leaves us unaware that it is largely an imaginary representation of what the astronomer merely feels in his blind groping among the mysteries. Alternative representations are of necessity excluded, and where a warning that we may be deceived is unavoidable, it is given almost reluctantly, with the result that—to change the metaphor—we are given a sumptuous meal when what we need is an appetite. The uninitiated reader is likely to lay the book down with the feeling that the most important secrets of astronomy have been read; he is not likely to feel with Galileo the overwhelming force of "those wise, ingenuous, and modest words—*I do not know*". But, all the same, he will have had a delightful experience.

(2) Prof. Rosseland's book is of an entirely different character. Those who are familiar with the excellent "Struktur der Materie" series to which it belongs will have a general idea of its scope, and will need no assurance of the excellence of its printing and production. The book, the author tells us, is intended as an introduction to astrophysics for physicists who are concerned with astronomy and astronomers who are concerned with physics, and although limits of space necessitate a high degree of condensation and the omission of certain parts of the subject—particularly those concerned with solar magnetism—a great deal of ground is covered in a very satisfactory way.

Prof. Rosseland writes with commendable clearness and strikes just the right balance between impartial exposition and critical selection. Considering the rigidity of the treatment, mathematical formulæ occupy a remarkably small proportion of space, and are not difficult. The book is, however, essentially theoretical, the data of observation being mainly confined to the first dozen pages. The chief subject of the book is the physics of the interiors and atmospheres of stars, and the treatment of this, in fact, together with a chapter of thirty-five pages on the nebulæ, comprises almost the whole volume. It is a pity that Milne's new approach to the problem of stellar structure was not in time to be included, for it might have shifted somewhat the general point of view which the author adopts in facing this problem. Prof. Rosseland's view of the present situation would be of considerable interest. There are several illustrations, which are well reproduced.

(3) More food for the specialist is provided by Miss Payne, but her book, unlike that of Prof. Rosseland, is almost entirely devoted to observational material. It is in no sense a practical handbook, for methods of observation are never described, although the difficulties inherent in them are sometimes mentioned in so far as they bear on the validity of possible interpretations. Neither is it a mere collection of data; the facts are throughout regarded in the light of existing theory, with which the reader is presumed to be familiar.

The book meets an urgent need, and meets it very adequately; the provision of 110 tables in addition to complete catalogues of the *c*-stars and Cepheid variables reveals its character better than any verbal description could do. From one point of view the book may be regarded as the author's "Stellar Atmospheres" of 1925 brought up to date, but the metamorphosis is almost complete, for the study of spectrum line contours, then barely begun, forms the backbone of the present volume. By a star of 'high luminosity' is meant a star brighter than visual absolute magnitude -2. Such stars, although they form an almost negligible fraction of the stellar universe so far as numbers go, are extremely important—first, because they provide almost our only means of estimating the distances of remote stellar groups, and secondly, because they include at least the vast majority of variable stars and have a special significance in the theory of stellar constitution. The book is saturated with Miss Payne's own contributions to the subject, and astronomers will be grateful to her for making them available in so compact a volume.

(4) Dr. Shapley's "Flights from Chaos" is mainly a descriptive classification of material systems from the most elementary corpuscles to the "Cosmoplasma" and beyond. In this aspect it will be of interest to astronomers generally. The classification is systematic and comprehensive, and much of it will probably command general assent, although in some respects it would seem that the artistic passion for a general classification has triumphed over the scientific necessity for a fundamental one. It is doubtful, for example, if the æsthetic satisfaction of grouping diffuse nebulæ with comets and planetary nebulæ with solar systems is a sufficient compensation for separating two types of nebulæ which appear to differ only in accidental circumstances. Dr. Shapley's predilection, however, is revealed on p. 132, where he remarks of a certain classification that it "has the advantage of providing many categories without suggesting any hypothesis, evolutionary or otherwise". We know that a classification may deceive, but is the best remedy to strike it dumb ?

The appeal of the book, as exemplified by the opening, is directed towards the general public, and readers of that class who scan the first chapter will certainly be tempted to proceed. The author's enthusiasm for his subject, however, soon takes charge of his pen, and by the time the reader has reached, say, the chapter on "Double and Multiple Stars", he finds himself expected to know by instinct the meaning of such terms as 'spectroscopic binary' and 'optical double'.

Dr. Shapley is never dull, however, and the book would be very pleasant to read were it not for the appearance on almost every page of a minute, undescribed sketch of some astronomical phenomenon or diagram which, as often as not, bears no relation to the subject there discussed, and is frequently woven into the initial letter of a word. Possibly this way of presenting things is familiar to trans-Atlantic readers, but to us it suggests that the flight from chaos has been less successful than might otherwise have been imagined.

(5) Prof. Stetson's book is like a very nice picture badly bespattered with mud. It is as elementary as Sir James Jeans's book, but it has a wider purpose inasmuch as it aims at tracing the influence of astronomical discoveries on man's reactions to his environment. On the whole, it satisfies very well the fundamental requirements of such a purpose. It creates the right atmosphere, and, occasionally, one experiences the shock of pleasant surprise, so rarely received from scientific books, which accompanies the reading of just the right word or phrase. More often, however, the surprise is unpleasant. The book abounds in blemishes of almost every kind—faults of expression such as the excessive colloquialism of "hiding in jest a prayer to God, he (Galileo) shoved off together those two iron masses", or the errant metaphor in "I have sought to convey some viewpoints which I have often embodied . . ."; errors of scientific fact, such as the account of the spectrum of the strontium flame, which suggests that the author has not seen what he attempts to describe; errors of history, such as the ascription of the scurrilous "Ye men of Galilee" sermon to Scheiner instead of to Caccini, of the pioneer work in radial velocities to Vogel instead of to Huggins, and of the discovery of the cosmic rays, and even the electron, to Dr. R. A. Millikan of California. The printing shows the same qualities as the writing, for while it is clear and pleasant to read, it contains far too many mistakes. If another edition is called for, we hope the book will be thoroughly revised; it is so good that it is a thousand pities it is not better. H. D.

Strength of Materials.

Materials and Structures: a Text-book for Engineering Students. By Dr. E. H. Salmon. Vol. 1: *The Elasticity and Strength of Materials.* Pp. x + 638. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 15*s.* net.

Strength of Materials. By Prof. S. Timoshenko. Part 1: *Elementary Theory and Problems.* Pp. xii + 368. 15*s.* net. Part 2: *Advanced Theory and Problems.* Pp. xi + 401-735. 18*s.* net. (London: Macmillan and Co., Ltd., 1931.)

NO section of engineering science has been so frequently dealt with in treatise or textbook as that which provides the title common to both publications before us. Within the past decade there have been several notable efforts along similar lines and with equally ambitious aims. Yet the older textbooks on the subject did not fail to reach high standards. There must clearly be special reasons for these newer and repeated attempts. These reasons are not far to seek. Methods of analysis have been enriched by fresh contributions; applications to practical matters have been widely extended; advances of great value have been made in experimental technique; and new lines of research have been rapidly developed. On every score the somewhat stereotyped forms and standardised treatment of the older books have been superseded.

Modern engineering makes a demand upon knowledge of the properties of materials which shows up the methods of design of a generation ago as processes requiring, relatively, neither great skill nor nerve. A few simple values, a little theory, and a large factor of safety dealt effectively with most cases. The advent of the high speed rotor, the internal combustion engine, the high pressure, high temperature boiler, and the countless problems which have advanced in their train, have altered all this. The few simple values have been subject to forced growth by the development of more subtle methods of testing; the somewhat casual use of simple theory has had to give way to more exact methods of calculation; and the factor of safety has shrunk in size and lost flexibility. The continued development, experimental use, and establishment of a host of new materials, and the treatment and testing thereof, complicate all issues and confuse the factors of applicable knowledge. Any author facing an adequate treatment of such a subject in such a condition is confronted with serious problems of matter and classification. The former is formidable in quantity; the latter difficult to order. A comprehensive knowledge is an essential; but a clear idea of values and courage in selection are equally so, if range, balance, and conciseness are to be achieved. The adequate and yet not too cumbrous textbook is probably more difficult to produce than the treatise; which perhaps explains an observable tendency in publications of the kind.

Dr. Salmon's book is the first volume of a treatment of materials and structures, to be completed with a second volume mainly on the latter subject. The present volume deals wholly with what is understood technically by strength of materials, and the treatment occupies more than 600 pages of well-packed text. Prof. Timoshenko takes fully 700 pages, in two volumes, to deal with the subject. The relative loading per page is such that probably Dr. Salmon's book contains the greater total length of text. In addition to extensive analytical developments, both authors give sections on the experimental and empirical aspects of the subject; but whereas in Dr. Salmon's volume more than a third of the space is devoted to this, Prof. Timoshenko has not much more than a tenth set apart for the purpose. These relative spaces provide a clue to the main points of contrast. The first author is presenting a comprehensive textbook, showing both sides of the subject with reasonably equal thoroughness; the second provides an example of the analytical expert who adds a chapter on experimental aspects for completeness. It must be added, however, that Prof. Timoshenko enriches a great many of his analytical discussions with clear and valuable summaries of the appropriate experimental facts and conclusions.

The chapter divisions of Dr. Salmon's analytical section and of Prof. Timoshenko's first volume (elementary theory and problems) are very similar in headings and reflect the usual order of development through simple stress, complex stress, bending theory, combined bending and direct stress, combined bending and twisting, etc., and strain energy. Within each chapter the first author deals with both the elementary and advanced problems appropriate thereto, so far as his intentions go; whereas the second author postpones the most difficult lines of development to the second volume. Prof. Timoshenko's advanced volume contains, in addition, some special chapters, such as that on buckling of bars, plates, and shells, and that on stress concentration. Dr. Salmon gives a chapter on vibrations and actual speeds, and two others dealing with formal mathematical theory and its applications. He treats the standard lines of work with great clearness, and develops all essential matter with that degree of detail which is desirable if a book is to be of real value to students. His development of bending theory is useful and concise, although full value is scarcely extracted from the Mohr method of treating deflections; and it is something of a fault not to present the Macaulay method. There is a useful resurrection of the Claxton-Fidler procedure of characteristic points. Prof Timoshenko handles general processes with great power and brevity, the latter quality, to some extent, telling against ease of reading from the student's point of view; but there is that individuality in the methods and wide range in the problems that marked the previous publication on applied elasticity (by Timoshenko and Lessels) and still more notably characterises these new volumes.

It might be contended that the subject of strain energy should be treated earlier than either author has arranged. The idea should be made to thread the whole subject, and the Castigliano theorem—which Dr. Salmon presents, but does not so designate—could be put to greater service in the earlier parts. It is also open to question whether vibrations and critical speeds should now be looked upon as a theme for one chapter of a book on materials. The subject has grown in extent and importance to such a degree that it deserves special treatment. Prof. Timoshenko has a separate book on this topic.

In treating the experimental side of the subject of materials, one of two principles of attack may be adopted. A general report of testing methods and mechanical properties may be compiled, or a general essay on the significance in design of modern materials testing and properties may be attempted. On the whole, the former is Dr. Salmon's method and the latter represents the attitude taken up by Prof. Timoshenko in his shorter discussion. Both treatments are very readable and give due and accurate weight to such lines as fatigue and high temperature effects. Dr. Salmon has a final chapter introductory to the study of metallography, which should be of distinct service and does for the experimental side what his equally interesting chapter on general mathematical method does for the analytical, namely, stimulates interest in the more profound processes of study.

These volumes are all copious in references to original papers and other sources of information. Dr. Salmon has adopted an exceedingly valuable plan of arranging a full and classified bibliography at the end of each chapter, which compares very favourably with the more usual footnote method followed in Prof. Timoshenko's volumes. But adequate reference is a strong feature of both works and, in conjunction with the wide range and the excellence of treatment, should render them of distinct service to advanced students and technical engineers.

Extinct Volcanoes of Western Scotland.

Memoirs of the Geological Survey, Scotland. The Geology of Ardnamurchan, North-west Mull and Coll. By J. E. Richey and Dr. H. H. Thomas; with Contributions by E. B. Bailey, J. B. Simpson, V. A. Eyles and the late Dr. G. W. Lee; with Chemical Analyses by E. G. Radley and B. E. Dixon. Pp. viii + 393 + 7 plates. 10*s*. net. Sheet 51: *Coll.* Scale of one Inch to a statute Mile. Third edition. Colour printed. 30½ in. × 22½ in. 3*s*. net. (Edinburgh and London: H.M. Stationery Office, 1930.)

ARDNAMURCHAN, the most western point on the mainland of Scotland, is a peninsula of gneiss cape- [illegible] the remains of extinct volcanoes. It project [illegible] he gap between Mull and Skye and is exposed [illegible] e full force of Atlantic gales. Its battered clift [illegible] nd the landmark formed by its ancient volcanoes are familiar to all who pass by sea along the Western Isles. The geology of the peninsula is now for the first time adequately described in a well-illustrated and excellently compiled memoir of the Scottish Geological Survey, and is accompanied by sheet 51 of its one-inch maps. The sheet, in addition to western Ardnamurchan, includes the island of Coll and north-western Mull. Each of these areas has a very different geological history. Coll is one of the islands composed of Lewisian gneiss. North-western Mull consists of basalt lava-flows from the vents in the central part of the island; and western Ardnamurchan has as its chief feature the dissected base of a huge volcano.

One interesting feature of Coll is the occurrence of numerous glassy rocks due to fusion by crushing, for which, as is remarked in the present memoir (p. 25), "the term flinty crush-rock has come into general use among Scottish geologists". The adoption of this term in Scotland in regrettable. Flint is formed of organic silica, deposited from solution. These glassy rocks are of far more complex composition than flint and have solidified from a molten state. Prof. Shand's name of pseudotachylyte is more appropriate. The description of these rocks as flinty, instead of as glassy, is one of those illogical usages which have done so much to prejudice geology as a subject in general education. The vitrification of these rocks in Coll is shown to be pre-Torridonian; it is not, as may be possible elsewhere in Scotland, due to movements of the age of the Moine thrusts.

The main interest in this volume is its important contribution to the Kainozoic volcanic history of Scotland, with its repeated testimony to the truth of Judd's conclusion that the igneous masses of the Western Isles and of Ardnamurchan are the remains of a series of great central volcanoes like those of Hawaii and Etna. This view was for long, as the authors remark, generally rejected in favour of Sir Archibald Geikie's theory that the volcanic rocks were discharged by fissure eruptions and not from isolated vents. The fissure eruption theory was shown to be inapplicable in the main to Mull in a former Survey memoir, which held that it might still play a minor rôle: Mr. Richey and Dr. Thomas remark in the present volume that even the supposed minor share rests on slight evidence. There is said to be very little positive support to the origin of plateau basalts by fissure eruptions: and there are many features that require a different explanation (p. 52), and it is pointed out that in spite of the clearness of the cliff sections, "no undoubted case of a dyke feeding a lava flow has been recorded" (p. 52). The Ardnamurchan volcanoes are surrounded by circular dykes rising from the lava basin below. These ring cone dykes were first recognised in Glencoe by Messrs. Clough, Maufe, and Bailey, and have since been found in

Mull and Arran. The same structure is shown to be well developed in Ardnamurchan, which throws further light on this type of volcanic eruption. The intensely dissected volcanoes of western Scotland doubtless reveal the structure of the foundations of such great cone-volcanoes as Etna, in which the central crater is surrounded by a zone of large secondary craters that may be the outlets from ring dykes.

A second topic on which earlier views are vindicated by the present memoir is the extent to which rocks of different composition are combined by the absorption of material by a molten rock or the mixture of different rock magmas. Such composite rocks are known as hybrids and were described by Dr. Harker in his memoirs on Skye and the adjacent islands. The importance of these rocks was discredited by the survey of Mull. Dr. Thomas reaffirms the formation of true rock hybrids, and though his statements are cautious, they suggest that he regards these rocks as more important than has been recognised in some Survey memoirs.

Western Scotland is traversed by innumerable parallel dykes in groups known as swarms. The distribution of the four or five swarms in northern Britain and Ireland is shown in an instructive diagram (p. 52). The dykes in Coll belong to the Mull swarm and those east of Ardnamurchan to the Skye swarm. The dykes trend from north-west to south-east, except in the Southern Uplands of Scotland and the north of England, where they curve round to approximately west to east. Their number is so large that Dr. Tyrrell's measurements in Arran prove that the fissures into which these dykes were injected amounted to an eighth of the width of the area.

These dykes belong to all stages in the last Scottish volcanic period, though they were most numerous towards its end. Their distribution must have been controlled by some process that acted on a continental scale, and was probably due to the tensional rifting of the crust during the last great subsidence of the North Atlantic. Their parallelism to the Scottish sea lochs, as in Skye, indicates that those fiord-like valleys are due to the same process. The volume says little, however, about the physiography and glacial history of the area.

The Mesozoic sedimentary rocks of Ardnamurchan, the importance of which was first recognised by Judd, are fully described. Unfortunately, there is little such material associated with the lavas. A thin mudstone below them contains a shark's tooth derived from the Chalk, which probably once existed in the area. The few coaly beds add nothing to the evidence from Mull as to the age of the eruptions.

The Memoir contains many excellent illustrations and a geological map of the whole of Ardnamurchan, of which the eastern part lies in sheet 52 and has not yet been completely surveyed. This map, being somewhat diagrammatic, is more convenient in reference to the general history than sheet 51, which is more crowded and less clear. The Geological Survey and the authors are to be congratulated on the volume, which completes the series of monographs on the main Kainozoic volcanic centres of the Western Isles. J. W. G.

Formal Logic.

The Foundations of Mathematics: and other Logical Essays. By Frank Plumpton Ramsey. Edited by R. B. Braithwaite. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xviii + 292. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1931.) 15*s*. net.

FRANK PLUMPTON RAMSEY, recognised as a leader of Cambridge thought at the age of sixteen, died at the age of twenty-six. This volu contains his chief writings on logic and philosop about half of them unpublished, with a short app ciation by Prof. Moore and a longer one by editor; his work on economics, a secondary i terest, is represented only by a letter from Mr. Keynes to the editor. To those who knew him, the book will serve in some measure as a fitting memorial to his brilliant intellect and vivid personality; those of us who did not must judge it primarily as a contribution to learning.

Any attempted estimate by the number and importance of conclusions established would be quite misleading. In the field of very abstract thought in which Ramsey lived, to travel magnificently is more important than to arrive; the works of Ramsey's masters, of Whitehead and Russell and of Keynes, are universally acclaimed, although nobody — certainly not Ramsey — accepts their main conclusions. Moreover, Ramsey at his death was still in the stage when "calmness in infanticide" (to quote the editor) is a merit, and the certainties of to-day are the fallacies of to-morrow. The quality of the thought is what really matters.

Nevertheless, a brief summary of his work must be attempted. He was concerned in the main with two great classical problems, of which the first is indicated in the title. As is well known, Whitehead and Russell, following Frege, tried to exhibit pure mathematics as a branch of formal logic, and to show that all its results flow from the axioms that make consistent thought possible. They encountered two chief obstacles, one arising out of the nature of 'implication', the other represented by the famous contradictions. Ramsey, using the ideas of Wittgenstein, surmounts the first obstacle to his own satisfaction; but he can find no way of surmounting the second, except by introducing assumptions that are not completely self-evident. Since he rejects the view, dominant on the Continent, that another satisfactory basis for mathematics can be found, he seems driven to the conclusion that the part of mathematics in which the contradictions arise is not true. This conclusion, the editor tells us, he finally accepted, although acceptance would have involved much recantation. Since the rejected part is that involving the conception of infinite aggregates, he finds himself at last in accord with common sense.

The second problem is to find a meaning for 'probability', as a degree of belief, such that the mathematical theory of probability can be interpreted as a 'logic of consistency', related to partial knowledge as ordinary logic is to full knowledge. This problem inevitably leads to that of the relation between belief and truth. Ramsey's solution is to define a method of measuring belief by means of the odds accepted in betting; he can then show that the mathematical theory states rules that must be obeyed if betting is not to lead to certain loss, just as logic gives rules that must be obeyed if even true premises are not to lead to false conclusions. This view is less in accord with common sense; but it is wholly consistent with, and indeed inspires, his general philosophy, which is extremely pragmatic. Logic, he holds, is concerned only with consistency; it can lead to nothing not contained in the premises. Truth is determined by value in action; consistency in thought is a form of truth because it leads to consistency in action.

Ramsey admits that probability in this sense is not the probability of statistics or science; the paper on "Probability in Science", in which the connexion would have been described, was never written. But it is unlikely that it would have satisfied scientists; for Ramsey's philosophy, like that of most formal logicians, seems to leave no room for any distinctively scientific reasoning. He leaves to science the task of discovering truth; but induction, the process of discovering it, is not deduction, and is therefore nothing but a good habit. As for theories, his extremely difficult paper on this topic begins with the assumption that a theory is merely a new language. He seems to deny that there is any difference between scientific truth and falsity other than value in action.

This refusal to recognise any form of reasoning other than that of formal logic makes Ramsey's work curiously uneven. When he is discussing any problem amenable to formal logical treatment, he is extremely subtle and profound. But when he is not—and books about logic are mainly non-logical—his 'arguments' are chiefly an appeal to prejudice. He makes no real attempt to meet the views of those who differ from him fundamentally; he cannot have believed that Hilbert would have been seriously perturbed by his reasons for rejecting 'formalism'; and when he attempts a *reductio ad absurdum*, his absurdity usually seems to me the plain and sober truth. It is curious that modern logic, arising from the discovery that the Aristotelian syllogism is too narrow, should have stopped so short in removing its limitations. The difficulties that Ramsey discusses in the expression of facts by propositions are closely similar to those that puzzled the medieval logicians when they tried to express all arguments as syllogisms. But it never seems to occur to him that the limitation of reasoning to ordered propositions may be too narrow, and that his difficulties would vanish if he would investigate more closely the nature of 'facts'.

It is unlikely, therefore, that Ramsey's work will change the opinion of those who regard formal logic as an entertaining game, of value only to those who find interest in it. Even as an exponent of a game, he is not so attractive to amateurs as many of his predecessors. He lacks the graceful lucidity of the earlier Cambridge school. He was brought up to think in terms of the new symbolism; it is his natural language; between his formal logic and that of Russell there is all the difference between the French of the schoolroom and of the Parisian streets. Yet even those who cannot truly appreciate the importance of his work may join with those who can in deploring his early death as a great blow to British learning.

NORMAN R. CAMPBELL.

Plant Biochemistry.

The Principles of Plant Biochemistry. By Muriel Wheldale Onslow. Part 1. Pp. vii + 326. (Cambridge: At the University Press, 1931.) 16*s.* net.

THAT recently named branch of science, biochemistry, has grown within the last few years to such dimensions that no single worker can embrace the subject as a whole. Hence subdivision has become necessary. The two great branches of the subject are those devoted to plant and animal physiology. They are complementary, and one could not continue its existence without the other. The present volume, written by an investigator who has established a reputation by her researches in the subject, is the first part of a textbook intended for the student and for the beginner in research.

The book is divided into six chapters. That dealing with the sugars gives a useful summary of our knowledge, and the work of the leading authorities who have contributed to the biochemistry of the subject is cited. The statement on p. 59 that "sucrose is probably the chief sugar of translocation" is one that cannot be accepted. Sucrose is an intracellular reserve sugar. The hexoses are the translocation sugars. Numerous investigators are mentioned as having reported that maltose exists in foliage leaves, but their methods of estimating that sugar are open to criticism. Mrs. Onslow doubts the existence of maltose in the leaf and assimilating organs. Probably no reducing sugars of higher molecular weight than the monosaccharides occur in such organs of plants.

The belief is growing of the presence of the so-called γ-sugars in Nature, and the observation of F. F. Blackman is quoted that the sugars concerned in respiration are the γ-forms. Mrs. Onslow suggests that these labile forms are the first products of photosynthesis. She also suggests that starch and inulin may contain residues of these γ-sugars, and indeed there is some evidence that this is the case.

In the chapter on the "Cell Wall", celluloses, hemicelluloses, gums, mucilages, pectic substances, cutin, and suberin are dealt with. A scheme is outlined to explain the formation of the structural and reserve polysaccharides from the monosaccharides. Under gums and mucilages the greater part of the text is taken up with a description of the recent work of Norman. Spoehr's work, suggesting that in the formation of gums the high pentosan content is due to the oxidation of the hexoses, is referred to. It has long been known that some moulds growing parasitically on certain trees induce the formation of gums, and the late Marshall Ward in 1901 pointed out that the so-called 'gummosis' is a pathological phenomenon. The bacterial origin of gums was demonstrated by R. Grieg Smith in 1904. Reference to this work might have been expected.

No mention is made of the physics of the cell wall, but perhaps the author regarded this as extraneous. Overton's work, however, suggesting that the semipermeable character of the cell membrane is due to a lining of lipoid, might perhaps have been referred to. A concise account is given of our knowledge of oxidising and reducing systems and of respiration. The chapter on nitrogen metabolism is a well-written summary of our knowledge of a difficult and obscure branch of science.

A useful feature of the work is the very complete bibliography attached to each chapter. There can be no doubt that the author has achieved her object, and that she has produced a valuable and concise work on the principles of plant biochemistry.

ARTHUR R. LING.

The Chemical Engineer.

Elements of Chemical Engineering. By Prof. Walter L. Badger and Prof. Warren L. McCabe. (Chemical Engineering Series.) Pp. xvii + 625. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 25*s*. net.

WE believe the engineer began as a person responsible for the construction of engines of war; the profession has prospered and to-day there are all sorts of engineers, of which the latest is the chemical variety. For a time opinions differed as to his utility, his function, and his training, but clarity on these points seems to be forthcoming with the very rapid development of chemical industry, and the chemical engineer is settling down to become a very useful member of society. It has been recognised that there are many unit operations common to all chemical processes and even vital to many industries not ordinarily considered chemical. Such are the transportation of liquids, the flow of heat, evaporation, diffusion, distillation, humidifying, drying, gas absorption, extraction, filtration, and a few more.

In many manufactures it may be that not a single chemical reaction occurs; they consist of a series of unit operations such as the above. An engineer thoroughly trained and versed in all these unit operations will be of considerable value in industry. In this way a more definite line of demarcation of the chemical engineer from both the chemist and the engineer has been arrived at, and there is a movement on foot to train the student on the lines indicated. Industrial chemistry, which is concerned with individual processes as entities, is thus clearly differentiated from chemical engineering.

A committee of the American Institute of Chemical Engineering has attempted to set out the relative weighting of the several major subjects which should be taught; it is of interest that in a four-year course it gives 28 per cent to chemistry, 12 per cent to chemical engineering, and 14 per cent to other engineering. The book before us aims at teaching the 'elements' of chemical engineering along the lines indicated. It overlaps to some extent the pioneer work on the "Principles" by Walker, Lewis, and McAdams, which, however, is too advanced for beginners; so there is ample room for the work of Badger and McCabe. Both authors are so well known in their profession that there is no fear that they will have shirked their task. The book is blessed by A. D. Little, who contributes a very practical introduction containing much sound advice. If the chemical engineer will teach manufacturers, as Dr. Baekeland puts it, to "make their blunders on the small scale and make their profits on the large scale", then new inventions will be more often a source of profit to those who finance them. E. F. A.

Modern Views on Magnetism.

Magnetic Phenomena: an Elementary Treatise. By Prof. Samuel Robinson Williams. (International Series in Physics.) Pp. xxii + 230. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 15*s*. net.

THIS is the fourth volume of the series. The three which preceded it dealt with subjects in advanced physics. In the first of these, which discussed the most recent of the recent advances, it was a matter for thankfulness to find that the title "The New Physics" never once appeared. It is probably due to the much greater popular interest which is taken in scientific subjects in the present century, as compared with that taken in the past century, that the phrase has now come into very frequent use. Yet in the past century great and even revolutionary advances, without which the now recent advances could scarcely have matured, were made in physics. Nevertheless, these were spoken of with reticence as 'recent advances in physical science', though time has placed them as the greatest at that date since Newton's day. There is only one physics developing continuously as time progresses. Had Newton been asked if his Laws were observed in sub-atomic dynamics, he would very certainly have said that he had no data on which to found an answer. The universe of molar physics is entirely untouched by the discovery of the electron, and that is the main subject matter of elementary physics. Similarly, it is untouched by the quantum and by relativity. But the supposed inversion of all physics, which has been impressed on the popular mind, has induced an expectation of inverted textbooks.

A glance at Prof. Williams's textbook dispels fear on this point. The electron appears in a few sentences only; the magneton, even, in a page or two only; the quantum in one paragraph; and relativity not at all. Yet the book is thoroughly up to date and modern. The treatment is fresh. This appears even in the titles of chapters, and in their arrangement. 'Magneto-magnetics' instead of 'magnetism' may seem peculiar. That chapter occupies, as it ought, about half the book. 'Magneto-mechanics', 'magneto-thermics', etc., are expressive. The student who uses the book will find fresh breezes blowing through it, and will be led up to the mountain tops, or at least see them temptingly in the distance. It is a book for a learner who wishes to go far.

One sentence may be quoted: "There is no physical existence of these [magnetic] lines of force" (p. 6). Here the author is pointing out, quite necessarily, that there is no terminal magnetic charge corresponding to electric charge in the case of electric lines of force. But reference to the closed electric lines of force which surround the line of motion of a magnetic pole would be useful. Faraday and Maxwell regarded both sets as having real physical existence in the ether. Probably the author does so also; and so would Newton have done. Yet those mathematicians who pay attention to formalism alone, and those philosophers who pay attention to idealism alone, deny physical existence to the ether itself because it is not required for the expression of the formal relationships given in the modern physical equations. Newton's famous dictum, given by him as an *experimentalist*, *Hypotheses non fingo*, tends to be regarded as an absolute dictum applicable even to modern physical theory, and the abolishment of the ether. But Newton's dictum, given by him as a *theorist*, was this, "that one body may act upon another at a distance through a *vacuum*, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it".

W. PEDDIE.

Short Reviews.

Anthropology and Ethnology.

Ethnos: or the Problem of Race considered from a New Point of View. By Sir Arthur Keith. (To-day and To-morrow Series.) Pp. 92. (London: Kegan Paul and Co., Ltd., 1931.) 2*s*. 6*d*. net.

Avowedly and of intention, Sir Arthur Keith in this little book has departed from the tacit understanding among anthropologists that they should not in any way trespass on politics; but, as he says, it is impossible to write about human races without touching upon matters which concern statesmen just as much as anthropologists. In fact, Sir Arthur, in hoping that he may induce politically-minded people to study the problems of race from an anthropological point of view, is doing no more than extend to international affairs that practical application of anthropology for which we have pressed in the administration of the dependent races of the British Empire.

In this essay, Sir Arthur has carried a little further the ideas he put forward in his Huxley Lecture to the Royal Anthropological Institute in 1928 and a subsequent public lecture before the Institute in 1929, and has applied them in principle to the problem of internationalism, in its relation to the future peace of the world. In Sir Arthur's opinion, every nation is a potential race, and a sense of nationality, or patriotism, has been one of the most potent of factors in the evolution of the races of mankind as they exist to-day. As race-consciousness is held to be largely responsible for our present troubles, this conclusion may seem pessimistic in so convinced an evolutionist as Sir Arthur; but he sees two possible solutions in either deracialisation by fusion into one race throughout the world, or a continuance of the evolutionary process through race, but under rational control. While Sir Arthur's views, therefore, are not without some comfort for struggling humanity, his more recent pronouncements suggest the inference that only the federally-minded are to survive.

Matriarchy in the Malay Peninsula and neighbouring Countries. By G. A. de C. de Moubray. Pp. ix + 292. (London: George Routledge and Sons, Ltd., 1931.) 15*s*. net.

Mr. de Moubray's book on the matriarchate in the Malay Peninsula illustrates a serious difficulty. Changes are taking place with such rapidity in modern conditions of contact between European and non-European civilisations that it is almost impossible for the inquirer to ascertain the truth in respect of many customs. The apparent inconsistency or inaccuracy may be due merely to recent changes; it is even possible that this statement of custom may never have been more than a semblance of the truth—in fact, it may resemble the idea laid up in Heaven in the Platonic sense. Thus, among the people of Negri Sembilan, with whom the author was more intimately concerned, inheritance was in the female line, and no male could hold land. Now, however, owing to the development of the rubber industry, land cleared and cultivated by the individual has come to be regarded as in the nature of any other form of personal property, and so may be held by the male.

Mr. de Moubray, in his inquiry into Malayan matriarchy, has obtained a great deal of evidence at first hand, valuable material, which is here printed in full. With the view of arriving at the underlying principles of the custom, he has been led to compare it with the matriarchal system in Menangkabau, the place of origin of part at least of the population of Negri Sembilan, Canara, and Malabar, where the Nayars still hold to it. His discussion of the social value of the matriarchal system in present conditions serves to emphasise once more the practical value of an inquiry of this nature for the work of administration.

Leitfaden der Anthropologie. Von Dr. K. Saller. Pp. iv + 284. (Berlin: Julius Springer, 1930.) 25·80 gold marks.

A brief note must suffice to direct attention to this excellent and much-needed textbook of physical anthropology. The treatment is comprehensive, each aspect, biological, morphological, palæontological, evolutionary, and so forth, being covered. Methods are fully explained, the exposition being accompanied by numerous diagrams, and the present position of our knowledge on the main questions outlined. The section on race is well illustrated by distinctive types, and some attention is given to the neglected question of cross-breeds and hybrids.

Biology.

One Touch of Nature: a Literary Nature Study Reader for Boys and Girls. Arranged by Dr. F. W. Tickner. Pp. viii + 187 + 7 plates. (London: University of London Press, Ltd., 1931.) 2*s*. 6*d*.

In these days of mechanism, when school books and teaching deal so much with the mechanical, it is a refreshing change to find such a book for children as "One Touch of Nature", written and compiled as it is from a varied selection of well-known, well-tried, and well-read Nature writers.

In arranging a volume of this type, for boys and girls, one must not overlook the fact that the average modern boy and girl is often more intrigued by, and interested in, the mechanical side of life. The importance of encouraging the younger generation in a closer and more intimate study of Nature is clearly described by William Warde Fowler on p. 137. In view of the delicacy with which a child's interest in Nature should be captivated and retained, to include such portions from the extracts of John Richard Jefferies as "Bevis and the

Wind" is to risk courting ridicule from the average schoolboy, whose interest in this book would centre rather round its nature study than its literary study.

The value of the book as a helping hand to readers would undoubtedly be greatly enhanced by illustrations and more photographs, and one is sorry to find so little reference to the commoner birds, such as the robin, thrush, and blackbird, which may usually be seen even by the city or town child.

Dr. Tickner wisely discloses the fallibility of Nature writers, a point which will tend to inspire the child with a desire to find out for himself. In passing, attention might be directed to the inferred contradiction as to the behaviour of the tortoise in rain.

"One Touch of Nature", though in places a little advanced for the average child-mind, is on the whole a delightful book, and should go far in helping its readers to observe things in the right way and then to describe concisely and clearly what has been observed and noted.

Fifty-two Years of Research, Observation and Publication, 1877–1920: a Life Adventure in Breadth and Depth. By Prof. Henry Fairfield Osborn. Edited by Florence Milligan. With Complete Bibliography, Chronologic and Classified by Subject, 1877–1929. Pp. xii + 160 + 9 plates. (New York and London: Charles Scribner's Sons, 1930.) 1.50 dollars.

HERE is a most impressive monument to the accomplishment of a great scientific worker. Osborn early found that "research is work of the hardest kind, requiring persistence, intelligence, and imagination", and all those qualities are necessary for a proper understanding of this skeleton of a life's work. Its main bulk is made up of a chronological and a classified list of the author's publications, 801 of them; of the share he has taken in the work of learned academies, revealed by lists of awards, degrees, and fellowships; and little space is left for a personal or intimate account of the great adventure. But the outstanding facts are clear.

The application of a two-edged discipline of detailed, intensive investigation, illumined by broad generalisations or hypotheses, has resulted, on one hand, in monographic researches on the rhinoceroses, horses, titanotheres, proboscideans, and reptilian sauropods, as well as in hundreds of lesser investigations. On the other hand, from the details have sprung a crop of 'principles', such as adaptive radiation or divergence, coincident selection, rectigradation or the predeterminate origin of new characters, allometrons or the adaptation of proportions in skull and skeleton. Osborn frankly admits that several of his principles have "gained no acceptance in the current realm of either biologic or palæontologic thought", but he is content to bide his time, believing that sound principles will finally gain universal acceptance, and that the less widely unsound ones are accepted the better.

J. R.

Chemistry.

Handbuch der anorganischen Chemie. Herausgegeben von Prof. Dr. R. Abegg, Dr. Fr. Auerbach und Prof. Dr. I. Koppel. In vier Bänden. Band 4, Abteilung 3: *Die Elemente der achten Gruppe des periodischen Systems.* Teil 2: *Eisen und seine Verbindungen.* A Lieferung 1. Pp. Axvi + A336. (Leipzig: S. Hirzel, 1931.) 40 gold marks.

THE present volume of this well-known treatise deals mainly with the physical properties of metallic iron. The atomic weight is also discussed. The spectrum, magnetic properties, crystalline form, thermal properties, electrical resistance, etc., are treated very fully, the numerical data being given in great detail. The preparation of pure iron, including electrolysis, and colloidal iron form the chemical part of the volume. The physical side is more prominently dealt with than in most of the preceding volumes of the series, and, for example in the sections on magnetism, it seems as though this aspect has been given too much prominence in a treatise on chemistry. It would probably be wiser in succeeding volumes to stress the chemistry more and to avoid expanding the series too much in the direction of pure physics, thereby adding to the size and expense to an unnecessary degree. The volume is a welcome step towards the completion of the excellent series and should be in all chemical libraries. The printing and paper are of the best quality.

The Modern Soap and Detergent Industry: a Complete Practical Treatise in Two Volumes on the Manufacture of Laundry, Toilet, Pharmaceutical, Textile, Abrasive, Scouring and Powdered Soaps. By Dr. Geoffrey Martin. Second edition, revised and enlarged. Vol. 1: *Theory and Practice of Soap Making.* Pp. xii + 76 + 37 + 34 + 53 + 13 + 100 + 64 + 4. Vol. 2: *The Manufacture of Special Soaps and Detergent Compositions.* Pp. xii + 102 + 40 + 26 + 50 + 16 + 35 + 38 + 6 + 37 + 31 + 51. (London: Crosby Lockwood and Son, 1931.) 36*s.* each vol.

THIS very practical and detailed treatise has been brought up to date by the author, and contains an account of all important recent advances and new patents in the soap industry. It covers British, American, and Continental practice and deals also with analysis and laboratory control. Dr. Martin's work is authoritative and will be welcomed by those interested in the soap and allied industries. It is fully illustrated and indexed.

A Life of Joseph Priestley. By Anne Holt. Pp. xviii + 221. (London: Oxford University Press, 1931.) 8*s.* 6*d.* net.

ALTHOUGH a good account of Priestley's scientific work has been given by Sir Edward Thorpe, there has been no adequate biography dealing with his many other activities. This need is, to some extent, supplied by the present work. The chapter on Priestley's chemical investigations is inadequate, but the author's intention was evidently to discuss in greater detail the personal life and the political and theological activities of Priestley, and she has made good use of the material available, some unpublished. The book covers the whole of Priestley's life, and in addition to making clear the great disadvantages under which Priestley carried out his scientific work, it provides a clear picture of the social life of his time. There is a useful bibliography.

Mathematics.

The Elementary Theory of Tensors: with Applications to Geometry and Mechanics. By Prof. Tracy Yerkes Thomas. Pp. ix + 122. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 10*s.* net.

The difficulties of the theory of relativity are much increased by the combination of unfamiliar physical ideas with the unfamiliar mathematical notation of the theory of tensors. Some universities are trying the experiment of separating these difficulties by giving an elementary course in tensors to undergraduates, with applications to ordinary geometry and dynamics.

Prof. Thomas's book is based on such a course given at Princeton University. After an introductory chapter recapitulating properties of determinants, it gives a brief chapter on the pure theory of tensors. Then follow three longer chapters, dealing respectively with the application to Euclidean geometry (emphasising the invariant point of view), kinematics (especially of the displacements and accelerations of a rigid body), and Newtonian dynamics (with a good deal about Lagrange's equations). The treatment throughout is such as to prepare the way for a study of Einstein's theory.

H. T. H. P.

Vorlesungen über Grundlagen der Geometrie. Von Prof. Kurt Reidemeister. (*Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen mit besonderer Berücksichtigung der Anwendungsgebiete*, herausgegeben von R. Courant, Band 32.) Pp. x + 147. (Berlin: Julius Springer, 1930.) 11 gold marks.

This book is a comprehensive survey of the present conditions of the foundations of geometry. In the first part, the author follows Klein's programme of Erlangen, and discusses the notions of congruence and invariance, using freely the theory of groups, and giving an analytical treatment of generalised vectors without, however, employing determinants. But algebra is scarcely sufficient for an adequate description of the implications of space: geometry is more than a combination of numbers. So, in the second part of the monograph, the author gives an exposition of geometry as an autonomous axiomatic construction, discussing single systems of axioms with their logical characteristics.

The whole work is limited to plane geometry. On a point of method, however, it seems that a more rational presentation of such a difficult subject could be obtained by starting with axiomatic geometry.

T. G.

Introduction to Vector Analysis: with many Fully Worked Examples and some Applications to Dynamics and Physics. By L. R. Shorter. Pp. xiv + 356. (London: Macmillan and Co., Ltd., 1931.) 8*s.* 6*d.* net.

There is still considerable diversity of opinion concerning what amount of time students of mathematics and physics should devote to vector analysis, and at what stage it should be introduced. No one can doubt its value in advanced work such as differential geometry or electrodynamics, but it is still an open question whether it should be introduced to students of elementary geometry, mechanics, and physics. Many years ago, intermediate science students at the University of London were given a fairly full course in vectors, but now it is more usual to give only a very brief treatment, such as an introductory chapter to a textbook of physics. Mr. Shorter has come to the conclusion that this is unsatisfactory, as it does not give the grasp necessary to enable one to use the method with confidence. He therefore reverts to the older idea of supplying a complete elementary course. The distinctive feature of the book is the large number of fully worked examples. Those who can afford the time to study these should have a good grip of the subject.

H. T. H. P.

Metallurgy.

The Elements of Ferrous Metallurgy. By Dr. Joseph L. Rosenholtz. Pp. vii + 248. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 15*s.* net.

In view of the importance of the iron and steel industry to Great Britain, it is remarkable that so few textbooks are available to metallurgical students. One or two which formerly enjoyed a well-deserved reputation are now hopelessly out of date. The present volume comes from America, and the descriptions of plant relate to American works, but there is little which is not also applicable to English practice, and it is convenient to have the blast furnace, steel furnaces, and rolling mills well described and illustrated in a single volume of small size, whilst clear accounts are also given of such processes as tube-making.

The second part of the volume is occupied by an account of metallographic methods of study and of the constitution of iron and steel. This is excellently done, and the volume is to be recommended to students of engineering as well as of metallurgy. The chemistry of the various processes is simply and accurately explained. There are a few slips; the experiments suggested to the student on p. 15 could not be actually performed, and it will surprise Sheffield cutlery manufacturers to learn that shear steel cannot keep a cutting edge on account of its slag inclusions—these being the cause of the known great superiority of such steel for cutting. The illustrations have been drawn from other sources with good judgment, and well portray present practice.

The Metallurgy of Bronze. By H. C. Dews. (The Specialists' Series.) Pp. ix + 147. (London: Sir Isaac Pitman and Sons, Ltd., 1930.) 12*s.* 6*d.* net.

IN 1903, Heycock and Neville published their study of the copper-tin alloys, one of the classics of metallurgy, and the work of later investigators, which has filled in the gaps in their account, has only confirmed the accuracy of their diagram and their foresight in adopting long periods of annealing as a means of obtaining equilibrium. The bronzes are of great technical importance, and an account of their composition and uses, by a metallurgist accustomed to handling them in industry, is therefore to be welcomed.

This little book, high in price for its size, is well printed and contains the information most necessary to those who have to use bronzes for casting and other purposes. The term 'bronze' is taken in its proper sense, as meaning copper alloys in which tin is the principal added metal, but including complex bronzes, of which many now exist. There are some misprints, and the theoretical treatment of the subject is weak, the account of the iron-copper equilibrium on p. 84 being quite inaccurate. Most of the illustrations are good, but Figs. 9, 13, 14, 15, and 22 are merely black smudges, which is the more remarkable since these alloys give very clear structures when properly etched. The book will be of special use to foundrymen.

Impurities in Metals: their Influence on Structure and Properties. By Dr. Colin J. Smithells. Second edition, revised. Pp. xiii + 190 + 26 plates. (London: Chapman and Hall, Ltd., 1930.) 18*s.* net.

THE first edition of this book was well received by metallurgists, and a second has been called for. In addition to general revision, which has much improved the work, the subject of gases in metals has now been discussed in detail, mainly, however, in connexion with the non-ferrous metals. A fuller account of the state of knowledge concerning gases in steels, admittedly a controversial subject, would have been useful. The subject being the effect of impurities on the properties of metals, the section on magnetic properties might well have been expanded, in view of the enormous influence of even very minute quantities of impurity, of great theoretical significance as well as practical importance. Should another edition be required, the section on corrosion will also need expansion. The author's special acquaintance with tungsten enables him to illustrate several points by reference to that metal.

Metallurgists whose interest is in steel will be disappointed by the omission of many matters of importance to them which might have been included, but on the whole this attractively produced work will be found to contain a large amount of valuable information on a variety of metallurgical subjects.

Miscellany.

The Scientific Journal of the Royal College of Science. Vol. 1: containing Papers read during the Session 1930–31, before the Imperial College Chemical Society, the Royal College of Science Natural History Society, the Royal College of Science Mathematical and Physical Society. Pp. 158. (London: Imperial College Union, 1931.) 3*s.* 6*d.* net.

THIS publication, which appears as a result of collaboration between the three student societies named, may conceivably meet with criticism from some readers on the ground of redundancy, seeing that the substance of its most important papers can probably be found in print elsewhere. Others will discern in it a token of the vitality of the societies concerned. Moreover, it is apparent that a student journal of this type can fulfil an important service in broadening the interests of the members of each of the contributing societies. This result can only follow, however, if a judicious selection of the published papers is maintained: besides the more specialised papers, each section of the journal should contain at least one paper of general interest.

The first issue conforms to this criterion through the inclusion of instructive lectures on "The Life and Work of W. H. Perkin, Jun." (Prof. J. F. Thorpe), "Plant-Breeding" (Prof. F. L. Engledow), and "The Nature of Vowel and Consonant Sounds" (Sir Richard Paget). The biographical sketch of England's greatest organic chemist is full of interesting detail; and we cannot refrain from quoting a neat expression of a reflection which must occur frequently to all who experience the joys and sorrows of supervising organic chemical research: "It would appear, in fact, that these great manipulators possess some power which ordinary beings lack—some radiation from the eye, or some force which passes from them to the reaction vessel and compels the material to behave in the desired manner. Otherwise it seems impossible to account for the fact that compounds which in the hands of the ordinary research student remained, and would always remain, as an intractable gum, in Perkin's hands rapidly assumed the form of splendid crystals of undoubted homogeneity and purity." J. R.

An Outline of the Universe. By J. G. Crowther. Pp. xvii + 376 + 24 plates. (London: Kegan Paul and Co., Ltd., 1931.) 12*s.* 6*d.* net.

THIS brilliant and useful book deserves a warm welcome. The author describes it as the first attempt he knows in a new and necessary craft—"the conveyance of the atmosphere and facts of recent scientific research to the public, the conveyance of atmosphere being the more important part". He has certainly managed to compress into a smaller space the latest results in astronomical, physical, and biological science than any other writer we know; in fact, there is nothing quite like it, and Lord Rutherford's commendation is well deserved.

Mr. Crowther has divided the field into three approximately equal areas—the universe (in the astronomical sense), the atom, and life. On each of these he collects the latest and most striking scientific observations or theories, and ends with a short exhortation to mankind to emulate Nature and try to organise society as efficiently as Nature has organised the community of cells in his own body. That is the philosophy or moral of the book, so far as it has one, but the author certainly did not start with any philosophic purpose in mind. He is intensely interested in all the recent discoveries and is anxious that the educated public should share his interest.

Of the three main sections, that on life is the fuller and bears more trace of intimate personal knowledge and research. The astronomical section mostly follows the lines with which Sir James Jeans has made us familiar.

A word should be added on the abundant and most ingenious and suggestive illustrations. They could scarcely be better for the purpose in view.

F. S. M.

The Girdle of Chastity: a Medico-Historical Study. By Eric John Dingwall. Pp. x + 171 + 10 plates. (London: George Routledge and Sons, Ltd., 1931.) 10*s*. 6*d*. net.

IN this work, which forms an interesting companion volume to the author's study of male infibulation reviewed in these columns some years ago (NATURE, 97, 150; 1926), Dr. E. J. Dingwall makes a survey of the history and use of the girdle of chastity from the twelfth century down to the present day. Evidence is brought forward to show that the idea of the girdle of chastity is derived from that of female infibulation which originated in the East.

Seven types of girdles are discussed, the earliest being that described by Kyeser von Eichstadt in his military encyclopædia entitled "Bellifortis"; of which the MS. in the library at Göttingen is dated 1405, and the latest that devised by John Moodie, a Scottish doctor, as a means of preventing masturbation and seduction, and described by him in a work published at Edinburgh in 1848. A special chapter is devoted to the forensic aspects of the subject, and is followed by one dealing with the references to the girdle of chastity in belletristic literature from the fifteenth to the twentieth century. The text is illustrated by photographs and drawings of various girdles in different museums in Europe.

The author is to be congratulated not only for having produced a richly documented and very readable work, but also for continuing his valuable researches in the sexuological department of anthropology, which is still taboo to the great majority of the medical profession in Great Britain.

Philosophy.

Cosmic Problems: an Essay on Speculative Philosophy. By Prof. J. S. Mackenzie. Pp. ix + 122. (London: Macmillan and Co., Ltd., 1931.) 6*s*. net.

THE author of this book is not only a distinguished figure in the philosophical world, but also a teacher honoured by many hundreds of his former students. His power as a teacher, as well as a thinker, is manifest in all that he writes. He has the gift of making difficult matters seem at least not hopelessly incomprehensible. Indeed, he seems in some danger of sharing the philosophic fate of J. S. Mill, of whom it has been said that he made the mistake of writing clearly enough to be found out.

Throughout his career, Prof. Mackenzie has, as is well known, followed the line of idealistic speculation, and during that time there has not been, on the whole, much commerce between science and philosophy. But in these days, science has become philosophical, and some men of science, such as Whitehead and Russell, have become philosophers. Modern theories of evolution and of the spatio-temporal system are bound to be taken into account by speculative philosophy. In a series of short chapters, Prof. Mackenzie takes up one after another of the problems so raised, and tries to remove some of the difficulties in the way of a solution. For their complete removal, he says, the co-operation of the special sciences is required, and "happily there is now no real opposition between the results of the special sciences and the demands of speculative thought".

Orpheus: a History of Religions. By Salomon Reinach. Revised and partly rewritten. Translated by Florence Simmonds. Pp. ix + 487. (London: George Routledge and Sons, Ltd., 1931.) 15*s*. net.

THIS new and revised Anglo-American edition of M. Salomon Reinach's well-known history of religions, which in France has now reached its thirty-eighth edition, brings the survey of the religious movement in the modern world fully up to date. Here M. Reinach is amusing as well as instructive. In dealing with earlier times and other types of religion, the chapter on Christian origins has been almost entirely rewritten in the light of the fresh evidence furnished by the Emperor Claudian's letter to the Alexandrian community and by the Slavonic text of Josephus relating to Jesus, discovered some years ago and brought to the notice of the learned world in 1925. M. Reinach's interpretation of these two documents gives an entirely new conception of the course of events in Jerusalem leading up to the Crucifixion; for he concludes that the unnamed leader of the insurrection, which the text of Josephus states was in contemplation, was, in fact, Jesus.

Physics.

A Survey of Physics. By Prof. Frederick A. Saunders. Pp. x + 635 + 8. (London: G. Bell and Sons, Ltd.; New York: Henry Holt and Co., n.d.) 14*s*. net.

THE title of this volume is attractive, for it suggests a more interesting and readable account of physical phenomena and theories than is given in the ordinary textbook. This anticipation is realised in full measure, for Prof. Saunders of Harvard has been markedly successful in collecting novel illustrations of physical principles and in instilling the spirit of the scientific investigator. The gyroscopic ship-stabiliser, the diffusion or condensation pump, the Shortt clock, the internal combustion engine, the phonodeik and architectural acoustics, are a few of the titles attracting attention in the first half of the volume, and in the second half, dealing with electricity and light, the author revels in up-to-date applications of physical methods. Of particular interest and merit are the biographical notes scattered throughout the volume. These brief records of the leaders in physics, both ancient and modern, are well conceived and admirably executed; they are remarkably accurate, and our only regret is that they are not more numerous.

The book is designed for college students but "no great store of mathematical knowledge is required". In words which possibly reflect his own experience as a teacher, the author adds: "Beyond this the reader's equipment is supposed to include an inquiring mind, ordinary human powers of observation, and an average acquaintance with modern civilisation." Prof. Saunders is not afraid to introduce "the newer, and presumably better, conceptions usually referred to as 'modern' physics. These will prove useful and stimulating, perhaps at times even irritating." Towards the end of the book the reader is informed as to the emission of light in quanta, Bohr's theory of the hydrogen atom, wave mechanics, and finally the theory of relativity.

The book is well produced and well illustrated, and in its freshness and completeness can be confidently recommended to the general reader as well as to the teacher in search of new material. It is one of the best college textbooks yet provided by our American colleagues. H. S. A.

Wilhelm Conrad Röntgen und die Geschichte der Röntgenstrahlen. Von Dr. Otto Glasser. Mit einem Beitrag: *Persönliches über W. C. Röntgen,* von Margret Boveri. (Röntgenkunde in Einzeldarstellungen, herausgegeben von H. H. Berg und H. Frik, Band 3.) Pp. xi + 337. (Berlin: Julius Springer, 1931.) 29·60 gold marks.

In the autumn of 1895, Prof. Wilhelm Conrad Röntgen of Würzburg, Bavaria, discovered the rays which he called the 'unknown' or 'X' rays, but which are now frequently known by his name. In this book, Dr. Otto Glasser gives much miscellaneous information about his work, and Miss Margret Boveri, who was a friend of the great physicist, gives many interesting personal details of his life. An excellent photograph, signed 'Dr. W. C. Röntgen', forms the frontispiece, and there are many photographs of historic letters, documents, and skiagrams. A picture is given of the modest but attractive laboratory in the Physical Institute in Würzburg where Röntgen rays were first discovered. An excellent skiagram of a hand taken by Röntgen himself in Hamburg on Jan. 17, 1896, is shown. The development of Röntgen photography was extraordinarily rapid. Other skiagrams, taken in January 1896, are shown, including one by Campbell Swinton. In the appendix a list of 1044 communications to the press on the subject, published in 1896, is tabulated. Of these, twenty were written by Campbell Swinton, eight being published in NATURE. Lodge published fifteen and S. P. Thompson seven, several of which were in NATURE. A picture published in *Punch* on Jan. 25, 1896, shows that the new photography has its humorous side. A long list, but far from complete, of the well-deserved honours received by this great physicist in his lifetime is given. It includes the Rumford Medal of the Royal Society in 1896 and the Nobel Prize in 1901. His letters show that in his private life he was a modest and lovable man. The book would be improved if it had an index.

Electricity and Magnetism: an Advanced Text-book for Colleges. By Prof. Charles A. Culver. Pp. viii + 383. (New York: The Macmillan Co., 1930.) 14*s.* net.

THIS book sets out to give a reasonably complete presentation of the fundamental principles upon which rest the everyday applications of electricity and magnetism. Its standard is somewhat higher than that styled 'intermediate' in Great Britain, clear accounts of the elementary principles of alternating currents and thermionics being included. The author has also made an attempt to give an up-to-date and simple description of the earth's magnetic field, and throughout the book emphasis has been placed on the practical applications of physics. The diagrams are very good, but some of the photographic reproductions could be improved. Why is it that nearly all publishers appear content to reproduce X-ray photographs in a manner which gives an utterly false impression of the radiographer's work with modern apparatus? When a new edition is called for, the exceedingly poor skiagraph of a human skull should be omitted, if not replaced by a more satisfactory picture.

La synthèse des ondes et des corpuscules. Par Karl K. Darrow. Exposé élémentaire publié avec une introduction et des notes par Marcel Boll. Pp. 54. (Paris: Hermann et Cie, 1931.) 10 francs.

THIS booklet is a translation of one of the admirable articles contributed to the *Bell System Technical Journal* by Karl K. Darrow. The fact that foreign publishers consider these articles sufficiently important to warrant translation, indicates that English readers would do well to consult them. The article before us is an extremely instructive explanation of certain simple optical and electron phenomena, such as diffraction by a grating, on the basis of the corpuscular and undulatory theories. In it, the author shows how recent work has so modified our conceptions that we now look upon corpuscles and waves, not as two alternatives between which we must choose, but as complementary aspects of the truth.

Physiology.

Ephedrine and related Substances. By K. K. Chen and Carl F. Schmidt. (Medicine Monographs, Vol. 17.) Pp. v + 121. (London: Baillière, Tindall and Cox; Baltimore, Md.: Williams and Wilkins Co., 1930.) 11*s.* 6*d.* net.

IN the course of the last few years numerous papers have been published on the clinical use of ephedrine and it now has a definite place in therapeutics.

Although it may be considered by some a modern drug, yet the clinical use of the plant from which it is isolated dates back some 5000 years; and thirty-five years elapsed between its isolation and the discovery of its real value.

Ma Huang has been used in China by native physicians for thousands of years, and similar species of *Ephedra* have been employed as medicines in many other parts of the world since remote antiquity. It was not until 1885, however, that Yamanashi obtained an impure crystalline substance from the plant. Two years later, Nagai and Hori isolated the alkaloid in pure form. Miura found that the alkaloid was toxic in large doses, but advocated its use as a mydriatic. Its clinical value was not appreciated until 1917, when Amatsu and Kubota reinvestigated its properties; but their work passed unnoticed by the western world until 1923, when Chen and Schmidt began their researches.

The alkaloid ephedrine finds its chief use as a substitute for adrenalin, to which it is related in chemical structure; it is not so potent a substance, but it has the great advantage that it can be given by mouth. The authors describe in detail the actions of the drug on animals and its uses in the treatment of a variety of diseases in man. They also include a section on synthetic ephedrine and other related compounds.

The monograph gives a good though brief account of the work which has been carried out on the alkaloid during the past six years. Its perusal raises the question whether other valuable drugs may not be awaiting extraction from the herbs used by native physicians of the East.

The Metabolism of Tumours: Investigations from the Kaiser Wilhelm Institute for Biology, 'Berlin-Dahlem.' Edited by Otto Warburg. Translated from the German edition, with accounts of Additional Recent Researches, by Dr. Frank Dickens. Pp. xxix + 327 + 5 plates. (London: Constable and Co., Ltd., 1930.) 40*s*. net.

THE work of Otto Warburg on the metabolism of tumours is so well known that it needs no introduction; but for investigators working on the metabolism of isolated tissues, frequent reference to his methods and results is a necessity, so that the publication of an English translation will be widely welcomed.

Apart from a short introduction on the technical details of methods, the book consists of reprints of papers published since 1908 by Warburg and his co-workers. The earlier papers deal with the oxidation process in sea urchin eggs and red blood cells; from 1923 onwards the researches deal chiefly with tumour tissues. The metabolism of a tumour cell is characterised by the production of lactic acid in the presence of oxygen or aerobic glycolysis; normal tissues produce the acid in the absence of oxygen, but in its presence it is further oxidised; in other words, normal tissues obtain their energy by respiration, tumour tissues by the conversion of carbohydrate to lactic acid. The distinction between the two types, however, is not absolute: thus, tumours respire as well as showing aerobic glycolysis, whilst normal tissues can be made to develop the abnormal form of metabolism by interfering with their respiration. If a normal growing cell glycolyses aerobically, it usually dies; if it lives, a tumour results: hence, interference with the respiration in growing cells is the cause to tumours.

The English edition has been brought up to date by the inclusion of a few recent papers which were not in the German edition; it should prove of interest to a wide circle of readers.

Psychology.

Alcohol and Behaviour. By Prof. Sydney Smith. (The Henderson Trust Lectures, No. 10, delivered at the University of Edinburgh, 28th November 1930.) Pp. 37. (London and Edinburgh: Oliver and Boyd, 1930.) 6*d*.

IT is very refreshing to read a lecture on alcohol without finding any bias or the influence of vested interest as is so often the case in articles of this kind. Prof. Smith, in "Alcohol and Behaviour", the Henderson Trust Lecture for 1930, has presented as impartial a study of the subject as we could wish for. There are some most interesting, and at the same time most surprising, statements. We would scarcely expect to find that there is no relation between alcohol and the murder rate, that, despite the fact that drunkenness has diminished to such an extent, yet there is an increase in offences of a sexual nature up to twice the 1909 level, and that offences against property have considerably increased in the same period. It is also surprising to read that the expectation of life in those more than thirty years of age is not in any degree impaired by the moderate consumption of alcohol. The author concludes by reminding us that as a nation we are becoming year by year more sober, but at the same time more dishonest and less moral.

Crime as Destiny: a Study of Criminal Twins. By Prof. Dr. Johannes Lange. Translated by Charlotte Haldane. Pp. 199. (London: George Allen and Unwin, Ltd., 1931.) 6*s*. net.

PROF. LANGE attempts to show that in monozygotic twins there is a very strong tendency for one child to be a criminal if the other one is. We are not inclined to agree necessarily as to the "dreadful influence" of alcohol in creating criminals, nor do we agree that criminal tendencies are so largely the result of hereditary factors. The influence of bad environment and evil influence in childhood is of so much more importance. Much more can be done with problems of the young delinquent by means of child guidance than by any questions of sterilisation or the prevention of cross-breeding of inferior or criminal types.

Forthcoming Books of Science.

Agriculture, Forestry and Horticulture.

Baillière, Tindall and Cox.—Baillière's Encyclopædia of Scientific Agriculture, edited by S. H. Hunter, 2 vols. *Oxford University Press.*—Forestry Memoirs, No. 13: Regional Survey and its Relation to Stock-taking of the Agricultural and Forest Resources of the British Empire, R. Bourne; Historic Farms of South Africa. The Wool, the Wheat, and the Wine of the Seventeenth Century, Dorothea Fairbridge.

Anthropology and Archæology.

George Allen and Unwin, Ltd.—A Handbook of Classical Mythology, G. Howe and G. A. Harrer; The Evolution of Culture, J. Lippert, translated and edited by G. P. Murdock. *Edward Arnold and Co.*—The Psychology of a Primitive People: a Study of the Australian Aborigine, Prof. S. D. Porteous. *Macmillan and Co., Ltd.*—The Lakhers, N. E. Parry, with an Introduction and Supplementary Notes by Dr. J. H. Hutton. *Methuen and Co., Ltd.*—Egyptian Antiquities in the Nile Valley: a Descriptive Handbook, Dr. J. Baikie. *Oxford University Press.*—Roman Britain, R. G. Collingwood. *G. Routledge and Sons, Ltd.*—The History of World Civilization, from Prehistoric Times to the Middle Ages, Prof. H. Schneider; Sorcerers of Dobu: the Social Anthropology of the Dobu Islanders of the Western Pacific, R. F. Fortune, with an Introduction by Prof. B. Malinowski; Growing up in New Guinea: a Comparative Study of Primitive Education, Margaret Mead; Sexual Life in Ancient Greece, H. Licht; A Bibliography of Sex Rites and Customs, R. Goodland. *Charles Scribner's Sons.*—Tara: the Pagan Sanctuary of Ancient Ireland, Prof. R. A. S. Macalister; The Temple of the Warriors, E. H. Morris; The History of the Maya, from the Earliest Times to the Present Day, T. Gann and J. E. Thompson.

Biology.

George Allen and Unwin, Ltd.—The Life of Mendel, H. Iltis, translated by Eden and Cedar Paul; The Life of the Butterfly, F. Schnack, translated by Winifred Katzin; The Experimental Analysis of Development, Prof. B. Dürken, translated by H. G. and A. M. Newth. *D. Appleton and Co.*—The Insect Menace, Dr. L. O. Howard. *Baillière, Tindall and Cox.*—International Address Book of Botanists: being a Directory of Individuals and Scientific Institutions, Universities, Societies, etc., in all parts of the world interested in the study of botany. *Ernest Benn, Ltd.*—A History of Fishes, J. R. Norman. *A. and C. Black, Ltd.*—The Birds of the Air, or, British Birds in their Haunts, A. W. Seaby. *Cambridge University Press.*—Chemical Embryology, Dr. J. Needham, 3 vols.; Invertebrata: a Manual for Students, Dr. L. A. Borradaile, F. A. Potts and J. T. Saunders. *Chapman and Hall, Ltd.*—Oceanography, Dr. H. B. Bigelow. *J. and A. Churchill.*—Recent Advances in Botany, E. C. Barton-Wright. *W. Heffer and Sons, Ltd.*—Emigration, Migration and Nomadism, by the late Walter Heape, edited, with a Preface, by Dr. F. H. A. Marshall. *Methuen and Co., Ltd.*—Problems of Relative Growth, Prof. Julian S. Huxley; Microbes and Ultramicrobes: being an Account of the Bacteriophage in its Relations to Bacterial Variation and the Invisible Viruses, A. D. Gardner; Mendelism and Evolution, E. B. Ford; The Great Biologists, Sir J. Arthur Thomson; Plant and Animal Life: an Introduction to the Study of Biology, Rosamond F. Shove; The Teaching of Biology: a Handbook for Teachers of Junior Classes, Ethel M. Poulton. *Oxford University Press.*—Selecta Fungorum Carpologia of the Brothers L. R. and C. Tulasne, translated into English by W. B. Grove, edited by Prof. A. H. R. Buller and C. L. Shear, 3 vols.; Iconum Botanicarum Index Londinensis, G. A. Pritzel, Vol. 6: Saponaria-Zymum, with Emendanda; an Introduction to the Study of Vertebrate Zoology, based chiefly on the titles in the Blacker Library of Zoology, The Emma Shearer Wood Library of Ornithology, the Bibliotheca Osleriana, and other Zoological Collections of McGill University, Montreal, Canada, compiled and edited by C. A. Wood; West African Botany, F. R. Irvine. *Sidgwick and Jackson, Ltd.*—The Biology of Mammals, Prof. J. Ritchie (Biological Handbooks); The Principles of Animal Genetics, E. B. Ford; Experimental Zoology, Prof. Julian S. Huxley; Invertebrate Zoology, Prof. W. Garstang (Text-Books of Animal Biology). *University Press of Liverpool.*—L.M.B.C. Memoirs, No. XXX.: Manx Algæ: an Algal Survey of the South End of the Isle of Man, Dr. Margery Knight and Mary W. Parke. *Williams and Norgate, Ltd.*—Genetic Principles in Medicine and Social Science, Prof. L. T. Hogben; The Essentials of Bacteriological Technique, F. R. Hunwicke; Scientific Riddles, Sir J. Arthur Thomson. *H. F. and G. Witherby.*—The Art of Bird-Watching: a Practical Guide to Field Observation, E. M. Nicholson; Practical Handbook of British Beetles, N. H. Joy, 2 vols.

Chemistry.

D. Appleton and Co.—How to Understand Chemistry, A. F. Collis; Smith's Introductory College Chemistry, Prof. J. Kendall. *G. Bell and Sons, Ltd.*—Groundwork of Biophysics, Dr. G. M. Wishart. *Cambridge University Press.*—Molecular Rays, R. Fraser (Cambridge Series of Physical Chemistry). *Chapman and Hall, Ltd.*—Chemistry, Life and Civilisation, Dr. H. T. S. Britton. *J. and A. Churchill.*—Recent Advances in Physical Chemistry, Dr. S. Glasstone; The Colloid Aspects of Food Chemistry and Technology, Dr. W. Clayton. *Constable and Co., Ltd.*—Text Book of Physical Chemistry, Prof. Eggert, translated by Dr. S. J. Gregg, edited by Dr. W. A. Caspari; Systematic Organic Chemistry: Modern Methods of Preparation and Estimation, Dr. W. M. Cumming, Dr. I. V. Hopper and Dr. T. S. Wheeler, new edition revised by Drs. Cumming and Hopper. *C. Griffin and Co., Ltd.*—Friend's Inorganic Chemistry, Vol. 11, Part 3, Organometallic Compounds: Derivatives of the Elements of Groups V. to VIII. (excluding Arsenic), A. E. Goddard; The Analysis of Textile Fibres, S. R. Trotman. *Longmans and Co., Ltd.*—A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Dr. J. W. Mellor, Vol. XII.; Monograph on the Sulphur Bacteria, Prof. D. Ellis; The Glycosides, Dr. E. F. Armstrong and K. F. Armstrong (Monographs on Biochemistry); Alcoholic Fermentation, Prof. A. Harden, new edition. *Methuen and Co., Ltd.*—The Biochemistry of Muscle, Dr. Dorothy Moyle Needham; Surface Tension, Dr. A. Ferguson. *Oxford University Press.*—Elementary Chemistry for Technical Students, W. R. C. Coode-Adams. *G. Routledge and Sons, Ltd.*—The Sorption of Gases and Vapours by Solids, Prof. J. W. McBain.

Engineering.

Edward Arnold and Co.—Heat Engines (for technical students—3rd Year National Certificate book), S. H. Moorfield and H. H. Winstanley. *Cambridge University Press.*—Photo-Elasticity, Prof. E. G. Coker and Prof. L. N. G. Filon. *Chapman and Hall, Ltd.*—The Supply of Water, T. H. P. Veal; The Automatic Stabilisation of Ships, T. W. Chalmers; Photogrammetry: Collected Lectures and Essays, edited by O. von Gruber, translated by G. T. McCaw and F. A. Cazalet; Steel Structures: Examples of Modern Competitive Design, P. Russell and G. Dowell; Airless Injection Heavy-Oil Engines, revised translation by J. Calderwood and G. R. Hutchinson, from the German of Dr. F. Sass; The Wireless Valve: Its Design and Manufacture, A. C. Bartlett and M. Thompson. *Crosby Lockwood and Son.*—Chemical Engineering as Applied to the Cement Rotary Kiln, Dr. G. Martin; Electricity for Coal Mining Students, J. Stevenson and W. Miller; Central Heating and Hot Water Supply, G. C. Sanford; Angles on Practical Flying, P. W. F. Mills. *Longmans and Co., Ltd.*—Modern Practice in Mining, Vol. 5: Colliery Machinery and its Application, Sir Richard Redmayne; The Elements of Machine Design, Prof. W. C.

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Geology, Mineralogy and Mining.

Chapman and Hall, Ltd.—A Key to Mineral Groups, Species and Varieties, Dr. E. S. Simpson. *Methuen and Co., Ltd.*—Dalradian Geology: The Dalradian Rocks of Scotland and their Equivalents in other Countries, Prof. J. W. Gregory (Methuen's Geological Series). *Oxford University Press.*—Firedamp Explosions and their Prevention, W. Payman and Prof. I. C. F. Statham.

Mathematical and Physical Sciences.

Cambridge University Press.—An Introduction to the Mathematics of Map Projections, R. K. Melluish; Partial Differential Equations of Mathematical Physics, Dr. H. Bateman; Cartesian Tensors, Dr. H. Jeffreys; The Teaching of Mathematics, planned by C. Godfrey and A. W. Siddons; A Higher Course Geometry, H. G. Forder, 2 parts. *J. and A. Churchill.*—Recent Advances in Physics (except Atomic), Prof. F. H. Newman. *Longmans and Co., Ltd.*—Vision and Colour Vision, Dr. R. A. Houstoun; Elementary Calculus, F. Bowman, Part 1; Elementary Trigonometry, Dr. J. Prescott and H. V. Lowry. *Methuen and Co., Ltd.*—The Theory of Groups and Quantum Mechanics, Prof. H. Weyl, translated by Prof. H. P. Robertson; The Elements of the New Quantum Mechanics, O. Halpern and H. Thirring, translated by Dr. H. L. Brose; Thermionic Vacuum Tubes, Prof. E. V. Appleton. *Oxford University Press.*—An Introduction to the Theory of Functions of a Complex Variable (Taylor Series), P. Dienes; Constitution of Atomic Nuclei and Radioactivity, G. Gamow; The Theory of Electric and Magnetic Susceptibilities, Prof. J. H. Van Vleck. *Charles Scribner's Sons.*—Signals from the Sun, Dr. G. E. Hale.

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Meteorology.

Cambridge University Press.—Manual of Meteorology, Vol. 4, Meteorological Calculus: Pressure and Wind, Sir Napier Shaw, with the assistance of Elaine Austin.

Miscellany.

G. Bell and Sons, Ltd.—Water Diviners and their Methods, H. Mager, translated from the French. *John Murray.*—The Science Master's Book of Experiments, general editor, G. H. J. Adlam, 2 vols., Part 1: Physics; Part 2: Chemistry and Biology. *Williams and Norgate, Ltd.*—The Methods of Statistics, L. H. Tippett; Science and Human Experience, Prof. H. Dingle; Science To-day and To-morrow (compiled from a Series of Lectures delivered at Morley College).

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George Allen and Unwin, Ltd.—The Six Ways of Knowing, D. M. Datta. *Cambridge University Press.*—A History of Indian Philosophy, Surendranath Dasgupta, Vol. 2. *Methuen and Co., Ltd.*—Contemporary Schools of Psychology, Prof. R. S. Woodworth; Abnormal Psychology: Its Concepts and Theories, Prof. H. L. Hollingworth; An Introduction to Social Psychology, Prof. W. McDougall, new edition; The Use of the Self, in Relation to Functioning, Diagnosis and Human Reaction, F. M. Alexander. *Oxford University Press.*—Philosophies of Beauty from Socrates to Robert Bridges, being the Sources of Æsthetic Theory, selected and edited by E. F. Carritt; Proceedings of the Seventh International Congress of Philosophy: The Emergence of Life, J. B. Burke; A History of Psychology in Autobiography, edited by Prof. C. Murchison, Vol. 2. *Kegan Paul and Co., Ltd.*—The Psychology of Men of Genius, Prof. E. Kretschmer; Outlines of the History of Greek Philosophy, E. Zeller, new edition, rewritten by Dr. W. Nestle and translated by L. R. Palmer; The Psychology of Children's Drawings, H. Eng; Invention and the Unconscious, J. M. Montmarson; The Development of the Sexual Impulses, R. E. Money-Kyrle.

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"momentum of the system" to explain his observations on the behaviour of the motor neurones of spinal reflexes.

RUMOURS have persisted that a remnant of the once large herd of European bison which inhabited the Caucasus had survived the period of the War and the succeeding days when the herd proper was slaughtered for food by the distressed people of the district. In the early part of 1931, according to a bulletin issued by Science Service (Washington, D.C.), a Russian zoologist, M. Schaposnikov, set out to discover the truth or otherwise of these rumours, and his failure to report progress or to return has suggested that he may have fallen a victim to bandits. In the absence of any wild representatives of the European bison (or wisent), the only survivors consist of specimens in zoological gardens, and these at the beginning of the present year numbered sixty-one—thirty-two cows and twenty-nine bulls, including six calves born during 1930. During 1931, one bull calf and two heifers were born, but one of the heifers died. In addition, there exist a number of hybrid animals, the results of crosses with the American bison, but these, of course, cannot be reckoned in a wisent count.

IN many districts in England and Scotland the national grid of high-tension wires is now very conspicuous. In the Faraday centenary number of the *Times*, published on Sept. 21, Mr. P. V. Hunter points out that soon the subsidiary systems connected with it, operating at 30,000, 11,000, and 400 volts, will, so far as capital cost and magnitude of operations are concerned, be even more important than the grid itself. The British grid operates at 132,000 volts, and differs from similar networks abroad mainly by its very high factor of safety mechanically and the unusually high lattice towers used when it spans navigable estuaries. Mr. Hunter points out that there would be many advantages if underground cables were used for the subsidiary systems operating in agricultural and rural districts. These cables would not need to be armoured or otherwise carefully protected against accidental damage by other excavators, as they have to be in cities and in urban districts. He computes that if their cost does not exceed fifty per cent that of overhead conductors, then from the commercial point of view they would be more desirable. The better service, the better voltage distribution, the longer life, and the lower maintenance cost of the cables will more than offset their increased capital cost. The oil-filled cable which is being tried in certain situations is, at least as at present developed, of limited application, on account of the difficulties and expense of the necessary auxiliary equipment, especially where parts of the cables are at different levels. With our present knowledge it should not be difficult to make a cheap cable suitable for rural districts. As the great bulk of the lower pressure distribution systems have yet to be constructed, it is to be hoped that such cables will soon be forthcoming.

THE fortieth Annual Report of the Royal Society for the Protection of Birds makes an appeal for the clearing off of the debt still remaining upon the Romney Marsh Sanctuary. The step taken in the purchase of 140 acres of Romney Marsh was the direct answer—the only practical answer from England so far as is apparent—to the findings of the International Conference for the Protection of Migratory Wildfowl, held in 1927. At this conference a recommendation was made that there should be established in all countries winter sanctuaries where wildfowl might obtain a respite from constant pursuit and persecution. The Society, inspired by the recommendation, secured an excellent and varied area in Romney Marsh, the nucleus of which was purchased in 1928, but expenditure is required for the preparation of the land, for the provision of further cover for the birds, and for protecting boundaries. Up to the end of 1930, £1455 had been contributed in special donations, a considerable sum has been allocated from the general account (shown in the Report as £1995), but a sum of £639 is still required to meet the overdraft at the bank. The Society carries on an inestimable work on behalf of British bird life—its expenditure for 1930 on behalf of watching, lighthouse protection, oil pollution, and education amounted to £2230—and we commend the final appeal for the Romney Marsh Sanctuary to all bird-lovers.

IN the *Westinghouse International* for August, H. E. Dralle points out that there is great scope for the use of electricity as a motive power in the development of the Rumanian oilfields. Owing to the lack of transport facilities, development there was very slow before 1900. Many of the wells are thousands of feet deep, and so, although labour is very cheap, the cost of drilling them is high. Owing to the sandy nature of the soil, a successful method of pumping has not yet been invented and bailing is in general use. At some of the wells either flowing or being bailed, it is a common sight to see from four to sixteen people (men and women) standing up to their knees in pits of oil and cleaning away the huge quantities of sand that are brought up with the oil. When electric power is used for the drilling systems, it is necessary, owing to the presence of large quantities of inflammable gas, to use apparatus that makes no sparks or has been made gas-proof. For this reason also, the boilers which supply the wells with steam are located at least 2000 feet away from the nearest well. Transmitting steam at this distance at a pressure of 100 lb. per sq. in. presents many difficulties. At the present time the oil transportation is mainly by tank motor-car. Owing to the cost of the necessary electric pumping stations, it is doubtful whether pipe lines would be economical.

THE weather in England is a perpetual subject of interest, but nothing can give such substance to its consideration as the scientific correlation of its vagaries with the progress of plant and animal life in these islands. The Phenological Report for 1930 of the Royal Meteorological Society, therefore, is a very welcome document. The official verdict of 1930 is that it was a "wet year", and vegetation in general was a little later than the average for the past thirty-five years.

Apparently similar climatic conditions spread beyond the British Isles, else how can we account, to take one of the sets of phenomena discussed in the Report, for the late arrival of spring immigrants amongst birds, which cannot be seriously affected by conditions at the end of their migratory journey. A comparison of the lines of equal arrival dates of twenty species of birds in 1930 with those of the preceding year, shows that on the south coast of England arrival was delayed for three days, and that this delay affected the movements of the birds even to the north-east of Scotland, where a delay of the same period was noted. In both years, therefore, the progress of migration within these islands, from the Channel coasts to northern Aberdeenshire, occupied fifteen days, although it was almost a week later before the migrants penetrated to the inland districts. A new chart appears in the Report, showing the autumnal isophenes of the departure of the swift, swallow, and house-martin and arrival of the fieldfare and redwing, and this indicates a slower through-country movement, covering thirty days. Thus definite records substantiate a distinction which has been recognised in a general way between the characters of the spring and autumn migrations of birds.

IN a series of five illustrated articles in the *Engineer* from July 31 to Aug. 28, a review is given of modern methods of geophysical surveying. The subject is dealt with under the headings: the magnetic method, the gravitational method, electrical methods, and the seismic method. The theory of each method is discussed, the instruments used are described and illustrated, and some examples are given of successful geophysical surveys. Discussing the relative uses and application of the various methods and the place that they must take in physics and geology, the writer says the magnetic method finds a place in the equipment for any kind of geophysical surveying owing to its rapidity, but used alone the results obtained are sometimes of doubtful value, largely owing to the fact that the magnetic properties of materials are not so completely understood as are the properties made use of in other methods. The gravitational method suffers more than any other from the influence of topographical features, but it has the advantage that its theory is well understood. Electrical methods suffer from the disadvantage that the strength of the electrical indications falls off with disconcerting rapidity with increase of the depth explored, and are suitable for detailed investigations rather than large-scale surveys. On the other hand, the seismic method is well suited for large-scale survey, and is particularly valuable where stratification exists. It has been used with great success for the discovery of salt domes in the neighbourhood of which oil is to be found, and has been used extensively in America and by the Anglo-Persian Oil Company, Ltd.

IN ancient Indian carvings may be found represented a beast called by Sanskrit writers the water-elephant; this is depicted as a creature with the fore-parts of an elephant and the hind-parts of a fish, and might pass as a purely imaginary creature were it not for the fact that there are no tusks or ears, that the dentition given is that of a carnivore, with the characteristic canines, and that the trunk is abnormally short. These peculiarities suggest that the carvings are a rude attempt to portray the sea-elephant or elephant seal, which may once have ranged, if only occasionally, as far north in the Indian Ocean as it does in the Pacific to-day. At any rate, one of the diving-petrels—southern ocean birds which are not long-distance flyers—was believed to have been seen in Indian waters a century ago by Sundevall, and in our time by the writer of the present note; and in the *Field* for Aug. 22 (p. 300), G. Dickson, of Cape Town, publishes a photograph of what the editor very properly says is a young sea-elephant, taken at Cape Point. The suggestion is made that it had escaped from captivity, but the species is very rare in that condition, and, in view of the archæological evidence given above, a natural occurrence is at least possible.

PROF. WILLEM DE SITTER, director of the Leyden Observatory, was elected an honorary member of the American Astronomical Society at the recent meeting at the Perkins Observatory, Delaware, Ohio. The Society has elected the following new officers: *President*, W. S. Adams; *Vice-President*, C. G. Abbot; *Councillors*, J. C. Hammond, P. W. Merrill, H. H. Plaskett. Benjamin Boss was re-elected treasurer, and R. S. Dugan, secretary.

HAVING reached the statutory age for retirement, Mr. H. A. Hunt has retired from the position of meteorologist to the Commonwealth of Australia. Mr. W. S. Watt has been appointed his successor as from April 23, 1931.

DR. C. B. BRIDGES, of the California Institute of Technology, Pasadena, will give an address on "Genic Balance and Related Problems" at a meeting of the Genetical Society, to be held in the rooms of the Linnean Society at Burlington House at 3.30 P.M. on Oct. 19.

THE R.R.S. *Discovery II*, which was visited by many members of the British Association while she lay at St. Katherine's Dock, Tower Bridge, left on Oct. 3 for the Antarctic. The cruise is expected to last two years, and the work to be carried out will be mainly a continuation of the scientific investigation of the whaling industry.

ON Oct. 5, two American airmen, Mr. Herndon and Mr. Pangborn, completed a flight of 4465 miles across the Pacific Ocean from Sabushiro Beach, Japan, to Wenatchee, Washington. This is the first non-stop flight from Japan to the United States, and was accomplished in 41 hours 13 minutes.

THE opening meeting of the session of the Institution of Automobile Engineers took place at the Royal Society of Arts on Oct. 1. After Sir Herbert Austin had introduced Mr. W. A. Tookey, the president for the session 1931–32, to the chair, he was presented by Mr. Tookey with a commemorative certificate and badge. Mr. Tookey then delivered his presidential address, entitled "The Internal Combustion Engine and its Performance ". The Crompton Medal, which is awarded annually by the Council of the Institution of Automobile Engineers for the best paper read before the Institution during the session, has been awarded for the session 1930–31 to Dr. S. J. Davies and Mr. E. Giffen, of King's College Engineering Department, for their paper entitled " Injection, Ignition, and Combustion in High Speed, Heavy-Oil Engines ".

SIR WILFRED GRENFELL, in an article in the *Times* for Sept. 14, directs attention to the uncharted state of the greater part of the coast of Labrador. The coastal waters have been frequented by fishing boats for cod for many years, and, nevertheless, the charts are so inadequate that north of Cape Harrison they are, according to Sir Wilfred Grenfell, no use whatever to the navigator who has no personal knowledge of the coast. An aerial survey is now in progress, and the American Geographical Society is bearing the cost of constructing the map from the negatives. The British Admiralty is to begin surveying the coastal waters next year, so that before long this gap in the survey of the Empire will have been filled.

MR. H. V, GARNER, guide demonstrator of the Rothamsted Experimental Station, and other members of the staff of the institution are offering their services during the forthcoming winter in giving lectures to chambers of agriculture and horticulture, farmers' clubs, farm workers' associations, agricultural societies, etc., on the Rothamsted experiments. No fee will be charged for such lectures; but any association arranging such engagements must defray all expenses of the lecturer. Mr. Garner is offering several subjects, dealing chiefly with various forms of manuring. Subjects offered by other lecturers are: soil micro-organisms, Dr. H. G. Thornton, Mr. D. W. Cutler; agricultural botany, Dr. Winifred Brenchley; agricultural chemistry, Dr. E. M. Crowther, Dr. H. L. Richardson; soil physics, Dr. R. K. Schofield, Mr. G. W. Scott Blair; entomology, Dr. H. F. Barnes, Mr. D. M. T. Morland; mycology, Dr. W. B. Brierley, Dr. J. Henderson Smith, Dr. J. Caldwell, Mr. R. H. Stoughton. All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

THE Society of Glass Technology, with the support of the Glass Research Delegacy, is arranging an exhibition to illustrate the development of glass technological research in modern times. The exhibition, which is being accommodated in the Science Museum, South Kensington, London, will be opened by Sir Richard Gregory on Oct. 21, and will probably remain open until at least the end of November, and if possible, until the close of the year. Glass demonstrating the best chemical and physical properties for optical, illumination, electrical, mechanical, and artistic purposes will be shown. Processes in glass-works will be illustrated by photographs and specimens. A series of lectures on various kinds of glass is being arranged for Thursday evenings.

THE *Proceedings of the South London Entomological and Natural History Society* for 1931–32 contain, as usual, besides the reports of meetings, several articles of interest. Mr. H. M. Edelsten writes on the British species of *Nonagria* and their habitats, while Mr. A. E. Tonge contributes an article on the ova of many of the British Lepidoptera, illustrated by three excellent photographic plates. In his address, as retiring president of the Society, Mr. C. N. Hawkins deals with numerical variation in the ecdyses of lepidopterous larvæ, and collects together in convenient compass a good deal of data on the subject. We note from the treasurer's report for 1930 that the financial position of the Society is sound, with a substantial balance carried forward.

Two years ago the Division of Plant Industry of the Australian Council for Scientific and Industrial Research commenced a compilation of known Australian fungi (pathogenic and saprophytic), the work being carried out by Mr. C. C. Brittlebank, formerly mycologist to the Victoria Department of Agriculture. No systematic list had been prepared since 1895, when Mr. D. McAlpine recorded 2284 species and 415 hosts. The new catalogue contains more than 56,000 references to literature recording 6078 distinct species (with nearly 5000 synonyms) and 1343 hosts. State Government departments and universities in Australia have co-operated in its preparation, and material assistance has been given by the Imperial Institute of Mycology, Kew. The catalogue will now be kept up to date and should prove very useful to mycological investigators.

THE chapter on plant virus diseases from vol. 7 of " A System of Bacteriology in relation to Medicine ", published by the Medical Research Council of the Privy Council (see NATURE of Feb. 21, 1931), has been issued in pamphlet form. The article is by Dr. J. Henderson Smith, of the Rothamsted Experimental Station, and although only twelve pages in extent, it gives a remarkably full account of our present knowledge of these maladies. The economic damage caused by virus diseases is mentioned, and a comprehensive description of symptoms is given. Cytology, ætiology, and the various characteristics of virus extracts are dealt with, and considerable space is devoted to descriptions of transmission and specificity. It is interesting to note that even at the end of 1928, virus diseases had been reported on 264 species of plants. Many new diseases have been described since then, and it seems that the science of ' virology ', as some workers term it, will eventually rank with bacteriology and plant pathology.

MR. R. S. Frampton, 37 Fonthill Road, N.4, has sent us a copy of his catalogue (No. 65) of books, nearly a thousand in all, on natural history subjects. The prices asked appear very reasonable.

A LIST (No. 188) of some 432 second-hand works dealing mainly with floras of Europe, Asia, Africa, America, and Australia has just been issued by Messrs. Dulau and Co., Ltd., 32 Old Bond Street, W.1, and is worthy of perusal.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Doppler Effect in Light-Scattering.

IT is a problem of great interest to consider the changes in spectral character of monochromatic radiation resulting from the thermal agitation of a medium in which it is scattered. If we regard the subject classically, the result to be expected is obvious: there should be a Doppler broadening of the incident spectral line, varying with the angle of observation, and determined by the Maxwellian distribution of velocities of the molecules which scatter the light. It can readily be shown that, except in respect of the total intensity of scattered light, it would make no difference to the argument by which this result is deduced whether the molecules are loosely distributed as in a gas or are closely packed together as in a dense vapour or liquid.

It is very remarkable, however, that a wholly different result was deduced by L. Brillouin,[1] following the idea that the medium which scatters the radiation can be treated as a continuum filled with moving sound-waves of various wave-lengths which reflect the light-waves much in the same way that a moving crystal would give Bragg's reflection of X-rays. Brillouin's theory indicates that in the spectrum of the scattered rays the single line which represents the incident light should be replaced by a close doublet, the frequency shifts of which are given by the formula $\Delta\nu/\nu = \pm 2a/c \sin \frac{1}{2}\theta$, where a and c are the velocities of sound and light respectively, and θ is the angle of observation; the incident line itself would be missing in the scattered light. Brillouin's deduction of this formula has outwardly the appearance of being based on classical ideas. Actually, however, the argument ignores the existence of discrete molecules in the medium, and the results to which it leads cannot be reconciled with the classical point of view, according to which the incident line should persist in the scattered light in the same position with no change except a Doppler broadening.

The paradox presented above is resolved if we adopt the following view of the matter based on quantum principles. In a medium scattering light we are dealing with an assemblage of photons having energy $h\nu$ and momentum $h\nu/c$, material particles having translatory energy $\frac{1}{2}Mv^2$ and linear momentum Mv and also associated with the latter, quanta of sound, having energy $h\nu_s$ and linear momentum $h\nu_{s/a}$. The result of an individual encounter must satisfy the equations of the Compton type:

$$\tfrac{1}{2}Mv^2 + h\nu_s + h\nu_l = \tfrac{1}{2}Mv'^2 + h\nu'_s + h\nu'_l$$

$$\overrightarrow{Mv} + \overrightarrow{h\nu_{s/a}} + \overrightarrow{h\nu_{l/c}} = \overrightarrow{Mv'} + \overrightarrow{h\nu'_{s/a}} + \overrightarrow{h\nu'_{l/c}}.$$

The first is a scalar and the second is a vector equation. We obtain Brillouin's result immediately, if the energy and momenta of the material particles are ignored, and the equations are solved. If, on the other hand, the energy and momenta of the sound quanta are ignored, and the equations are solved, the classical Doppler broadening results. These are, however, two extreme cases, and in general both types of phenomena may be expected to be present and to influence each other.

It must here suffice to remark very briefly that the considerations set out above enable us readily to offer a satisfactory interpretation of the experimental results recently reported by Gross[2] on the modification of the fine structure of spectral lines produced by scattering in liquids and solids.

C. V. RAMAN.

210 Bowbazar Street,
Calcutta, Sept. 5.

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[1] *Annales de Physique*, vol. 17, p. 88; 1922.

[2] NATURE, vol. 126, pp. 201, 400, 603; 1930; and *Zeit. fur Physik*, vol. 63, p. 685; 1930.

Activated Adsorption of Hydrogen by Zinc and Chromium Oxides.

THE adsorption of hydrogen by zinc oxide has been the subject of investigation[1] by one of my students, Mr. D. V. Sickman, on a so much more comprehensive scale than that recently recorded by Garner and Kingman[2] that it seems desirable to state the results in outline prior to their publication some months hence.

A slow adsorption of hydrogen on zinc oxide (from the oxalate by ignition at 400° C.) occurs from 0° C. upwards. On 20 grams of material at *circa* 400 mm. pressure adsorption reached 2·9 c.c. in 1345 minutes at 0° C.; at 110° C. the velocity of adsorption increased so that 7·25 c.c. were adsorbed in 1200 minutes; at 184° C. this same amount was adsorbed in 45 minutes and as much as 14 c.c. were adsorbed in the longer time interval. The adsorption is reversible, *all* the hydrogen being recoverable by evacuation at 450° C. The activation energy of the adsorption amounts to 14 kgm. cal. for the main surface covered, with smaller values on the more active areas. By a new mathematical analysis of the velocity measurements Sickman has deduced[1] a heat of adsorption of 21 kgm. cal. per mol, a more trustworthy figure than a value of 16 kgm. cal. deduced from isotherms at high temperatures on a partially deactivated surface. The higher value is in excellent agreement with the value recorded by Garner and Kingman for the heat of adsorption of hydrogen on their $ZnO - Cr_2O_3$ catalyst. This would indicate, as they conclude with respect to carbon monoxide, that the hydrogen is adsorbed on the zinc oxide of the mixed material.

Below 0° C. another type of adsorption occurs which attains equilibrium practically instantaneously with no activation energy. The heat of this adsorption is only 1100 calories per mol. As much as 21 c.c. at −190° C. and 3 c.c. at −78° C. are adsorbed on 20 grams of oxide at 400 mm. From the data cited it can readily be calculated that this type of adsorption is negligible at 0° C.

We are inclined to ascribe the minute adsorption of hydrogen found by Garner and Kingman on the single oxides of zinc and of chromium to the slowness with which activated adsorption occurs at ordinary temperatures on the single oxides in comparison with the rate of adsorption on the mixture.[3] That hydrogen is markedly adsorbed in an activated form by chromium oxide is evident from work by Sherman and the writer in which precipitated chromium oxide (ex nitrate) has been shown to be effective in producing the change from para to ortho-hydrogen at ordinary temperatures. This, as we have already shown,[4] is intimately associated with activated adsorption of hydrogen at such surfaces.

HUGH S. TAYLOR.

The University, Manchester,
Sept. 14.

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[1] Thesis, Princeton, (1931).

[2] Garner and Kingman, *Trans. Farad. Soc.*, **37**, 322; 1931.

[3] Cf. Taylor and Williamson, *J. Am. Chem. Soc.*, **53**, 813, 2168; 1931.

[4] Taylor and Sherman, *J. Am. Chem. Soc.*, **53**, 1614; 1931.

Origin of Chromosome Linkage in *Œnothera.*

SEVERAL years ago the hypothesis was put forward that in *Œnothera* new species have arisen through crossing and been perpetuated by the chromosome linkage which, it was assumed, had arisen as a result of crossing between unrelated species (Gates, 1928).[1] It has recently been possible to test this hypothesis experimentally, with results which show that chromosome linkage (catenation)[2] can arise when species or mutants showing no catenation are crossed together.

It is known from previous work that *Œ. deserens* and *Œ. blandina,* both of which are secondary mutant derivatives from *Œ. Lamarckiana,* have seven free pairs of chromosomes in meiosis, and that the same condition exists in *Œ. purpurata,* a species described from Germany by Klebahn.[3] Reciprocal crosses were made between these three forms, which thus furnish us with a triangle of species in which the bivalent chromosomes were all unlinked in meiosis.

A preliminary examination of some of the F_1 hybrids shows the following catenations: *deserens* × *blandina,* ring of 6 and 4 pairs; *deserens* × *purpurata,* ring of 4 and 5 pairs; *blandina* × *purpurata,* ring of 4 and 5 pairs. In all three crosses catenation has thus arisen through hybridisation between forms having only paired chromosomes.

The view is thus experimentally confirmed that the species of *Œnothera,* most of which show catenation, have arisen through crossing between previous species and breed true because of the genetic linkage resulting from that catenation. That heterozygous species can breed true because of apogamous reproduction is a familiar conception. That they can breed true because of catenation (linkage) of the chromosomes in meiosis is not generally recognised, but is now well known in *Œnothera.*

Without going into details, it seems clear that the chromosome-complexes of *deserens* and *blandina* have become different by two chromosome segmental interchanges, involving three non-homologous chromosomes. The results of crossing these forms with *Œ. purpurata* may be explained on the assumption that *purpurata* differs from *blandina* by one of these segmental exchanges and from *deserens* by the other.

A full account of this work and its bearing on problems of chromosome linkage will be published later.

R. RUGGLES GATES.
D. G. CATCHESIDE.

King's College, London,
Sept. 22.

[1] *Zeit. fur Abst. u. Vererb.* Suppt. Vol., p. 752. *Bibliographia Genetica,* vol. 4, p. 480.

[2] Gates, "The Cytological Basis of Mutations", *Amer. Naturalist,* vol. 65, p. 97; 1931.

[3] See Gates and Goodwin, *Proc. Roy. Soc.*, B, in press.

Magnetic Resolution and Nuclear Moment of Rhenium.

FOR some time the spectrum of rhenium has been the subject of investigation in the Amsterdam Laboratory "Physica". With the Hilger E_1 quartz spectrograph we have studied the spectrum of the arc and of the underwater spark. The hyperfine structure and the magnetic resolution have been investigated with the 20-ft. grating in an Eagle mounting.

The following strong complex arc lines: λλ3465; 3460; 3452; 3424; 3399 A., which give absorption in the underwater spark and therefore should be considered as combinations with the ground-level ($d^5 s^2\, {}^6S_{5/2}$), are of special interest. Meggers[1] has identified the first three lines as the combinations ${}^6S_{5/2} - {}^6P_{5/2\ 7/2\ 3/2}$.

From the number of satellites and from the interval rule we conclude that the hyperfine structure originates from the $d^5 s p\, {}^6P$-term, and that the nuclear moment of rhenium is $\frac{5}{2}$, as was suspected by Gremmer and Ritschl.[2]

The hyperfine structure in the Zeeman components of the line λ3460 ${}^6S_{5/2} - {}^6P_{7/2}$ has been resolved. The strongest σ component is split up into six nearly equidistant hyperfine structure components, which indicate also that the nuclear moment is $\frac{5}{2}$. The mean distance of these components is 0·334 cm.$^{-1}$ and gives an interval constant a of 0·095 cm.$^{-1}$ in accordance with the value 0·096 cm.$^{-1}$ obtained from the hyperfine structure without magnetic field. On these six components are partly superposed more feeble groups of non-resolved σ-components.

It seems that the ${}^6P$-term has a slightly anomalous g-value, 1·76 (normal value, 1·714). The observed values for the six subcomponents of the strongest σ-components and the values calculated with $g = 1·76$ and the interval constant of the hyperfine structure without magnetic field are given below. Magnetic field: 38,900 gauss.

Obs.	+2·91	+2·62	+2·24	+1·95	+1·60	+1·25
Calc.	+2·94	+2·60	+2·26	+1·93	+1·59	+1·26
Obs.	−2·90	−2·60	−2·28	−1·93	−1·61	−1·24
Calc.	−2·94	−2·60	−2·26	−1·93	−1·59	−1·26

We are expecting to make a further report as soon as the investigation can be completed.

P. ZEEMAN.
J. H. GISOLF.
T. L. DE BRUIN.

Laboratory "Physica",
University of Amsterdam,
Sept. 16.

[1] Meggers, *Phys. Rev.*, 37, 219; 1931.

[2] Gremmer und Ritschl: *Zeit. fur Instrumentenkunde*, 51, 170; 1931.

Infra-Red Absorption Spectrum of Carbonyl Sulphide.

RECENT developments in the theory of band spectra in the infra-red[1] lend particular interest to all new experimental results for triatomic molecules. We have recently examined the absorption spectrum of carbonyl sulphide, making use of a monochromator method in order to avoid the photochemical decomposition to be expected on exposure of this substance to the full energy of a Nernst filament. We find a complicated spectrum—a fact which in itself demonstrates the lack of symmetry in the molecule: the results are summarised in Fig. 1. In the few cases in which the bands have been resolved, the separation between the P and R branches is given.

In assigning observed bands to certain fundamental frequencies with their corresponding overtones and combinations, due consideration has to be paid to their relative intensities, which are dependent upon the magnitude and orientation of the effective electric doublets concerned. The latter will be governed by the configuration of the molecule; when this is known, the deduced moments of inertia, the interatomic angles and separations must agree with those obtained by other physical methods, such as X-ray analysis or electron diffraction. Finally, the molecular structure must tally with known chemical and thermochemical data.

We have explored at some length the mechanical possibilities of a system of three different masses having various force constants with (*a*) covalent and (*b*) ionic linkings; the tedious calculations involved have at least enabled us to discard certain forms, but we believe we are justified in directing attention to this particular piece of work, inasmuch as it illustrates the need for cautious statements on such matters.

In spite of the experimental detail available, we find ourselves unable to pronounce definitely for either a rectilinear or a triangular structure: if the latter, our results and deductions are more consistent within themselves, but they seem to require two modifications of the substance; if the former, agreement is obtained with Vegard's recent X-ray analysis at the temperature of liquid air,[2] which demands a straight line molecule. Furthermore, thermochemical data indicate that the types of binding in carbon dioxide and carbon disulphide are probably those which exist in carbonyl sulphide.

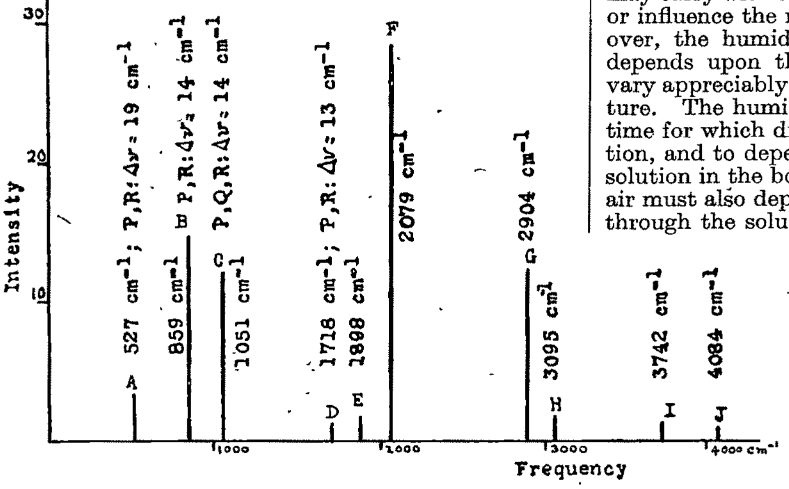

FIG 1.—The near infra-red absorption spectrum of carbonyl sulphide.

It is unfortunate that no determination of the Raman spectrum has been attempted; this is probably a consequence of the ready photochemical decomposition, but perhaps something might be done by examining the light scattered from the crystals at low temperatures.

C. R. BAILEY.
A. B. D. CASSIE.

The Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College, London,
Aug. 29.

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[1] Dennison, *Reviews of Modern Physics*, vol. 3, p. 280; 1931.
[2] *Zeit. Krist*, vol. 77, p. 411; 1931.

A Method of Obtaining Air Currents of Different Humidities.

FOR various experiments in which the change of a physical property with the humidity of the surrounding air has to be studied, for example, the calibration of a hair hygrometer, it is necessary to have some means of producing currents of air of different relative humidities. The usual method of attaining this in practice is to bubble air through wash bottles containing solutions of water and sulphuric acid of suitable strengths. A certain percentage of the acid in the solution gives rise to a certain definite humidity to the air in contact with it, and the bubbles of air through the solution are supposed to acquire this humidity.[1]

For some time past experiments have been in progress in this laboratory to investigate the changes in the electrical resistance of pencil lines due to varying humidities of the air to which they are exposed, with the view, ultimately, of evolving an electric hygrometer.[2] In these experiments air currents of different humidities were obtained in the above-mentioned manner. It was found, however, that changes in the resistance when exposed to varying humidities, though regular enough to encourage further experimentation for hygrometric purposes, were not as regular and reliable as one could wish. While investigating causes for such irregularities, they were traced, among other things, to the currents of moist air having been produced by bubbling it through sulphuric acid water mixtures.

It is not unlikely that the current of air so produced may carry with it traces of the acid, which may act on or influence the material under investigation. Moreover, the humidity imparted by a certain solution depends upon the temperature, and therefore may vary appreciably if there are large changes of temperature. The humidity also seemed to change with the time for which dry air was bubbled through the solution, and to depend on the 'empty' space above the solution in the bottle. The humidity of the outgoing air must also depend on the rate at which it is passed through the solution, and so may not always be the same as that which the strength of the solution indicates. Then, again, fresh solutions must be made for each experiment, and even then its strength may alter appreciably towards the end of an experiment if the bubbling has been continued long enough.

In order to get over these difficulties, a method has been devised of obtaining air currents of any required humidities without the above drawbacks. The principle is to mix a current of dry air, dried by any of the usual means, with a current of air saturated with moisture obtained by bubbling air through a bottle full of water. By regulating the strengths of the two currents, any desired humidity can be produced. The strength is regulated by turning a stop-cock or a pinchcock suitably placed in each of the two branches. Each of the two streams is then made to pass through a small, equal length of a capillary tube, whence it passes into a wider tube where the two mix before passing over the resistance. The two branches are also connected to two U-shaped oil manometers, the other ends of the manometers being connected together and to the wide 'mixing' tube.

From calibration curves giving the relationship between the pressure difference as indicated by the manometer when one of the branches is gradually opened, the other remaining closed, and the rate of flow of air as obtained from the volume, collected during a certain time, of water escaping from the aspirator or any other arrangement used to draw air through the apparatus, the humidity of the air in the mixer when both branches are working at any given rate of flow can be calculated. Production of different humidities is obtained by the regulation of the two cocks until, for the rate of flow in progress, the two manometers indicate the requisite pressure differences. An example will make this clear. Suppose the rate of flow is 60 c.c./min. and a 40 per cent relative humidity is sought. Evidently this can be brought about if the rate of flow of the saturated stream is 24 c.c./min. while that of the dry current is 36. Now from our calibration curves we find that a pressure difference of 5·75 cm. of the oil used corresponds with the rate of flow of 24 c.c./min. in the humid air branch and a pressure difference of 8·10 cm. with 36 c.c./min. in the other, dry air, branch. All that would be necessary then to get a 40 per cent humidity in the above case would be to regulate the two cocks so that the two manometers indicate the above-mentioned pressure differences respectively.

None of the disadvantages of the old method affects the new one, which also does away with the large number of wash bottles and attendant laborious manipulations which are needed in the old method, and which constitute yet another drawback to be added to the list given above. Credit for this new device and working out various details in connexion therewith is due to one of my students, Mr. Abdul Basir Pal.

It seems worth while to mention, before concluding, that by working with moist air obtained in this new way and at the same time arranging that the flow of air over the resistance took place at a constant rate, the changes in the resistance due to varying humidities were found by Mr. Pal to be much more regular, reliable, and repeatable than in previous experiments, and thus more helpful and encouraging towards the devising of our electric hygrometer. Full details will be published elsewhere.

J. B. SETH.

Physics Laboratory,
Government College, Lahore.

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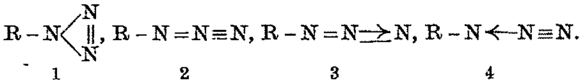
[1] *Proc. Phys. Soc*, vol. 34, Discussion on Hygrometry

[2] *Proc Phys Soc*, vol. 41, p. 29, and *Phil Mag.*, March 1930, p 415.

Structure of the Azides, from their Electric Dipole Moments.

As is well known, the chemical evidence regarding the structure of the azides is far from being unambiguous, and four formulæ have been proposed,[1, 2, 3]



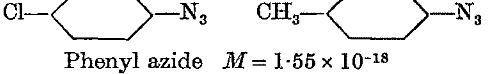
$$R-N\langle{}^{N}_{N}\| ,\quad R-N=N\equiv N,\quad R-N=N\rightarrow N,\quad R-N\leftarrow N\equiv N.$$

1 2 3 4

Of these, 2 is ruled out because the central nitrogen atom would have a shared decet of valency electrons, which, for an element in the first short period, is impossible.

Lindemann and Thiele concluded from parachor measurements that the ring structure was the correct one, and it seemed to be of interest to apply other physical measurements to the solution of the problem. Accordingly, the electric dipole moments of phenyl azide, *p*-chlorphenyl azide, and *p*-tolyl azide have been determined and found to be 1·55, 0·35, and $1{\cdot}96 \times 10^{-18}$ e.s.u., respectively.

From the comparative smallness of the moment of phenyl azide, formula 3 can be ruled out, as in this the moments due to the C–N link and the N→N link would be at an angle of less than 90° to one another and would probably give a resultant moment of $3-4 \times 10^{-18}$ e.s.u. (compare nitrobenzene $M = 3{\cdot}9$ and di-phenyl-sulphoxide $M = 4{\cdot}1 \times 10^{-18}$ e.s.u.). It is possible to discriminate between the two remaining formulæ, because in 1 the negative pole of the group dipole would be farther from the benzene ring than the positive one,[4] while in 4 the reverse would be the case because of the direction of the co-ordinate link. From the moments of *p*-chlorphenyl azide and *p*-tolyl azide it is clear that actually the negative pole is farther from the benzene ring:[5]



Phenyl azide $M = 1{\cdot}55 \times 10^{-18}$
Chlorbenzene $M = 1{\cdot}56 \times 10^{-18}$
Toluene $M = 0{\cdot}45 \times 10^{-18}$

and therefore the ring structure is the most probable of the three. There is, however, a still stronger argument in its favour.

It will be noticed that the moments of *p*-chlorphenyl azide and *p*-tolyl azide are almost exactly equal to the difference and to the sum, respectively, of the single group moments (the moment $0{\cdot}35 \times 10^{-18}$ of the *p*-chlor derivative corresponds to a polarisation of only 2·5 c.c. and by the method of measurement used it is impossible to distinguish this from zero, owing to the possible atom polarisation).[6] This indicates that the moment of the azide group lies almost exactly along the direction of the valency linking it to the benzene ring. Now, neither formula 3 nor formula 4 could lead to this, since the main moment would be in that part of the group which is inclined at an angle, not equal to 180°, to the C–N link. In the ring formula, however, the moment of the N=N link would be zero, and that of each N–N link, though the nitrogen atoms are not in exactly the same state of combination, would be almost zero. Therefore the only appreciable moment would be that of the C–N link itself, and this would explain the fact observed.

It is therefore fair to say that the evidence of the dipole moments is strongly in favour of the original ring structure.

L. E. SUTTON.

The Dyson Perrins Laboratory,
Oxford, Aug. 11.

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[1] Curtius, *Ber.*, **23**, 3023; 1890.

[2] Thiele, *Ber*, **44**, 2524, 1911.

[3] Lindemann and Thiele, *Ber.*, **61**, 1529; 1928.

[4] Hammick, New, Sidgwick, and Sutton, *Jour. Chem, Soc.*, p. 1876; 1930.

[5] J. J. Thomson, *Phil. Mag.*, **46**, p 497; 1923. J. W. Williams, *Physikal. Zeit.*, **29**, p 174 and p. 633; 1928: Hammick, New, Sidgwick, and Sutton, *Jour. Chem. Soc.*, p. 1876; 1930.

[6] Debye, "Polare Molekeln", Leipzig, 1929, p. 43.

Raman Spectra of Liquid Mixtures.

IT is well known that mixtures of polar liquids often exhibit marked deviations from the additive law in respect of such properties as density, vapour pressure, viscosity, and refractive index. Such changes taking place in aqueous solutions are usually attributed to the formation of definite hydrates. Important evidence concerning the constitution of liquid mixtures is furnished by a study of their Raman spectra. I have made a careful examination of the spectra of aqueous solutions of methyl alcohol, acetic acid, and pyridine over a series of concentrations, and have shown that marked variations occur in the spectra. The phenomena noticed include cases in which some Raman lines of the solute suffer displacements, or broaden or split up into components, or undergo changes in relative intensity.

It must suffice here to mention only the effects observed in acetic acid–water mixtures. These refer principally to the behaviour of the broad line of wave-number displacement 1667 found in the spectrum of pure acetic acid and usually attributed to the C=O bond in the molecule. Slight dilution of the acid to 95 per cent strength introduces a new faint component to this line at 1712 cm.$^{-1}$. The latter is observed to increase in intensity relatively to the first on further dilution to 90 per cent and 85 per cent concentrations. Finally, at 75 per cent, which corresponds nearly to the composition $CH_3 . COOH, H_2O$, only one broad line at 1712 cm.$^{-1}$ is present. Further dilution produced no change, except for a slight sharpening of the 1712 line.

From these observations, it would appear that a hydrate is formed of the composition mentioned. It may be remarked that the acetic acid solutions exhibit a point of maximum density at about the same concentration (77 per cent) at 25° C.

P. KRISHNAMURTI.

210 Bowbazar Street,
Calcutta, July 31.

Research Items.

An Archaic Egyptian Figurine.—M. G. Loukianoff describes and figures in *Ancient Egypt* for June 1930 a rare type of small figurine of ivory, purchased in Cairo in 1927. The figure is one and a half inches high, almost entirely black and remarkably heavy for its size, weighing 12·6 grains. It represents a seated infant with legs doubled back, and, as may be inferred from the inclination of the right arm, which is broken, and a mark on the lips, sucking its finger. The lips are a little twisted, as owing to the position of the finger in front of the mouth, the artist was unable to fashion them with an unbroken stroke. The left hand lies extended along the knee. The head is crowned by a little cap fitting close to the cranium. From the artistic point of view the minute accuracy of the work is to be remarked; while equally characteristic is the cast of the features, which is not Egyptian, the nose being large and the cheek-bones prominent. The attitude of the figure is that which was traditional for the infant Horus from the early dynasties to the decline of Egyptian civilisation. It is the same as that of the lapis lazuli figurines recently found in the tomb of Tutankamen, in which the Pharaoh is represented as the infant Horus. The motive of the present example is so exactly repeated in the alabaster figurine of Pepy II., found last year at Saqqara, that it would suggest an identity of date, if it were not that there is a still closer resemblance to the ivory statuettes of pre-dynastic date discovered by Petrie at Abydos and Ballas. The type is, indeed, very different from that of the early dynasties—a fact which immediately suggested its attribution to the archaic epoch of Egyptian art. It has been examined by Dr. Reisner, who pronounces it authentic and assigns it to Dynasties 0-2.

A Sea-lion Census.—In 1930 a census of the sea-lions off the coast of California was made, in view of the possibility that recommendations to the legislature might be desirable. It was made at the height of the breeding season, from mid-June to mid-July, and although no census was made in 1929, the figures made an interesting comparison with the censuses of the two previous years (Paul Bonnet, *California Fish and Game*, vol. 17, p. 150; 1931). Of Steller's sea-lion, with twelve rookeries the largest containing 2500 individuals, the grand total in 1930 was 6360, against 4593 in 1928 and 5781 in 1927. The California sea-lion, with eleven rookeries of which the largest had 340 individuals, numbered 968 in 1930, 1338 in 1928, and 892 in 1927. The presence of more Stellers in 1930 than in 1928 is attributed to migrations from the north, where the animals are still hunted under a bounty system; while the decreasing population of the California sea-lion is due to the unrestricted collecting and hunting of the previous two years. The casual shooting by fishermen of sea-lions in the neighbourhood of fishing operations does not seem to lower the population to any great extent, but the slaughter due to professional trimming hunters and to collectors who capture living specimens for zoos and circuses is a serious menace, and has brought about the material reduction and even the abandonment of several of the larger rookeries.

***Blepharoceridæ* of Japan.**—This small family of dipterous insects has a very wide distribution, and is remarkable on account of the peculiar morphological characters exhibited in the different post-embryonic stages. The larvæ and pupæ are particularly interesting in that they are aquatic and confined to rapid mountain streams. Until recently, only four species of the family were known from Japan, but neither their larvæ nor pupæ had been discovered. In *Memoirs of the College of Science*, Kyoto Imperial University (Series B, vol. 6, 1931), Mr. Sirô Kitakami describes the results of his researches on this family. His discoveries have led to the recognition of five genera and eighteen species in Japan. Of these, one genus, *Parablepharocera*, and fourteen species are described as being new, the largest number of species belonging to the genus *Philorus*. In the new genus *Parablepharocera*, the adult is distinguished from *Blepharocera* by the much longer vein Rs, and its larva bears a pair of finger-like processes on each side of the first six abdominal segments, together with a pair of caudal appendages. In *Blepharocera*, it may be added, neither type of organ is evident. In the pupal stage the two genera are scarcely separable from each other. The paper is well illustrated with ten plates of carefully drawn figures portraying structural characters of the different stages of the species described.

Chromosome Homologies in Wheat, Rye, and Aegilops.—In a paper on chromosome homologies in wheat, rye, and *Aegilops*, Prof. W. P. Thompson (*Canadian Jour. Research*, vol. 4, p. 624) summarises in a series of tables the results of crosses among members of these three related genera, as regards chromosome pairing in the hybrids. A number of workers have drawn various conclusions regarding the relationships of species from the way in which the chromosomes pair in their F_1 hybrids. In this way it has been concluded that the einkorn (diploid) wheats have an A set of seven chromosomes, the emmer (tetraploid) $A+B$ and the vulgares $A+B+C$; similarly that *Aegilops cylindrica* has $C+D$ sets and *A. ovata* $D+E$ sets. There are, however, difficulties and inconsistencies in the application of these conceptions of chromosome homology, for the cytological results (pairing) do not always agree with the genetical ones. Thus, rye chromosomes are D as judged by their mating in hybrids with *A. triuncialis*, but the genetic characters are not those associated with D. Again, the morphological differences found within the chromosomes do not correspond with their mating peculiarities. Thus, several of the chromosome types in *T. dicoccum* and *T. polonicum* are not found in *T. vulgare*, although every chromosome in these two species finds a mate in crosses with *vulgare*. It is believed that with further work these anomalies will be cleared up, and that the cytological behaviour will throw further light on evolutionary divergence in these forms.

Gyromagnetic Effect for Salts of the Iron Group.—The small spin which a body acquires when it is magnetised is connected closely with the behaviour of the electrons in the atoms in the magnetic field, and it is theoretically possible to decide in certain cases between theories of the action of the field from the *gyromagnetic* effect. This has been done for certain ions of chromium, cobalt, and iron by W. Sucksmith, in an investigation of extreme delicacy which is described in the issue of the *Proceedings of the Royal Society* for September. The salts used have an even smaller susceptibility than dysprosium oxide, the only non-ferromagnetic body which had been studied hitherto, and the angular momenta generated were correspondingly more difficult to measure. The method employed was again that in which a resonant angular movement was set up in an alternating field. The results show that of the various theories which have been advanced, that which supposes the angular momenta of the effective electrons due to their intrinsic spins and their orbital motions to be separately quantised relative to the field axis is the most nearly correct, and further, that the orbital moments may be wholly or partially suppressed by the fields of neighbouring ions. Measurements were also made upon manganese ions, but in this case the conflicting theories all predicted the same result, which was actually obtained.

Reflection of X-Rays.—Some results of much interest in connexion with long X-rays are contained in three papers from Prof. T. H. Laby's laboratory, which appear in the September number of the *Proceedings of the Royal Society.* The first of these, by R. T. W. Bingham, contains a description of the construction and use of a compact vacuum spectrometer; this is of the Seeman single slit type, and was specially designed to give a high intensity of radiation at the photographic plate, together with accurate angular measurements. In the second paper, Mr. Bingham and Prof. Laby describe some investigations on the reflection and diffraction of soft X-rays. They find that these are reflected from surfaces of glass, quartz, and stainless steel at angles very much greater than the critical angle that would be expected theoretically. This fact increases considerably the range of angles for which gratings can be used with this radiation, and has been employed in some new determinations of relative wavelengths. It also permits of focusing of long radiation by a spherical mirror at large angles of incidence. The last paper, by Mr. Mohr, deals with certain details of the total reflection of long X-rays. Within the limits of experimental error, agreement was found between the observed and calculated values of the critical angle, and for the rate of fall of intensity near the critical angle, for the light substances quartz, calcite, and glass, but not for the denser bodies steel, silver, and gold, it being found that increasingly large discrepancies occur with increasing density of the reflector.

Inertia of Loud-Speaker Vibrating Diaphragm.—In addition to the theoretical difficulties of treating the many variable factors involved in loud-speaker design, there are also numerous experimental difficulties concerned in the laboratory measurement of the quantities. Following a treatment (*Phil. Mag.*, **11**, 1-54) of the theory and performance of certain types of modern acoustic apparatus for reproducing speech and music, Dr. N. W. McLachlan has now given an account (*Phil. Mag.*, **11**, 1137-1152) of five methods, each necessitating the measurement of the inductance of a coil situated in a magnetic field, of measuring the accession to inertia of a vibrating diaphragm driven by the reaction between the magnetic field and that of the alternating current in the coil. Three measurements of the inductance are made respectively with the coil fixed, free to move in air of known density and free to move *in vacuo.* In the free condition the value of the inductance depends on the effective mass of the moving system. When vacuum equipment is not available, the necessary conditions for the third measurement can be simulated by removing the diaphragm from the moving coil. Experimental arrangements and precautions necessary to attain accuracy are discussed in detail, and the importance of ensuring that the diaphragm move as a whole is emphasised. The results obtained for a conical diaphragm are in good agreement with those computed from Rayleigh's formula for a rigid disc. It is shown that with a limited size of baffle the accession to inertia decreases with frequency.

Astronomical Topics.

An Interesting New Minor Planet.—On the average three new minor planets are discovered every week, so such announcements are received with equanimity. But when the new object has an unusual rate of motion the case is a little different, for it implies either proximity to the earth or that the body lies on the outer fringe of the asteroid region. *Circular* No. 465 of the Berlin Rechen-Institut announces that a new planet designated 1931 *RA* was found by Herr Reinmuth at Königstuhl, which had the remarkably slow motion of -20^{sec} per day in R.A., and 1′ south in declination; this is slower than the usual rate of the Trojan planets when near opposition, as the new planet was. The motion was verified by another observation two days later. The slow motion may arise either from great distance or from the linear velocity of the planet being nearly the same as that of the earth. In either case the body is deserving of careful observation, so the positions are given as a guide to observers:

	U T.	R.A.	N. Decl	Mag.
1931 Sept.	7^d 23^h $49·1^m$	23^h $38·9^m$	6° 34′	13·7
	9 21 59·5	23 38·2	6 32	

The second observation was a visual one, made by M. Mündler. The observation of minor planets is one of the principal lines of work at Konigstuhl; the earliest image of Pluto that has yet been identified was found on a plate exposed there on Jan. 23, 1914.

Van Gent's Short Period Variable.—Reference has been made in this column to the variable discovered by Mr. H. van Gent in R.A. 8^h $10·6^m$, S. Decl. 18° 45′, with a period of 100 minutes. It was noted that photographic study of the light changes was difficult, owing to the considerable variation during the time of exposure. Mr. Harold L. Alden contributes a paper on the star to *Astr. Jour.* No. 958: the star can be photographed at maximum with 2 minutes' exposure with the Yale 26-inch refractor at Johannesburg. Fifteen plates were taken on 11 nights, giving 56 exposures of the variable. The light range is from 14·05 to 15·12. The light-curve shows an extremely rapid fall after maximum (about 1 magnitude in 7 minutes). The curve is then nearly horizontal for about 40 minutes; the increase of light is fairly uniform for the remaining 53 minutes. In Cepheid variables the increase of light is usually more rapid than the decrease, so that this star differs notably from them.

A New Cluster of Faint Nebulæ.—Quite a number of clusters of faint spiral nebulæ have been detected in recent years. *Astr. Nach.* No. 5815 contains an account by Dr. W. Baade of a new one that he detected on plates taken with the large reflector at Bergedorf Observatory, Hamburg. Its position for the equinox of 1925·0 is R.A. $10^h 54·7^m$, N. Decl. 57° 11′, about half a degree from the star Beta Ursæ Majoris. It extends over a region some 24′ by 17′; the southern part of the region is filled by a densely packed cluster of very faint nebulæ (probably fainter than mag. 17). They are on the limit of visibility, and no structure can be detected. Dr Baade concludes that the nebulæ are considerably more distant than those of the other cluster, also in Ursa Major, that he announced a few years ago.

International Illumination Congress.*

On Sept. 8 the International Illumination Congress proceeded to Buxton, where, on the evening of arrival, there was a demonstration of railway light signals and railway coach lighting at the Buxton railway station. The following day was occupied by a visit to Sheffield, in the course of which numerous local steel works and other places of interest were seen, and an opportunity was afforded of inspecting the Corporation Public Lighting Department, under the supervision of Mr. J. F. Colquhoun. While most of the factories were of considerable technical interest, members were dismayed at the very unsatisfactory lighting conditions prevailing in some of them.

The following day was devoted to sessions at which series of papers on industrial lighting, architectural lighting, the lighting of railways and mines, farm and horticultural lighting, and light sources were read. In the Industrial Lighting Section, Dr. H. Lux (Germany) presented the recommendations of the German Illuminating Engineering Society on this subject, and Herr N. Goldstein and Herr F. Putnoky discussed the lighting of textile mills. A bulky review of current practice in the lighting of factories by gas was presented by the Society of British Gas Industries. Perhaps the most interesting contribution in this section was that by Dr. M. Luckiesh and Mr. F. K. Moss (United States), who made a plea for 'humanitarian foot-candles', that is, the provision of an intensity of illumination beyond the requirements of safety and in excess of demands from the point of view of production.

The section which aroused most interest was possibly that dealing with architectural lighting, on which seven papers were read. Developments in Great Britain were surveyed by Mr. R. W. Maitland and Mr. W. J. Jones, and decorative lighting in France by MM. H. Maisonneuve and J. Wetzel. A paper on "Illumination and Architecture" by Mr. L. Kaeff (Holland) contained some interesting speculations on the influence of climatic conditions on architectural design, and the effect of varied conditions of natural and artificial lighting on shadows cast by embellishments on buildings. The engineering aspects of architectural lighting were dealt with by Mr. W. J. Jones, and researches of a mathematical character were reported by MM. Dourgnon and P. Waguet. These papers gave rise to an interesting discussion, in the course of which the application of laws relating to the illumination derived from a luminous point, a line, and illuminated surfaces were analysed, and views on the best methods of securing the co-operation of the architectural profession in illuminating engineering considered. Interesting information on procedure in the United States, where courses of instruction for architectural students in illumination and, conversely, lectures on architecture for illuminating engineers have been arranged, was forthcoming.

The other papers covered a wide variety of topics. Mr. A. Cunningham outlined the development of lighting on British railways, and discussed such problems as the lighting of platforms, goods sheds, and goods yards, for which tentative standards were suggested and reference made to the use of floodlighting in connexion with shunting operations. Convenient designs for illuminated station name-plates were illustrated. This paper was supplemented by a similar one by M. J. W. Partridge outlining practice on the French railways: in this, further information on the use of floodlighting for the illumination of large open spaces was furnished. Papers on the lighting of mines deplored the very low standard of illumination prevailing and advocated the use of miners' lamps of higher candle-power. The possibility of floodlighting the coal face, by the aid of electric light, was considered. In this connexion data illustrating the influence of conditions of illumination on safety and output in certain mines in Silesia were presented by Dr. L. Schneider (Germany). Mr. W. A. Villers was responsible for a paper on cinema studio lighting, in which the use of incandescent lamps for 'talking' films was illustrated. There were several papers reviewing processes in incandescent lamp manufacture, and comparative data on the qualities of sunlight and artificial daylight. Finally, there was a group of papers, "Electric Light on the Farm" (R. Borlase Matthews), "Plant Cultivation with Electric Light in Sweden", and the "Artificial Lighting of Greenhouses in Germany", all of which illustrated the important part that light may play in connexion with horticulture.

At Birmingham, where the Congress next proceeded, there were interesting visits to local works. That to the glass works of Chance Bros., Ltd., at Smethwick, was notable for some pleasing demonstrations, such as methods of tracing the rays from optical equipment by means of chemical smoke. The experimental lighting in the Hagley Road, where sections are lighted alternately by gas and electricity, was of considerable interest. The papers read at Birmingham were less varied than at Buxton, being chiefly concerned with signalling apparatus. Four papers, all from Japan, described signal systems in use on the Japanese railways and experiments on the production of coloured glasses. There was a good paper by Mr. J. P. Bowen, engineer-in-chief to Trinity House, reviewing the development of lighthouses. Informative contributions by A. V. Blake and W. M. Hampton and E. Schuppen discussed the development of traffic control signals in Great Britain and Germany respectively. The former paper showed how requirements in Great Britain chiefly demand the independent control type of signal, and discussed such technical problems as the best form of distribution curve and the elimination of 'phantom indications' of signals. Herr E. Schuppen studied the use of simultaneous and progressive systems of control in Berlin, the length of individual cycles, and the design of automatic controllers. It is stated that since automatic control has been introduced, 20 per cent more traffic is carried by the same streets in Berlin, and with very much less hindrance.

In the Section on Motor-Car Headlights there were communications from France and Great Britain reviewing recent progress in methods and design. Dr. F. Born (Germany) discussed in considerable detail the basis of an international agreement on motor-car lighting, assuming the provision of two kinds of light, a main beam and an anti-dazzle beam; 100 m. has been proposed as a minimum value for range of the main beam and 25 m. for the anti-dazzle (alternative) beam. Provisions for limiting glare are most easily based upon the illumination at the observer's eye. Suggestions for standardising the various constituent parts were also made. A report from the Japanese Committee on Motor Vehicle Headlights described experiments with the R.A.C. disc and suggested some modification in the test with this apparatus. Other papers treating light distribution and heterochromatic photometery were of a somewhat specialised character, either dealing with the details of photometric processes or recording experiments determining the order of accuracy attainable in comparing sources of different colour. The final day at Birmingham was devoted to a day-trip to Stratford-on-Avon, after which members proceeded to Cambridge.

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* Continued from p. 589.

The meeting at Cambridge was generally regarded as one of the most successful parts of the Congress, and was well attended. In the course of the visit, there were trips to Ely and Peterborough (the latter an evening visit so that the artificial lighting of the cathedral might be inspected) and an address on "The Light of the Stars" by Sir Arthur Eddington. There was also a comprehensive demonstration of anti-dazzle devices by the Royal Automobile Club, which was instructive in demonstrating recent progress in this field. A considerable amount of work was done, sessions being devoted to such matters as street lighting, daylight illumination, nomenclature, definitions and symbols, photometric test-plates, traffic signals, glare, motor-car headlights, photometric accuracy, aviation lighting, heterochromatic photometry, the lighting of schools and factories, etc.—on most of which reports reviewing progress and, in some cases, leading to definite recommendations were presented.

Amongst the numerous points on which decisions were taken the following may be noted. It was agreed that in visual photometry the most accurate measurements are possible with illuminations between 5 lux and 20 lux, and that in the laboratory a mean error of an order not exceeding 0·25 per cent is possible, whilst in commercial work a limit of 3 per cent may be attained. In regard to daylight, the 0·2 per cent daylight factor (at present applied in Great Britain legally in connexion with Ancient Lights cases) was regarded as a minimum—which would be definitely inadequate in the case of work involving much visual discrimination. It was further agreed that a committee should be set up to consider the standardisation of artificial daylight. The Section on Lighting Education formulated many recommendations, such as the inclusion of instruction in illumination at post-primary schools and in architectural colleges, and the organisation of at least one full specialised course in illuminating engineering in each country. In connexion with headlights, the distinction between the 'driving beam' and the 'passing beam' was recognised, and steps to limit glare and ensure adequate illumination were proposed. It is interesting to observe a consensus of opinion that coloured beams of light are of no material advantage in fogs.

Other resolutions related to traffic control and street lighting, a desire for fuller data in regard to the influence of traffic signals on road accidents being expressed. In connexion with street lighting, it was recommended that, in order to facilitate international comparisons, contributors should give (*a*) a description of the fitting, (*b*) particulars of spacing, and (*c*) both average and minimum illumination.

An invitation for the next meeting of the International Illumination Congress to take place in Germany was accepted for 1934, when the president will be Dr. A. R. Meyer.

International Congress for the Testing of Materials.

THE New International Association for Testing Materials held its first congress at Zurich on Sept. 6–11. Although this was the first congress of the New International Association, eleven international congresses on the testing of materials have been held in the past. Ten of these were held by the original International Association which was formed more than thirty years ago under the auspices of Tetmayer and Bauschinger. This Association was broken up during the War, but a new International Association was formed at a congress in Amsterdam which had been arranged in September 1927 by the Dutch Association for Testing Materials. The new Association, although it is continuing the most valuable work of its predecessor, differs from it in many important respects, particularly by being a much simpler organisation, which avoids so far as possible the formation of numerous permanent committees, and also by entirely eliminating all questions of international standard specifications.

The Congress at Zurich was presided over by Prof. A. Mesnager, of the Conservatoire National des Arts et Métiers, Paris, and its work was carried out in four sections, namely: (*A*) Metals, under the presidency of Dr. W. Rosenhain, London; (*B*) Inorganic Materials, stone, cement, concrete, etc., under the presidency of Prof. M. Roš, director of the Swiss Federal Testing Laboratory at Zurich; (*C*) Organic Materials, bitumen, paints, rubber, etc., under the presidency of Prof. Roos af Hjelmsater, Stockholm; (*D*) Questions of General Importance, under the presidency of Prof. Goerens, of Messrs. Krupp. Most of these sections held five sessions, each occupying a whole morning or afternoon and each devoted to the discussion of a single selected subject, upon which a number of reports by experts of international standing were first presented in brief abstract, a general discussion following. The reports were of a very high order of interest and importance, and particularly good discussions took place. The work of the Congress was, throughout, animated by the spirit of international co-operation and friendship, and by the desire of all those taking part to further the common cause of improving our methods of testing and of advancing our knowledge of the properties of materials, upon which satisfactory methods of testing must be founded.

In Section *A*, the subjects discussed were cast iron, notched-bar impact testing, fatigue, materials at high temperatures, and the progress of metallography. In regard to cast iron, considerable divergence of opinion and practice appears to exist, particularly between the French engineers and those of other countries. As a result of the discussion, however, the president of the Section hopes to issue a brief summary acceptable to all those who took part. Such a summary should serve as a guide to those bodies whose business it is to deal with standardisation, both national and international. The same applies to the notched-bar impact test, where the adoption of a standard test piece affording comparable results in different countries is particularly desirable.

In Section *B*, the importance of geological factors in the testing of stone was discussed, and new data on the resistance of road-building materials to shock were presented. Cement testing, concrete testing, and the testing of reinforced concrete were also discussed at length, the latter subject presenting a series of particularly important problems.

Section *C* dealt with the problems of asphalt or bitumen, which has attained so much importance in regard to road construction, and special attention was devoted to the question of nomenclature, upon which international agreement appears to be highly necessary. In regard to the testing of timber, the decisive importance of moisture content on all strength properties was emphasised; it is suggested that consideration of this factor clears up the existing difficulties in the relations between compression, bending, and tensile strength. Questions of ageing of materials such as oils, textiles, synthetic resins, and rubber were also discussed, the importance of temperature, oxygen, and light being considered. A discussion on viscosity brought out a consensus of opinion that the 'poise' should be adopted as the unit of dynamic viscosity and the 'stokes' as the unit of kinematic viscosity. Tables for the conversion of data expressed in other units to this system are to be prepared. Considerable attention was also paid to the question of solid fuels, particularly with regard to the sampling of coal.

In Section *D*, the subjects treated related to the determination of grain size in powdery materials, the calibration of testing machines, and the general conceptions implied by the terms 'elasticity', 'plasticity', 'toughness', and 'brittleness'. A general discussion on the latter question proved of particular interest.

At the opening meeting of the Congress, the delegates of some thirty-four nations made brief speeches in reply to the opening addresses of the president and the representatives of the Swiss Federal Government and of the Canton and City of Zurich; they paid tribute to the early work of Tetmayer at Zurich and to that of his present successor, Prof. Roš, for the great work he had done in the successful organisation of the Congress in his capacity of general secretary of the International Association. Great Britain was represented by Sir Henry Fowler and Dr. W. Rosenhain. The latter, as representative of Great Britain on the Permanent Committee of the International Association, was the bearer of an invitation from the British Committee to the International Association to hold its next Congress in London in 1935. At the final plenary session of the Congress, this invitation was accepted, and Dr. Rosenhain was elected as the next president of the New International Association. It is hoped that the sectional presidencies will be filled as follows: (*B*) Dr. Barta, Czechoslovakia; (*C*) Prof. Suenson, Denmark; (*D*) Dr. G. K. Burgess, director of the Bureau of Standards, U.S.A. The presidency of Section *A* has not yet been filled, but it is hoped that it may be accepted by Prof. Goerens, of Essen.

It is interesting to note that on this occasion, although British participation was not very numerous—some five hundred members attended the Congress, and of these not more than twenty were British—yet the British representatives took a very active and important part in the work of the Congress, and the importance of their work and influence was fully appreciated and is likely to prove of value to British technical and industrial prestige throughout the world.

Association of Special Libraries and Information Bureaux.

THE eighth annual Conference of the Association of Special Libraries and Information Bureaux was held at Lady Margaret Hall, Oxford, on Sept. 18–21, and the attendance and papers presented at the Conference, as well as the discussions, manifested a growing appreciation of the value of such a clearing house for multiplying sources of specialised information both in science and industry. Anxiety regarding the future of the Association in view of its unsatisfactory financial situation, which Dr. R. S. Hutton emphasised at the annual general meeting, appeared indeed rather to intensify the sense of the value of the Association's work, and several speakers at this and other sessions urged the importance of defining more clearly the functions of A.S.L.I.B. so as to prevent undue diffusion of effort.

The need for some such central index and pointer to sources of special information was repeatedly emphasised, and discussions on the Library and Information Departments of the Royal Institute of International Affairs and on the League of Nations and the International Labour Office as sources of information for economic affairs ultimately issued in a resolution urging the Council to promote the effective organisation of some such central index or means of co-ordination. An offer to provide clerical assistance in such a move was made by Mr. B. M. Headicar, of the London School of Economics, and the experience of the groups established during the year in Yorkshire and in Lancashire and Cheshire has indicated the value of local co-operation and contact, as well as central organisation in promoting the rapid exchange of information between members to their mutual advantage.

Special interest was supplied to the opening session of the Conference by a paper in which Prof. A. M. Carr-Saunders analysed some of the problems of professionalism, including professional training and the restriction of entry to professions to which allusion has recently been made in NATURE. State control or interference in professional matters is largely determined by the necessity of maintaining a reasonable standard of competence as in law and medicine, or of securing the public safety as in regulations relating to marine officers. When the contact between the members of a profession and the public is only indirect, as in certain professions the legal restriction of which has been attempted in recent years, it is much more difficult to establish a case for State regulation. The growth of specialisation makes the question of competence much more difficult, and even in the medical profession the question of dealing with or proving incompetence has not been entirely solved.

Prof. Carr-Saunders, pointing out the dangers inherent in registration and professionalism, suggested that as an alternative to multiplication of self-governing professional organisations a wider use might be made of powers obtained under and administered through the Privy Council as a means of maintaining high professional standards. Referring to professional training, Prof. Carr-Saunders stated that in the modern tendency for professional training to be given at the universities, the universities are reverting to their original functions. The development of the Association of Special Libraries and Information Bureaux is an indication of the importance of these questions in regard to librarians and the competent handling of information.

In the session over which Sir Charles Sherrington presided, Mr. E. N. Simon directed attention to the valuable and original scientific information which is now contained in the publications of industrial firms and frequently only available in such literature. In recent years the character of such publications has totally changed, and technical service literature now contains an increasing amount of information and data of direct practical, scientific, and technical value to scientific workers in general and not to research workers in industry alone. Other speakers who confirmed this view directed attention to the difficulty even in industry of rendering such information readily accessible, and the importance of co-operation in making it known, whether through the offices of A.S.L.I.B. or otherwise, was evident.

Sir Frederic Nathan's paper on international abstracting and indexing of scientific and technical literature was a further presentation of the scheme he outlined last year before the Chemical Engineering

Group of the Society of Chemical Industry, which has since been discussed at a special conference on abstracting convened by Mr. H. T. Tizard at the Imperial College of Science and Technology in July, as well as at the recent conference of the International Institut de Bibliographie at the Hague, at which Sir Frederic presented a similar paper. The scheme met with severe criticism on several points, particularly from representatives of industry, and it is evident that the adoption of the Universal Decimal Classification as a basis meets with serious difficulties in the more highly specialised field of industry. Whether the advantages of a universal classification designed to facilitate the correlation of all branches of knowledge outweigh such difficulties in particular and detailed applications is probably a matter for the industries concerned to determine. A system admittedly must represent a compromise. A weakness inherent in Sir Frederic Nathan's scheme is the well-known disparity in the character of the abstracts prepared by different countries, and some limitation of the principle that each country should be responsible for preparing its own abstracts is inevitable, even if only in grouping of the smaller countries. There must be general confidence in the abstracting efficiency of all participating countries if the scheme is to be acceptable generally. Furthermore, translation provides an acute practical difficulty whether the translations are provided by the abstracting country or made in other countries from the abstracts provided. It was further pointed out that it is important that the length and detail of the abstract should bear some relation to the geographical or lingual accessibility of the paper abstracted. Here again we are faced with a question of comparison and of evaluating obvious advantages against serious disadvantages which in practice may or may not outweigh the advantages.

Other papers presented at the Conference included one by Dr. A. Preeder, Director of the Library of the Technische Hochschule, Berlin, describing an ever-ready printed catalogue, and a discussion of the value of films as a medium of information in education, science, and industry by Mr. F. A. Hoare. At the concluding session of the Conference, Dr. E. Shenkman gave an account of the Russian Five-Year Plan in its special relation to British industry and commerce. An exhibition of sound films was given during the Conference by the Western Electric Co.

Birthdays and Research Centres.

Oct. 11, 1864.—Sir **Henry Lyons**, F.R.S., Director of the Science Museum, South Kensington, and formerly Director-General of the Survey of Egypt.

Although only a part of the new Science Museum as planned by the Committee of 1911 has yet been completed, the reorganisation and development of the collections have already occupied several years. They are now being increasingly used by technical visitors and students, as well as by the general public, in large numbers, and they are supplemented at frequent intervals by special exhibitions to illustrate recent developments in various groups.

As soon as the next block of the Museum has been constructed, the representation of current practice in all branches, which is most urgently needed, can be more adequately provided for than is now possible.

Oct. 11, 1875.—Sir **Arthur W. Hill**, K.C.M.G., F.R.S., director of the Royal Botanic Gardens, Kew.

The direction of the affairs of the Royal Botanic Gardens, Kew, covers so wide a range both in the realms of systematic and applied botany and also in the domain of practical horticulture that the Director is unfortunately left with very little spare time for carrying out botanical investigations himself. He is, however, able to suggest to the members of his scientific staff and visiting botanists various problems which come to his notice on which investigation is needed, and for the solution of which Kew affords such unrivalled opportunities. These relate principally to matters of systematic or economic interest which affect botanical or agricultural progress in the Empire.

My own long connexion with Kew gives me the opportunity of noticing many points of great scientific interest urgently in need of investigation, which I seldom have time to study in detail, nor is there any member of the Kew staff who can be diverted from his proper sphere to carry out the necessary research.

Kew is very much in need of the assistance of one or two research students to work in the laboratory, herbarium, and gardens on these many interesting problems: it may be in plant physiology, ecology, or general morphology; and if such posts could be suitably endowed for university graduates, there would be ample opportunity for the research students to work at these problems, since all facilities in the way of living material, laboratory accommodation, our library and herbarium collections, as well as personal direction, are available at Kew.

As an example of what has been done in the past at Kew may be cited the work of Brown and Escombe, Dr. D. H. Scott, and other voluntary research workers.

Oct. 11, 1881.—Dr. **L. F. Richardson**, F.R.S., Principal of Paisley Technical College and School of Art.

The mystery of the connexion between mind and matter may be approached by considering time and intensity. For time and intensity belong both to physics and to psychology, as Fechner emphasised. I have found that the variations in time of mental images can be estimated quantitatively, and that equations describing the time-changes can be fitted to the observations (*Jour. General. Psych.*, April–July 1929).

Another clue to the same problem is suggested by the behaviour of the neon lamp, which in some of its time-relations resembles human behaviour; for example, B. van der Pol's model of the heart (*Phil. Mag.* Suppl., Nov. 1928). Also, I have arranged three neon lamps so that the lighting of any one of them will extinguish any other, just as rival thoughts extinguish each other (W. McDougall's "inhibition by drainage"). Many other analogies between mental images and sparks are collected by me in the *Psychological Review* (May and July), 1930.

Another, and more natural, clue is provided by periodic electrolytic phenomena (E. S. Hedges, Nature, **128**, 398, Sept. 5, 1931).

Oct. 11, 1886.—Mr. **A. C. G. Egerton**, F.R.S., reader in thermodynamics in the University of Oxford.

My immediate interests lie in three directions: (1) researches at high temperatures, 3500° and above; (2) study of processes of combustion; and (3) properties of vapours. The first entails a study of gaseous reactions at high pressures and high temperatures. The second is a continuation of an investigation on the oxidation of hydrocarbons and the inhibition by various substances, such as antiknocks, and has led to a study of the behaviour of the two forms of hydrogen (ortho and para) at surfaces. The third is a continuation of researches on the thermal properties of vapours, an accurate determination of the vapour pressure of steam having recently been accomplished in an apparatus designed by the late Prof. H. L. Callendar at South Kensington.

I am interested in the application of thermodynamical studies to every branch of activity, for example, fuel conservation, heating and ventilating, economical use of heat in chemical processes, etc., and think that more attention should be paid to such studies. In Germany, within the Technische Hochschule at Munich, there is an institute under Prof. Knoblauch devoted to such work, and I should like to see something similar in Great Britain.

Oct. 14, 1891.—JAMES GRAY, F.R.S., University reader in experimental zoology, Cambridge.

A study of the metachronal rhythms of ciliated epithelia has led to an attempt to analyse similar phenomena in muscular systems, and I am at present interested in the mechanical principles underlying the propulsion of fish and of annelid worms, the muscular systems of which exhibit well-defined rhythms. By means of a suitable camera it is possible to record such movements with accuracy.

In association with others, an attempt is being made to analyse the osmotic properties of the membrane which surrounds the egg of the trout. It is now possible to define its permeability to ions with considerable accuracy, but a complete interpretation of the results must depend on the degree to which the membrane is found to be permeable to water.

Oct. 14.—Dr. MARIE CARMICHAEL STOPES, formerly lecturer in palæobotany at University College, London, and at Victoria University, Manchester, fellow of University College, London.

In conjunction with the Coal Research Club, I am continuing to probe into the ultimate nature and composition of the constituents of coal, which affords very complex problems in spite of the great increase in knowledge on all sides in recent years.

As founder and president of the Constructive Birth Control Society and Clinic, I am carrying on research and observation in various aspects of human sex-physiology, and accumulating data about very large numbers of women (approximately 15,000 to date at the Clinic).

In my holidays at Portland, while founding the Portland Island Museum, I am accumulating Cycadoidea and searching for Jurassic Angiosperms.

Societies and Academies.

PARIS.

Academy of Sciences, Aug. 10.—**A. Lacroix**: The recent (June 27, 1931) fall of an asiderite meteorite in the extreme south of Tunis. The term asiderite is applied to meteorites free, or practically free, from metallic iron. The meteorite now described fell near Tatouine and is of Tschermak's diogenite type, only four of which have hitherto been observed.—**Charles Achard, Augustin Boutaric, and Arthur Arcand**: The physical properties of the serum proteins and of the hydropic serosities in lipoid nephrosis. In lipoid nephrosis the colloidal granules of the serum have lost the property of hydration on heating. The same anomaly is shown by the proteins separated from this serum. Hence in this disease there are not only quantitative modifications of the various proteins but also modifications in the physical properties of these proteins.—**D. Belorizky**: The convergence of the series in the solution of the problem of three bodies given by Sundmann.—**R. de la Boulaye and G. Balme**: The velocity of propagation of musical sounds. The velocity of musical sounds in the open air is constant and independent of the frequency, but in a tube of one metre diameter the velocity varies slightly with the frequency. Part of this work was carried out by the late Th. Vautier.—**Pierre Auger and Charles Lapicque**: Variation in the spectrum of the sensibility of cuprous oxide cells. The photoelectric cell used in this investigation consisted of a layer of cuprous oxide on a copper plate, the former being covered by a thin transparent film of metal obtained by cathode sputtering. The maximum sensibility was shown for light of λ5000 A.—**G. Darzens and André Lévy**: The constitution of the methyl ether of butyl-*m*-cresol and of its dinitro derivative, ambrette musk.—**Jean Roche and Albert Bendrihem**: The combination of globin with hæmatins of various origins. Hæmatin extracted from helicorubin, from yeast, or from cytochrome *c* combines with globin, giving a pigment spectroscopically identical with that of blood.—**F. Rathery, Mlles. S. Gibert and Y. Laurent**: The liver and muscle glycogen in the nephrectomised dog.

Aug. 17.—**Camille Matignon**: Commercial nitrates of lime. The author in a recent paper put forward the view that calcium nitrate, now manufactured on the large scale, should not be regarded as a dangerous chemical from the point of view of storage or transport. It only becomes dangerous when heated in contact with a combustible material. An account is given of a recent fire at Oslo, involving 70 tons of calcium nitrate, confirming the author's conclusions.—**L. Blaringhem**: The experimental production of spelt wheats (*Triticum spelta*) starting with a wild plant (*Ægilops ventricosa*).—**Paul Delens**: Affine geometry of congruences of curves.—**Maurice Golaz**: A new principle of hydraulics. This is given as follows: the stable form of flow is that which, under given external conditions, develops the maximum power in the section where parallel flow is established.—**René Dubrisay and René Pallu**: The photochemical oxidation of sulphur. The results of the experiments described by the authors are consistent with the view that the primary product of the oxidation of sulphur by air under the action of ultra-violet light is pentathionic acid. This decomposes readily, giving sulphuric acid, hydrogen sulphide, sulphur dioxide, and sulphur.—**J. Giuntini**: The spectrographic study of the compounds of tartaric acid and copper. The results show that copper tartrate is a salt in which a part of the copper is present as a complex compound. This confirms the results of Darmois.—**Justin Dupont and Jean Jacques Guerlain**. The dry distillation of Peru balsam. The hydrocarbons and phenolic ethers obtained are similar to those obtained by the dry distillation of Tolu balsam.—**André Meyer and Robert Vittenet**: The azo colouring matters derived from homophthalimide.—**Marcel E. Denaeyer**: Director lines and geological evolution of French Equatorial Africa and the Cameroons.—**A. Dauvillier**: Polar auroræ and the cosmic rays.—**Paul Wintrebert and Ouang-Te-Yo**: The digestion *in vitro* of the white and of the gluten of the egg of oviparous plagiostomes (*Scylliorhinus canicula*) by the frontal gland of the embryo.

ROME.

Royal National Academy of the Lincei, March 1.—G. Armellini: The theory of the variability of the family of Mira Ceti. As judged by the eye, the radiation of this star varies in the proportion of 200 : 1 or 100 : 1, whereas measurements with the bolometer or thermoelectric pile indicate the ratio 3 : 1 or 2 : 1. The values generally accepted for its extreme temperatures, namely, 2300° and 1800°, involve a very marked divergence between theory and observation. To obtain calculated results in good agreement with the observations, lower values, namely, 1500° and 1100°, must be adopted for the extremes, but these may give rise to difficulties in other directions. If these values are regarded as inadmissible, the observed phenomena are explainable only by associating the temperature variations with a variation in the atmospheric transparency, in accordance with the veil theory, advanced by Merill and supported by Hopmann.—**Q. Majorana**: New photoelectric investigations. It was found previously that, when light, periodically interrupted, falls on the first triode of an amplifying group, the telephone of the amplifier repeats the sound corresponding with the frequency of interruption of the light. Various new observations, now described, throw some light on this phenomenon.—**Gian Antonio Maggi**: Demonstration of a property pertaining to the theory of the potential function of surfaces.—**G. A. Blanc**: Certain properties of the silica remaining after attacking leucite with acids. A method is described for separating, from the liquid obtained on treating leucite with an acid, the residual silica existing as a colloidal suspension, and an explanation of the phenomena accompanying such separation is advanced.—**L. Petri**: A method for detecting the exceptional presence of mercury in vegetable tissues. The use of mercury salts as an external fungicide for seeds, particularly those of cereals, is followed by absorption by the plant of traces of mercury from the soil, with the result that the functional activity of the plant is stimulated. The presence of traces of mercury in plant material may be detected by treating the plant juices with hot hydrochloric acid and afterwards leaving a piece of silver foil immersed in the solution for some hours. Any slight amalgamation of the silver which occurs is readily revealed either by exposing the foil to iodine vapour or by heating the foil gently before a spectroscope.—**T. Boggio**: Relation between the Riemannian homographs relative to two spaces in conform representation.—**Giacinta Andruetto**: Relation between Riemann's symbols relative to two varieties, one immersed in the other.—**N. Théodoresco**: Dirac's system of equations with partial derivatives.—**Ugo Broggi**: Resolution of algebraic equations.—**R. Calapso**: Synthetic studies of differential projective geometry.—**R. Serini**: Propagation of transverse vibrations in a finite string with resistance of the medium.—**M. Maggini**: A direct method for determining the interferometric λ eff.—**G. Bernardini**: The technique of magnetic spectrographs for slow electrons.—**Paolo Straneo**: The unitary theory of gravitation and electricity. (1) Physico-geometric foundations for a deduction of the equations of the field.—**M. Amadori**: Mercury derivatives of divalent bromophenols. Various mercuric compounds of the di- and tri-bromo-derivatives of pyrocatechol and resorcinol are described. These compounds are formed by the replacement of two hydrogen atoms by one mercury atom, but whether these two hydrogen atoms are both hydroxylic, or one hydroxylic and one united to a carbon atom, is as yet undecided.—**G. A. Barbieri**: Molybdo-octocyanides. On the basis of various reactions shown by the red substances obtained by treating potassium molybdo-octocyanide with hot, concentrated nitric acid, the author does not consider the formula $H[MoO_2(CN)_2.2H_2O]$ suggested for this substance by Bucknall and Wardlaw (1927) to be justified.—**A. Quilico** and **M. Freri**: Azopyrrole blacks (4). Details are given of the experiments on which the results given in note (3) are based.—**L. De Marchi**: Fridtjof Nansen. A memorial notice, containing an account of Nansen's polar expeditions and discoveries.

Official Publications Received.

British.

Proceedings of the South London Entomological and Natural History Society, 1931–32. Pp. xx+94+5 plates. (London.) 10*s.*

The Quarterly Journal of the Geological Society of London. No. 347, Vol. 87, Part 3. Pp. lxv-cviii+375-550. (London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.*

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1376 (Ae. 501—T. 1892, T. 2084): Strength of Wooden Seaplane Hulls (Full-sized Machines—Third Series). By W. C. S. Wigley. Pp. 18+4 plates. 1*s.* net. No 1389 (Ae. 511—T. 3048): The Pressure on the Front Generator of a Cylinder. By Dr. A. Thom. Pp. 14+8 plates. 9*d.* net. No. 1390 (M. 73—A. 65, 74, 92): The Protection of Magnesium Alloys against Corrosion. By H. Sutton and L. F. Le Brocq. Pp. 22. 1*s.* net. No. 1392 (Ae. 513—T. 3064): Accelerations on Aircraft during Manœuvres. By E. Finn and A. E. Woodward Nutt. Pp 5+6 plates. 9*d.* net No. 1393 (Ae. 514—T. 3003): Several Cases of Non-Circular Torsion solved by Analysis and Direct Test. By James Orr. Pp. 21+9 plates. 1*s.* 3*d.* net. (London: H.M. Stationery Office.)

The British Mycological Society. Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 16, Part 1, September 4. Pp. 88. (Cambridge: At the University Press.) 7*s.* 6*d.*

Twelfth Annual Report of the Ministry of Health, 1930-1931. (Cmd. 3937.) Pp. xiv+324. (London: H.M. Stationery Office.) 5*s.* net.

Journal of the Society for the Preservation of the Fauna of the Empire. New Series, Part 14. Pp. 53. (Hertford: Stephen Austin and Sons, Ltd.) 1*s.* 6*d.*

Proceedings of the Royal Society. Series A, Vol. 133, No. A821, September 1. Pp. 350. (London: Harrison and Sons, Ltd.) 18*s.*

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Edited by Dr. Joseph Pearson. Vol 16, Part 2, August 8th. Pp. 115-228+plates 25-42. (Colombo: Colombo Museum; London: Dulau and Co, Ltd.) 3 rupees.

Indian Journal of Physics, Vol. 6, Part 2, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 15, Part 2. Conducted by Sir C. V. Raman. Pp. 81-163. (Calcutta) 1.8 rupees; 2*s.*

British Honduras. Report of the Forest Trust, 1930. Pp. 15. (Belize.)

Scottish Society for Research in Plant-Breeding. Report by the Director of Research to the Annual General Meeting, 30th July 1931. Pp. 26. (Corstorphine.)

The Quarterly Journal of the Geological, Mining and Metallurgical Society of India. Edited by K. K. Sen Gupta. Vol. 3, No. 2, May. Pp. 29-82. (Calcutta.)

Survey of India. Geodetic Report, Vol. 6, from 1st October 1929 to 30th September 1931. Pp. vi+106+lxxiv+34 plates. (Dehra Dun.) 3 rupees; 5*s.*

Foreign.

U.S. Department of Commerce: Coast and Geodetic Survey. Special Publication No. 173: Latitude Redeterminations. By Frederick W. Darling. Pp. iii+19+2 plates. (Washington, D.C.: Government Printing Office.) 10 cents.

U.S. Department of Agriculture. Circular No. 172: The Control of the Lesser Peach Borer with Paradichlorobenzene Solutions. By Oliver I. Snapp and J. R. Thomson. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

U.S. Department of Commerce: Bureau of Standards. Research Paper No 321: Volume Changes in Brick Masonry Materials. By L. A. Palmer. Pp. 1003-1026. 10 cents. Research Paper No. 326: The Freezing Point of Platinum. By Wm. F Roeser, F. R. Caldwell, H. T. Wensel. Pp. 1119-1129 5 cents. (Washington, D.C.: Government Printing Office.)

Ministry of Finance, Egypt: Survey of Egypt: Geological Survey. Miocene Foraminifera from the Clysmic Area of Egypt and Sinai, with an Account of the Stratigraphy and a Correlation of the Local Miocene Succession. By Dr. W. A. Macfadyen. Pp. vi+149+4 plates. (Cairo: Government Press.) 40 P.T

Publications of the Washburn Observatory of the University of Wisconsin Vol. 15, Part 4: Photo-electric Studies of Five Variable Stars. By Joel Stebbins and C. M. Huffer. Pp. 177-213. (Madison, Wis.)

Publications of the Observatory of the University of Michigan Vol. 4. No. 1; The Spectrum of Zeta Tauri. By Hazel Marie Losh. Pp. 27. Vol. 4, No. 2: The Radial Velocity of Beta Librae. By Dean B. McLaughlin. Pp. 29-36. (Ann Arbor.)

Smithsonian Miscellaneous Collections. Vol. 82, No. 11: Recently dated Pueblo Ruins in Arizona. By Emil W. Haury and Lyndon L Hargrave. (Publication 3069.) Pp. 120+27 plates. (Washington, D.C.: Smithsonian Institution.)

University Observatory, Oslo. Publication No. 1: On the Stability of Gaseous Stars. By S. Rosseland. Pp. 50. (Oslo.)

University of California Publications in American Archaeology and Ethnology. Vol. 31, No. 1: Mexican Kinship Terms By Paul Radin. Pp. 14. (Berkeley, Calif.: University of California Press.) 25 cents.

Meddelande från Lunds Astronomiska Observatorium. Ser. 1, No. 126: Über die Formanderungen der Sonnenkorona im Verlaufe des 11-jährigen Zyklus. By Walter E. Bernheimer. Pp. 19 Ser. 2, Nr. 59: On the Statistical Corrections in the Comparison of Magnitude Stars. By Sture Holm. Pp. 25. (Lund: C. W. K. Gleerup.)

Conseil Permanent International pour l'Exploration de la Mer. Journal du Conseil. Rédigé par E. S. Russell. Vol. 6, No. 2, Août. Pp. 17+175-354. (Copenhague: Andr. Fred. Høst et fils.) 4.50 kr

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 109: The Citrus Twig Gum Disease in Egypt. By Dr Ing. Ahmed Sirag-el-Din. Pp. ii+63. (Cairo: Government Press.) 5 P.T.

Catalogues.

Catalogue of Scientific Journals and Transactions of Learned Societies, including a Selected List of Scientific Works. (S.S. No. 2.) Pp. 16. (London: Oppenheim and Co, Ltd.)

Classified List of Second-hand Scientific Instruments. (No. 100, Centenary edition.) Pp. vi+58. (London: C. Baker.)

Diary of Societies.

FRIDAY, October 9.

Royal Society of Medicine (Clinical Section), at 5 30.

Malacological Society of London (at Linnean Society), at 6.—E. Ashby: Notes on Chitons from Port Alfred, South Africa, collected by Lt.-Col. W. H. Turton during 1930.—A. E. Ellis: A Reclaimed Saltmarsh.—G. C. Robson: Further Observations on the Distribution of *Cochlicella acuta*.—L. R. Cox: *Sycostoma* a renamed Genus of Lower Tertiary Gastropoda.—H. B Moore: The Systematic Value of a Study of Molluscan Fæces.—R. Winckworth: Notes on *Nucula nitida*.—Lt.-Col. A. J. Peile: Some Notes on Radulæ.

Oil and Colour Chemists' Association (Manchester Section) (at College of Technology, Manchester), at 7.—J. Barker: The Transference of Colour Processes from Laboratory to Works (Lecture).

Manchester Association of Engineers (at Engineers' Club, Manchester), at 7.15.—C. E. Stromeyer: Presidential Address.

Junior Institution of Engineers, at 7.30.—E. D Gill: Office Engineering.

Keighley Textile Society (jointly with Keighley Association of Engineers) (at Queen's Hotel, Keighley), at 7.30.—G. A. Rix: Faraday's Life and Work.

Institute of Metals (Sheffield Local Section) (jointly with Sheffield Society of Engineers and Metallurgists) (in Applied Science Department, Sheffield University), at 7.30.—Dr. W Rosenhain: Gases in Metals.

Institution of Production Engineers (at Society of Motor Manufacturers and Traders, 83 Pall Mall) (Annual General Meeting), at 7.30.—J. G. Young: Distribution and Production.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—D. M. Wilson: The Manufacture and Testing of Asphalt Paving Material.

Royal Society of Medicine (Ophthalmology Section), at 8.30.

Oil and Colour Chemists' Association (Manchester Section) (at College of Technology, Manchester).—J. Barker: Transference of Colour Processes from Laboratory to Works.

MONDAY, October 12.

Institute of Metals (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7 30.—L. Short: Some Random Reflections on Industrial Problems and Economics

TUESDAY, October 13.

Society for the Study of Inebriety (at Friends' House, Euston Road), at 4.—Viscount Brentford: How the Alcohol Question concerns the Duties of the Home Office (Norman Kerr Memorial Lecture).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5 30.—H. L. Allen: Sweating of Paraffin Wax.

Institute of Marine Engineers, at 6.—D. MacNicoll: Safety Valves.

Institute of Metals (Swansea Local Section) (at Y.M.C.A., Swansea), at 6.15.—A. M. Kempson: Chairman's Address.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—H. J. Burkill: Plant Galls: More Galls to be looked for.

Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Section) (at Borough Polytechnic), at 7.—E. M. Ackery: Thermal Storage for Central Heating.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—J. W. Craggs: Chairman's Address.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.30.—Dr. C. D Darlington: Microscopic Studies of the Mechanism of Heredity.

Institution of Welding Engineers (North-Western Branch) (at College of Technology, Manchester), at 7.30.—L. B. Wilson: Application of Resistance Welding.

Royal Anthropological Institute, at 8.30.—Miss Winifred Blackman: Medicine and Magic among the Egyptian Fellaheen.

WEDNESDAY, October 14.

Institution of Engineering Inspection (at Royal Society of Arts), at 5.30.—P. R. Coursey: Some Applications of Condensers to Electric Power Circuits.

Newcomen Society for the Study of the History of Engineering and Technology (at Science Museum, South Kensington), at 5.30.—H. W. Dickinson: Jolliffe and Banks, Contractors; also other Papers.

THURSDAY, October 15.

Optical Society (at Imperial College of Science), at 7.30.

Chemical Society, at 8.—E C. S. Jones and J. Kenner: The Interaction of 2:6-dichloro-4-methylquinitrol with Methyl and Ethyl Alcohols.—H. D. K. Drew, F. W. Pinkard, W. Wardlaw, and (in part) E. G. Cox: The Structure of the Isomeric Platinous Diammino Chlorides. Discovery of a Third Isomeride.—H. D. K. Drew, F. W. Pinkard, and W. Wardlaw: The Structure of the Simple and Mixed Plato Tetrammine Dihalides.—A. P. T. Easson and Prof. F. L. Pyman: Amidines of Pharmacological Interest.

Royal Society of Medicine (Neurology Section), at 8.

Royal Society of Tropical Medicine and Hygiene (at London School of Hygiene and Tropical Medicine), at 8.15.—W. H. Gray and Dr. J. W. Trevan: Experiments on Antimony Compounds used in the Treatment of Bilharzia and Kala-azar

Institute of Brewing (Midland Counties Section) (at White Horse Hotel, Birmingham).—S. Myer: The Season's Hops.

Institute of Brewing (North of England Section) (at Midland Hotel, Manchester).—W. J. Watkins: Notes on Enclosed Wort Refrigeration. Part II

Institute of Brewing (Yorkshire and North-Eastern Section) (at Queen's Hotel, Leeds).—E A. Braithwaite: Stainless Steel and its Practical Application

Royal Aeronautical Society.—H. Sutton: The Protection of Metals in Aircraft Construction.

Institution of Welding Engineers (at Institution of Mechanical Engineers).—E. B. Partington: Autogenous Welding of Lead and its Alloys, Ancient and Modern.

FRIDAY, October 16.

Physical Society (at Imperial College of Science), at 5

Institution of Mechanical Engineers (Special General Meeting), at 6.—Approval of Draft By-Laws.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow), at 7.15.—J. Bird: Presidential Address.

Junior Institution of Engineers, at 7.30.—C. C. Berger: The Characteristics of Commercially Pure Iron.

Nelson Textile Society (at Nelson Technical College), at 7 30.—J. Loxham: Wonderful Products from Coal.

Royal Society of Medicine (Obstetrics and Gynæcology, Medicine, and Psychiatry Sections), at 8.15.—Discussion on Medical Indications for Premature Termination of Pregnancy.

North-East Coast Institution of Engineers and Shipbuilders (Annual General Meeting) (at Literary and Philosophical Society, Newcastle-upon-Tyne).—J. McGovern: Presidential Address.

PUBLIC LECTURES.

SATURDAY, October 10.

Royal Institute of British Architects, at 3.—C. Williams-Ellis: Architecture? What's the Use?

Horniman Museum (Forest Hill), at 3.—Miss M. A. Murray: Egyptian Beliefs in the Hereafter.

MONDAY, October 12.

University College, at 5.—Dr. R. J. Lythgoe: The Physiology of the Sense Organs. (Succeeding Lectures on Oct. 19 and 26 and Nov. 2, 9, and 16.)

Royal Anthropological Institute (at University College), at 5.30.—The Marquess of Zetland: The Races and Cultures of India: India Past and Present.

University of Leeds, at 8.—Prof. A. Gilligan: The House we Live in.

TUESDAY, October 13.

University College, at 3.—Prof. B. Ashmole: Greek Sculpture.

London School of Hygiene and Tropical Medicine, at 5.—Sir George Newman: The Rise of Preventive Medicine (Heath Clark Lectures). (Succeeding Lectures on Oct. 15, 16, 20, and 22.)

Bedford College for Women, at 5.15.—Miss Hosgood: The Geography of Cities.

University College Hospital Medical School, at 5.15.—Prof. J. C. G. Ledingham: Resistance to Infection, Natural and Induced. (Succeeding Lecture on Oct. 20.)

King's College, London, at 5.30.—Sir Bernard Pares: Russian History to 1861: Country and Peoples.

University College, at 5.30.—Prof. K. Buhler: Theory of Language and Psychology of Speech. (Succeeding Lecture on Oct. 15.)

British Institute of Philosophy (at University College), at 8 15.—Sir James Jeans: The Mathematical Aspect of the Universe.

WEDNESDAY, October 14.

Royal Institute of Public Health, at 4.—Sir Ernest Graham-Little: The Health of the London Citizen.

London School of Economics, at 5.—Dr. R. S. Williams: The Production, Distribution, and Nutritional Value of Milk. (Succeeding Lectures on Oct. 21 and 28.)

King's College, London, at 5.30.—Prof. E. V. Appleton: James Clerk Maxwell.

University College, at 5.30.—Dr J. Needham: Speculation, Observation, and Experiment, as illustrated by the History of Embryology. (Succeeding Lectures on Oct. 21 and 28 and Nov. 4.)

THURSDAY, October 15.

London Hospital Medical College, at 4.15.—Prof. A. J. Hall: Chronic Epidemic Encephalitis (Schorstein Memorial Lecture)

King's College, London, at 5.—Dr. J. A. Hewitt: Metabolism of the Carbohydrates and Fats. (Succeeding Lectures on Oct. 22 and 29 and Nov. 5.)—At 5.30.—Dr. Eveline Martin: West Africa of To-day: The Entrance to British West Africa; the West Indies and the Gambia.

University College, at 5.—Prof. E. A. Gardner: Poet and Artist in Greece.

FRIDAY, October 16.

University College, at 5.—Dr. L E. Bayliss: The Respiratory Functions of the Blood. (Succeeding Lectures on Oct. 23 and 30 and Nov. 6.)

Institution of Electrical Engineers, at 5 30.—E. C Crittenden: The Measurement of Light: its Basis and its Significance. (Succeeding Lectures on Oct. 21, 23, 26, and 28.)

SATURDAY, October 17.

Royal Institute of British Architects, at 3.—H. S. Goodhart-Rendel: Some Opinions upon Furniture and Decoration

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Success and Failure in the Animal World

CENTENARY.

Friday, October 9.

Michael Faraday Centenary Celebration (in City Hall, Newcastle-upon-Tyne), at 7.—Dr. W. M. Thornton: Faraday and his Successors—the Growth of an Idea.

NATURE

SATURDAY, OCTOBER 17, 1931.

CONTENTS.

PAGE
Prevention of Atmospheric Pollution 649
Electric Pendulum Clocks. By C. V. Boys, F.R.S. . 651
Fluid Motion 654
Applied Entomology. By A. D. I. 655
Short Reviews 656
Population and Production. By Prof. Edwin Cannan 658
The Recorded Data of Science 662
Cancer Research 664
Obituary :
Dr. Joan B. Procter. By E. G. Boulenger . . 664
Sir Gregory Foster, Bt. By E. D. . . . 665
News and Views 666
Letters to the Editor :
The 'Lapides palmati' mentioned in the "Historia Naturalis" of the Elder Pliny.—Dr. Kenneth C. Bailey 672
Eclipse Plumage in the Mallard.—Violet K. Tallent 672
Change of Density of Carbon Disulphide with Temperature.—Dr. J. Mazur 673
Deep-Focus Earthquakes.—Rev. V. C. Stechschulte, *S.J.* 673
A Counting Device for Use with the Geiger Counter.—Dr. J. C. Jacobsen 674
Effect of Light on the Surface Tension of Boys's Soap Solution.—Dr. P. Lecomte du Noüy . 674
Fine Structure in the Arc Spectra of Indium and Thallium.—Dr. A. L. Narayan . . . 675
The Magneto-Electric Saturation Effect.—Dr. O. E. Frivold and Sture Koch . . . 675
Electric Circuit Breaker Research.—E. B. Wedmore, A. M. Cassie, and W. Bevan Whitney . 675
Research Items 676
The British Heavy Steel Industry 678
Applied Chemistry in Technical Colleges . . . 678
A Monument to Henri Moissan 679
Universal Decimal Classification 680
The Behaviour of Electrolytes in Solution . . 680
University and Educational Intelligence . . . 681
Birthdays and Research Centres 681
Societies and Academies 682
Official Publications Received 683
Diary of Societies 683

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Prevention of Atmospheric Pollution.

FROM time to time abnormal visitations like the heavy fog in the valley of the Belgian Meuse, Dec. 3–5, 1930, resulting in sixty-five deaths, emphasise the dangers of atmospheric pollution. Although John Evelyn, writing in 1661 in "Fumifugium"—the first smoke abatement pamphlet—clearly portrayed the noxious effects of an impure atmosphere, efforts at smoke abatement have not progressed at anything approximating to the rate at which sources of contamination have multiplied during the last two centuries.

In the Meuse fog tragedy, the evidence indicates that the poisonous fumes from industrial chimneys which became imprisoned in the fog were mainly responsible for the casualties. Similarly, Dr. Turner attributes the fog catastrophe in the industrial region south of Luttich to the presence in the atmosphere of fluorine compounds—hydrogen fluoride, silicon fluoride, or possibly silicofluorohydrins—from some industrial process.

It is only under abnormal atmospheric conditions when the scavenging of the air by turbulence is reduced that the menace to health which the emission of poisonous industrial fumes represents is clearly demonstrated. The aggregate number of annual deaths of both young and old which can be definitely attributed to the filthy atmosphere in our smoke-ridden towns is very much greater than those associated with such exceptional conditions. The increase in mortality rates from pneumonia, bronchitis, and other respiratory diseases associated with every spell of foggy weather, and the acceleration of invalidism and death owing to the acid condition of the atmosphere and the exclusion of direct sunlight, pass almost unnoticed, although John Evelyn's comment is as pertinent now as in Restoration times: "The consequences then of all is, that . . . almost one half of them that perish in London dye of phthisical and pulmonic distempers: that the inhabitants are never free from coughs and importunate rheumatisms, spitting of impostumated and corrupt matter: for remedy whereof, there is none so infallible, as that, in time, the patient change his Aer, and remove into the country".

Litigation concerning the Barton power station near Manchester has directed attention to the dangers of the emission of fumes as distinct from smoke. The remarks of the judges in this case appear to have had salutary effect and roused authorities in time to the importance of the new power stations consuming their own smoke. Not only has an eminent architect, Sir Gilbert Scott, been consulted on the design of the huge producing plant at the new Battersea station, but as a result of scientific research new methods of treatment of the fumes have been devised by Dr. G. L. Pearce and his assistants, which ensure the ready conversion of the sulphur dioxide into sulphuric acid or other products which are easily removed. The Minister of Transport has stated that as a result of the precautions, on which the Electricity Commissioners have insisted, only a negligible amount of sulphur will be emitted.

The problem of reducing or preventing the emission of smoke from factories is relatively simple, being mainly economic. Corrosion of plant and buildings and the heavy expense of cleaning and maintenance, which are the direct result of the deposition of a corrosive mixture of soot, tar, mineral ash, and sulphurous acid from the atmosphere, are rapidly impressing on industry the economic advantage of eliminating the pollution at its source. The realisation that smoke is largely the result of inefficient combustion has led to a widespread application of the principles of fuel technology in industry, which have already materially reduced the proportion of industrial smoke, and for many industrial purposes coke and other forms of smokeless fuel are largely used in place of raw coal.

The progress made in smoke abatement in regard to industry, and the fact that the most dangerous atmospheric impurities are derived from industrial sources, tend to obscure the importance of the domestic factor. By far the greater proportion of atmospheric pollution as smoke comes from the domestic sources in consequence of our preference for the open coal fire. In London and Glasgow, domestic fires, for example, account for 75 per cent of the deposited solid matter. Unfortunately, the minimising of smoke emission from such sources is a much more difficult problem, and scarcely capable of legislative control.

As the latest report of the Standing Conference of Co-operating Bodies for the Investigation of Atmospheric Pollution under the scheme organised by the Department of Scientific and Industrial Research indicates, however, owing to the importance of the domestic factor, further progress in the improvement of atmospheric conditions in many of our large towns is largely conditioned by the extent to which gas, electricity, or smokeless fuel replaces raw coal for heating in the house. Much more might be done in this field, particularly in regard to local housing schemes. The importance of the domestic factor renders it highly desirable that 'garden suburbs' and similar schemes should not involve a continuous extension of the radius of serious atmospheric pollution. Houses in such schemes might be wholly or mainly equipped for heating by methods other than that of burning raw coal.

The prevention and control of atmospheric pollution in its range and complexity is characteristic of those modern problems which require the leadership of science for their solution. The production of a satisfactory smokeless fuel is still in an experimental stage, although such fuels as coalite have already met with a certain amount of public approval. The production of these fuels at a popular price has yet to be achieved, and its possibility is openly challenged in some quarters. It will at best in part be determined by the value and successful exploitation of the by-products of the low temperature carbonisation process, especially the tar oils. The successful utilisation of the large quantities of such tars which would be available if the low temperature carbonisation fuels absorb any considerable proportion of the domestic market is a major industrial and scientific problem. Equally complex is the reaction on the coal industry of a large demand for the grades of coal used for such carbonisation processes, and a concurrent reduction in the demand for high grade house coal.

The whole problem is intricate and in every aspect demands the application of scientific methods, if the necessary elasticity and balance are to be obtained. In few fields could premature legislation have a more mischievous effect. Since April 1927 the Department of Scientific and Industrial Research has been responsible for co-ordinating observations of atmospheric pollution all over the country, and for the prosecution of research into the nature of this pollution, and of the best methods for measuring it. An Atmospheric Pollution Research Committee has undertaken a fairly extensive programme of research, and investigations on the lateral distribution of atmospheric pollution which are being carried out at Norwich have attracted particular attention.

There are indeed only three places in England and Wales with populations above one quarter of a million which do not appear on the list of co-operating bodies undertaking the investigation of atmospheric pollution. These are Bristol, Nottingham, and West Ham. The absence of Nottingham from the list gives pertinence to the record in the annals of Dunstable (quoted by Shaw and Owens in "The Smoke Problem of Great

Cities ") that, in the year 1257, Eleanor, Queen of Henry III., was obliged to leave the town of Nottingham, where she had been sent to stay during the King's absence in Wales, and removed to Tutbury Castle instead, owing to the smoke of the sea coals.

Apart from direct research on atmospheric pollution, scientific workers are making important contributions, as already indicated, in fuel technology and research, including methods for the precipitation and combustion of smoke particles as emitted, the design of new industrial plant, and the control of industrial processes. The efficient application of the results of research in this field largely depends on them. Suggestions for the improvement of industrial processes, especially the elimination of noxious vapours, are mainly due to their observations and investigations. Their participation in the educational campaign that is required should assist the removal of prejudices and correct the extravagant statements which are frequently made on behalf of new products. Observations made in their private capacity when adopting the smokeless methods of heating will materially assist in the improvement of the quality of the smokeless fuels or types of electric or gas fires in use. Progress in domestic heating can be greatly accelerated by scientific co-operation along such lines, and if such co-operation were more widely established a salutary check would be available on the activities of those who, by offering inferior smokeless fuel to the public, are prejudicing its sale. From every angle the prevention of atmospheric pollution is one that demands the support of all scientific workers, and not the least important contribution they can make is that of example.

Electric Pendulum Clocks.

Electric Clocks. By F. Hope-Jones. Pp. xv + 261. (London: N.A.G. Press, Ltd., n.d.) 12*s.* 6*d.* net.

THE fact that there is a foreword by the Astronomer Royal is the best evidence that this is a serious work. The Astronomer Royal indicates that it is characteristic of the author in manner and style, as I shall have occasion to do in this notice. I have at once discarded the customary third person and have begun in the first. When dealing with the later portion of the book, which relates to matters which I have followed so closely throughout their progress, any attempt to discuss the matter and express my own views and those of others would lead to too great a complication, if the conventional third person were to be used.

Let me at once say that the author writes as the 'high priest' who knows that his religion is the only true religion and his faith the only true faith: from one end of the book to the other he preaches the one doctrine as to the way to follow to attain the perfect clock; all other ways are vain, and lead, if not to perdition, to less perfect results. Like St. Athanasius, his faith is clear and emphatic, and the conclusion of 'St. Hope-Jones' is like that of his predecessor and in almost the same words, " This is the clock faith: which except a man keep faithfully he cannot be safe ". There is, however, this difference, that whereas the faith of St. A. requires much practice before it can be believed properly, that of 'St. H.-J.' appeals directly to reason and is quite easy to believe the first time. In fact, with thed amnation clause somewhat tempered, I am prepared to subscribe to it myself.

The title appears to me slightly misleading. An electric clock which vies in accuracy with the most perfect clock known, to which the whole book leads up, is not even mentioned. This is the quartz crystal clock perfected by Mr. W. A. Marrison, of the Bell Telephone Company's research laboratory, without which the real perfection of the champion clock would not and could never be known. A correct title would be " Electric Pendulum Clocks ", that is, clocks depending on gravity, as distinct from electric clocks with balance wheel control, which, if they exist, are quite unimportant, and from the quartz crystal clock which depends on the electro-mechanical properties of the crystal and is independent of gravity. It is this final comparative check on the going of *the* champion clock (Shortt) described in March last by Prof. E. W. Brown and Mr. Dirk Brouwer at the Royal Astronomical Society, of which publication has only recently taken place, that has shown the high-water mark of performance which has been reached. Mr. Hope-Jones may well be proud of the very important share that he has had in the development of an electric pendulum clock of unapproached perfection.

Mr. Hope-Jones traces the history of electric clocks from the earliest by Wheatstone and Bain, and his account is the more valuable because not only has he the whole history at his finger-ends, but also he brings to bear his very complete understanding of the conditions of success, which have made the synchronome and the Shortt clocks what they are, to examine critically the designs of earlier clocks. The peculiarity of the electric clock is that as soon as a student or a mechanic has learned about an electric circuit, an electromagnet, and a contact, he straightway invents an electric clock. As we are told, he is probably entirely ignorant of what has been done, of what is wanted, and of the precautions necessary if all the pitfalls are to be avoided. Proposals for electric clocks are as the sand on the seashore. A minute fraction of these have ever seen the light, but these still are legion. Those who remember the electric experiments that we used to make fifty to sixty years ago will realise at once one of the many causes of failure. The lightest contact of a platinum wire backed by the 'current of one Daniel cell' was found to respond, but except for the purpose of a temporary experiment, it would inevitably fail if it were depended on for continued service. Eighty-six thousand four hundred of such contacts every day, day by day and year after year, were impossible and useless, and it is very difficult for those conducting electrical experiments in these days with new materials and lots of volts to visualise the early conditions. Take, for example, the success of the Strowger system (to mention only one) for automatic telephones, where every call requires the faithful response of a very large number of contacts; such would have been impossible with the delicate means available for early inventors.

One of the points insisted upon by the author, not once but all the time, is that an electric contact in an electric clock must be almost of a violent kind; it must at least be very firm, to be any good, and he gets this by using the contact as the operative pressure point, so that hesitation is impossible. The light and hesitating contact invariably fails. It was no doubt the experience of repeated failure in one electric clock after another that led Lord Grimthorpe to his adverse opinion. Those who knew him will remember that he, too, had very definite views on clocks and bells and architects and things, and that he never seemed shy of expressing himself very definitely. Mr. Hope-Jones quotes these passages from his well-known book, "Clocks, Watches and Bells": "These clocks never answered in any practical sense, nor would anything but the strongest evidence, independent of the inventor, convince me that any independent pendulum directly maintained by electricity can succeed in keeping good time for any considerable period. . . . And anyone who sets to work to invent electrical clocks must start with this axiom, that every now and then the electricity will fail to lift anything, however small."

Well, this was a proper and natural conclusion at the time, and when Lord Grimthorpe showed me his gravity escapement regulator in the late 'seventies, that was, in his opinion, the last word in clock design. Jumping, then, the whole history of electric clocks in the interval, it is interesting to find the electric clock on a pinnacle of perfection such as we now see.

It would be tedious, even were space available, to refer chapter by chapter to the author's account of all the clocks discussed. It will be more useful to pick out a few examples which have an interest of their own or which mark steps on the road to the Shortt clock.

One of the early attempts to make a high precision clock was that by Sir David Gill at the beginning of the present century. He aimed at a free pendulum maintained at a uniform temperature and low pressure. The free pendulum was nursed by a slave pendulum of rather less period, which was released by an electric contact following the impulse on the free pendulum and then caught and held until it was released again. Sir David showed me the clock in its place at the Cape Observatory and spent a long time going into the details. I did not like the idea of the slave pendulum being arrested every two seconds and then starting again. Any slave clock should be a complete going clock, but it was difficult to criticise an instrument so dear to the heart of that delightful man. I felt that there were so many things to see to, that it would be a full-time occupation for an attendant to keep it in order.

The first slave pendulum clock which was a complete clock that I ever saw was that shown by Mr. C. O. Bartrum at a meeting of the Physical Society in or about 1914. Here the free pendulum sent a synchronising message to the slave every minute instead of every two seconds, while on the other hand the slave with a somewhat clumsy lost-time device sent an impulse message to liberate an impulse lever to keep the free pendulum going. Mr. Bartrum's ideas were good but his technique was poor, and this is severely criticised by the author.

We learn from Mr. Hope-Jones that the first free pendulum was one described by R. J. Rudd in the *Horological Journal*, 1898, 1899, but important as his contribution was, he did nothing with it. However, it is interesting to know that Mr. Hope-Jones acquired Rudd's clock and presented it to the Science Museum at South Kensington.

Early in the present century, Sir Henry Cunynghame made a number of experimental clocks. His aim was, as Airy's had been long before, to maintain the oscillations of a seconds pendulum by means of a chronometer escapement acting on the pendulum at the middle only of its swing. The escapement was placed at the lower end of the pendulum, a position advantageous for operation but decidedly inconvenient. Mr. Hope-Jones and Sir H. Cunynghame collaborated, and the outcome of this was a sort of combination of a most important prior invention of Mr. Hope-Jones, which he had described in 1895, and some of the features of Sir H. Cunynghame's clock. The important invention referred to was the use of the electrical contact to transmit mechanically a strong impulse, thus ensuring unfailing action. Further progress found the impulse operation removed from the lower end of the pendulum to a point near the upper end. Another important feature was the introduction of a count wheel which allowed an impulse to be applied every thirty seconds only, and the synchronome clock as we have known it for so long as a most successful instrument came into being. In this the Hope-Jones articles of faith are all to be found with another of his really beautiful mechanical devices, the form of ratchet drive by which all the dials operated by the master clock make their half-minute jumps without the possibility of overshooting or failing. They are not silent, and an irritable listener in a bedroom might want to throw a boot at the dial.

The synchronome system has been so great a success that the author may well congratulate himself that he was not discouraged by Lord Grimthorpe but went his own way. He may also congratulate himself in that it is the synchronome clock on which Mr. Shortt has grafted his invention. Mr. Shortt has a free pendulum in a nearly vacuous case—which should be deep underground but never is—subject to an impulse every half minute. The impulse lever is liberated by a slave clock which is a synchronome master clock, and the impulse lever, after acting on the free pendulum, drops and makes a firm contact which resets the impulse lever through the intervention of an inertia piece, and it also sends a current to the hit-and-miss device which keeps the synchronome pendulum in exact step. This latter device is most fascinating to watch, and people are apt to think that that is all that Mr. Shortt has done. The author shows what a long series of devices Mr. Shortt experimented with before he got his inertia delay action to ensure good contact and the right phase. Not the least important feature in the Shortt clock is the unfailing accuracy of response of the half-minute time signals to the position of the free pendulum. A mere contact operated by a slow-moving wheel would be quite useless except for rating over long periods. The lever actually dropped after its impulse on the free pendulum indicates the time correctly to a thousandth of a second at least, as proved by the operation of the Loomis spark chronograph, and if the hundred and twenty records in an hour are taken the time is known to the ten-thousandth.

The marvellous improvement in timekeeping effected by the Shortt clock was first recognised by the Astronomer Royal for Scotland. Shortly after, the Astronomer Royal at Greenwich found that it left all other clocks far behind, but neither of them had the means for ascertaining the full perfection of the clock. For these means the world is indebted jointly to Mr. Loomis of Tuxedo Park, New York, and to Mr. W. A. Marrison, already mentioned. Mr. Loomis obtained in the year 1928 three Shortt clocks and set them going in a constant temperature enclosure, and I had the good fortune to assist him in setting up the first. Owing to the uniformity of temperature in the clock room (±0·02° C.), these clocks have a better chance of proving their value than many others; but even though they might go better, the degree of perfection indicated in the analysis by Prof. E. W. Brown (of Yale) and Mr. Dirk Brouwer could never have been ascertained without the ceaseless record of each clock every half minute by the Loomis spark chronograph. Even so, the perfection of going could not be known without the use of the quartz clock in New York connected by private wire with Tuxedo, forty miles away. The quartz clock 'ticks' 100,000 times a second, and 1000 time signals a second are sent by it along the line. These are made to actuate the spark arm and the motor which feeds the paper of the spark chronograph. When in the United States, I had the opportunity of meeting Mr. Marrison and hearing from him the whole story of his quartz clock, and of seeing it, in so far as it is possible to see anything. Mr. Marrison's account of this research, published by the Bell Telephone Co. the following year, appears to me to be of such outstanding interest that the Physical Society of London might well reprint it, with Mr. Marrison's permission.

Now the degree of perfection to which I have been leading up is no less than the certain observation of a six-hourly fluctuation of rate of the pendulum clocks under the influence of the moon's gravity. This is vouched for by Prof. Brown and Mr. Brouwer, and it needed the unvarying rate of the quartz clock and the thousandth of a second accuracy of each record of each clock every half minute to bring this out. At the latitude of Tuxedo the calculated accumulated error of a pendulum clock at lunar six o'clock is $-0{\cdot}000153$ sec. as compared with lunar noon and midnight, and this is certainly shown by the clocks. There are, of course, other effects of the moon, but the agreement between the gravitational disturbance of the clocks observed and calculated leads the authors of the paper to conclude that these others very largely neutralise one another. They give the following way of realising what the figures mean. "The same effect would be produced if the clocks were given a vertical oscillation with a semi amplitude of 2·5 inches and with the same period. An amplitude of 1 inch could be detected in a month's observations."

This is such a triumph that the four who have made it possible—Hope-Jones, Shortt, Loomis, and Marrison—might well believe that the limit has been reached, and rest; but it is certain that none of them will. C. V. Boys.

Fluid Motion.

(1) *Handbuch der Experimentalphysik.* Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 4: *Hydro- und Aerodynamik.* Teil 1: *Strömungslehre und allgemeine Versuchstechnik.* Herausgegeben von Ludwig Schiller. Bearbeitet von J. Ackeret, A. Betz, J. M. Burgers, A. Busemann, H. Falkenhagen, H. Mueller, H. Peters, L. Prandtl, H. Schmiedel, O. Tietjens, W. Tollmien. Pp. xii + 730. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 68 gold marks.

(2) *Mécanique des fluides.* (Cours de l'École Nationale supérieure d'Aéronautique.) Par Prof. Henri Villat. Pp. vii + 175. (Paris: Gauthier-Villars et Cie, 1930.) 50 francs.

(3) *Elementary Applied Aerodynamics.* By T. G. Whitlock. Pp. viii + 242. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 12*s*. 6*d*. net.

(4) *Flow and Measurement of Air and Gases.* By Alec B. Eason. Second edition, thoroughly revised. Pp. xii + 254. (London: Charles Griffin and Co., Ltd., 1930.) 20*s*. net.

THE study of fluid motion, both theoretically and experimentally, has made rapid progress during the last two decades. On one hand, the general recognition of the laws of dynamical similarity has led to a better appreciation and to a closer co-ordination of the experimental results, and on the other hand, the introduction of certain simplifying assumptions by Prandtl has led to a development of hydrodynamic theory which is remarkable both for the width of its applicability and for the accuracy of its predictions. The study of the boundary layer by theoretical analysis and by a highly developed experimental technique has explained many phenomena of fluid motion which were hitherto obscure, and the extension of the conception of a perfect fluid to include the possibility of circulation round a body, accompanied by a system of trailing vortices, has led to successful theories of the behaviour of the wings and propeller of an aeroplane.

(1) This collective work gives an excellent account of the present position of the theory of fluid motion and of the experimental methods which have been developed for studying the motion. From this wealth of material it is perhaps invidious to choose individual items for special mention, more particularly since different readers may be mainly interested in the development of the theory, in the relationship between theory and experiment, or in the experimental technique.

A brief introductory article by Prandtl precedes a long section by Falkenhagen in which are developed the fundamental equations of fluid motion and those special conceptions which are necessary for the comprehension of the subsequent articles. Vortex motion naturally occupies a prominent position, whilst other items of special interest are the theory of Bjerknes' pulsating spheres and the full account of the various attempts to calculate the viscous drag of a sphere, including Goldstein's recent extension of Oseen's solution. Two articles by Tollmien on the boundary layer theory and on turbulent motion give a clear insight into the theories which have been developed from Prandtl's fundamental conceptions, and they provide a valuable review of the position which has been reached in this branch of aerodynamics. The boundary layer theory is now firmly established, and it has the merit that it advances without any empirical aids other than the fundamental conception that the action of viscosity is confined effectively to a narrow layer round a body and to its wake. The theory of turbulent motion, on the other hand, is developed by statistical and semi-empirical methods the validity of which is more open to question, and, although Prandtl's conception of a *Mischungsweg* has led to several interesting and valuable developments, the precise significance of this length is still rather obscure. The theory of the motion of a compressible fluid is also less highly developed, but Busemann gives a clear account of the subject and of the methods of investigating the compression waves which occur when the speed of a body through the fluid exceeds the speed of sound.

The sections dealing with experimental technique explain very thoroughly the measurement of pressure and velocity, and their value is enhanced by the clearness of the illustrations. Remarkable progress has been made in the technique of studying the details of the motion in the narrow confines of the boundary layer, and in the methods of making the flow pattern visible and of recording it photographically. These developments are described in Burgers' article on the hot-wire anemometer, which explains the theory and use of the instrument, and in Tietjens' account of various methods of studying and recording the flow pattern.

(2) This book is of a purely theoretical character and its aim is to develop in a precise form the fundamental theorems of hydrodynamics which constitute the basis of modern theories of fluid motion. M. Villat achieves this object in a clear and concise manner, but it is perhaps to be regretted that he has not found space to include a discussion of Prandtl's theory of the boundary layer. The development of the Kutta-Joukowski theorem, which is the basis of the theory of aerofoils in two dimensions, is perhaps the most interesting feature of the book, owing to the discussion of the singularities which arise when the theorem is applied to a straight line, to the explanation of the paradoxical results derived when the theorem is applied without due care, and to the extension of the theorem to a cylindrical body with isolated point vortices in the surrounding fluid. Other novel features are the proof of Kármán's expression for the drag due to a vortex street and the treatment of the problem of discontinuous flow.

(3) Textbooks of aerodynamics are few in number and generally assume an advanced knowledge of mathematics in the reader. Mr. Whitlock has now written an elementary book which forms a very good introduction to the subject. From the nature of the book it is necessary to accept many results without proof, but the author has succeeded in explaining in a simple manner the theories of the aerofoil and airscrew, the methods of estimating the performance of an aeroplane, and the factors which govern its stability. An occasional looseness of expression may be forgiven, but Mr. Whitlock has fallen into a serious error in introducing the moment coefficient and centre of pressure, owing to uncertainty in his convention of signs. It is regrettable also that he has used an old standard atmosphere, which was replaced by the present international standard some ten years ago.

(4) The fourth book, intended for practical engineers, is of a very different character, and deals mainly with the flow through pipes and the operation of pneumatic tubes. Mr. Eason appears to have read a vast number of original papers and to be acquainted with the latest theories of fluid motion, but he makes no serious attempt to analyse his material critically. A large part of the book consists of a succession of brief notes on the original papers, without any discrimination between experimental results which are old or new, good or bad, fundamental or trivial. The book undoubtedly contains much useful information, but one is left with the feeling that Mr. Eason has devoted too much energy to collecting the material and too little to writing the book.

Applied Entomology.

A History of Entomology. By Prof. E. O. Essig. Pp. vii + 1029. (New York: The Macmillan Co., 1931.) 42*s.* net.

THIS well-produced volume, replete with information and references, is in some ways both unique and exhaustive. Within a compass of rather more than 1000 pages there is related practically everything that is worth recording, and also much that is trivial, respecting the rise and development of applied entomology in the State of California. The point of view of the book is, therefore, essentially western American. The author explains this in the preface, partly on the ground that the historical growth of the subject is much less known in the west than elsewhere in the United States. California has kept well to the fore in applied entomology, and is one of the most highly progressive States of the Union in this respect. This, however, scarcely justifies the disconcerting title borne by the book, and the absence of any sub-title which might proclaim its actual scope.

Prof. E. O. Essig is a leading entomologist in the New World, and the volume before us bears the impress of his characteristic thoroughness and intimate knowledge of his subject. Of the ten chapters into which his book is divided, it will suffice to refer to the more important only. Chap. v., which deals with the injurious insects and mites occurring within the confines of the State in question, amounts almost to a manual on the subject, in its completeness and extensive bibliographies. Chap. vi., which is concerned with biological control, constitutes an authoritative detailed record of the many experiments undertaken in California. This State, it may be added, was the first to apply biological control on a commercial scale. Chap. vii., on insecticides, describes their history and methods of application, and will interest those specially concerned with this branch of insect control. The longest chapter in the book is Chap. ix., "Biography", which runs to just over 270 pages. It includes biographies of most North American leaders in entomology, besides a fair number of Europeans. The latter, however, form rather an odd assortment of names, and their sole connexion with California is often on the strength of having described species that occur within the confines of its territory.

The final chapter (Chap. x.) is a tabular chronological series of dates showing the development and progress of entomology in relation to history and other sciences. Commencing with the birth of Columbus (1446 ?), it carries us finally into the year 1929. A great deal of painstaking research must have been involved in ascertaining and correlating all the dates and events that are recorded. It is, however, often difficult to discriminate in these tables between events and incidents of obviously different values, and many seem to be of rather local interest. In conclusion, it may be said that the scope of this volume embraces much of North American applied entomology. We think that its chief value will be as a reference book, which economic workers will need often to consult, since it is a veritable mine of information difficult to obtain elsewhere. A. D. I.

Short Reviews.

The Poetic Impression of Natural Scenery. By Dr. Vaughan Cornish. Pp. vii + 90 + 4 plates. (London: Sifton Praed and Co., Ltd., 1931.) 6*s.* net.

In this little volume, dedicated to the Earl of Crawford and Balcarres, president of the Council for the Preservation of Rural England, Dr. Vaughan Cornish treats us to a succession of word pictures of homeland and foreign scenes, arranged in three chapters: i. Watching the Seasons; ii. To the Hills; iii. Across the Ocean. There are four beautiful photographs: The Breaking Wave; Bad Weather among the Mountains; The Rushing Torrent; The Placid Lake. The spirit of the book may best be given in the fine words of the author's preface: "The physical features of the landscape are but the warp of the garment of beauty in which the world is clad, the weft is woven by the changing light which sweeps o'er hill and dale. I have watched these varied incidents in many lands, and as the years roll on, the beauty of the Natural Scene makes an ever-deepening impression on my mind, until in later life the transient harmonies of light and landscape are not only the revelation but the image of eternal values."

Here Dr. Vaughan Cornish, a scientific observer, comes prominently to the fore as a poet and nature-mystic, a dual capacity which is happily becoming easier to adopt in these days when the old hard and fast distinctions between the different spheres of reality are tending to break down. At any rate, we strongly recommend the book to all who feel that there is more in a landscape with all its moods and expressions than can be reduced to purely physical terms; to all who if they were told that the difference between the mountains, let us say, when they have withdrawn into themselves asleep in the tranquil haze of fair weather, and the mountains when they are looming forth, glaring at one another in a stormy light, belonged entirely to the 'subjective' realm, would answer with calm assurance that this only begged the question, shifting it further back.

L. C. W. B.

Dixième Conférence de l'Union Internationale de Chimie, Liége, 14-20 septembre 1930. Rapports sur les hydrates de carbone (glucides). Pp. 287. (Paris: Union Internationale de Chimie; London: Hachette and Co.; H. K. Lewis and Co., Ltd.; David Nutt, 1931.) 50 francs; 9*s.*

This publication affords in a convenient form a really valuable collection of eleven papers dealing with various aspects of the chemistry of carbohydrates. These were read at a discussion which took place at Liège, in September 1930, during the tenth conference of the Union Internationale de Chimie. The wide range of the field of chemistry here concerned, its theoretical and technical importance, and the international character of the contribution under notice become evident from a mere glance at the list of contents. The papers deal with the history of monosaccharides (Bertrand), the ring structure of carbohydrates (Haworth), correlations of optical rotatory power and structure (Hudson), mutarotation (Lowry and Smith), starch (Pictet), structure of polysaccharides (Karrer), molecular weight of complex polysaccharides (Pringsheim), X-ray studies of polysaccharides (Mark), the relationship between the properties and applications of cellulose (Heuser), cellulose and its derivatives as colloids (Duclaux), and the relationship of the physical properties of artificial silk to the raw material and the methods of preparation (Viviani).

The publication calls for a cordial welcome, with one qualification: namely, that "the horrible nomenclature of a biochemical committee of the Union"—to quote the justifiable description of Dr. E. F. Armstrong—has been adopted, according to which carbohydrates are called 'glucides', and mono-, di-, and poly-saccharides disguise fair nature under the name of 'holosides'. Fortunately, 'silicides' had already been appropriated!

J. R.

Voice and Personality. By Prof. T. H. Pear. Pp. x + 247. (London: Chapman and Hall, Ltd., 1931.) 10*s.* 6*d.* net.

Prof. Pear has a place of his own among contemporary psychologists. His mind does not work on orthodox academic lines, and his writings are all the more refreshing on that account. Armed with his psychological equipment, he attacks such problems as remembering and forgetting, work and play, and study—topics that appeal to the whole educated public. In the present volume he brings together the results of preliminary research on a subject neglected by the ordinary systematic psychologist. the subject of voices, and of their significance as expressive of personality. Anyone who has had experience of interviewing candidates, or who has tried to analyse the secrets of success on platform or in pulpit, is aware of the subtle effects of voices; and in our time, broadcasting, the sound-film, and the gramophone specially suggest the study of voices.

We do not wonder, therefore, that the subject has occurred to Prof. Pear as an interesting and promising field of research. He would be the last to claim that this piece of pioneer work takes us very far, and he would be the first to insist that, as is usually and properly the case with pioneer efforts, he raises far more problems than he solves. That he has written an interesting book on an elusive subject there can be no doubt.

Gmelins Handbuch der anorganischen Chemie. Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. System-Nummer 59: *Eisen.* Teil A, Lieferung 3. Pp. 314-586. 40 gold marks. Teil B, Lieferung 3. Pp. 513-656. 24 gold marks. (Berlin: Verlag Chemie G.m.b.H., 1930.)

The third section of Part A of the volume on iron opens with a discussion of passivity, of which a comprehensive review has been attempted. Then follows the corrosion of iron, chiefly under the influence of aqueous solutions. The compilers apologise for any shortcomings in dealing with corrosion, which they ascribe to a certain lack of co-ordination between the work of different investigators in this field. The latter half of the section deals with the technical production of cast-iron and of wrought-iron. A valuable feature is the inclusion of a list of patent specifications, which will be of great use to those who are engaged in the industry.

The third section of Part B deals particularly with the carbonyls, carbonates, acetates, and derivatives of other organic acids, including the ferro- and ferri-cyanides, the complex cyanides alone occupying 100 pages.

Organic Chemistry for Medical, Intermediate Science and Pharmaceutical Students. By Prof. A. Killen Macbeth. Second edition. Pp. xiv + 296. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 6*s.* 6*d.*

In its second edition Prof. Macbeth's book has been revised and expanded from 235 to 296 pages, and extra chapters have been inserted on unsaturated hydrocarbons and urea and its derivatives; apart from these changes, the features of the original edition of 1920 have undergone no alteration which calls for comment. In his prefatory remarks the author expresses his opinion that the inclusion of descriptive experimental work in a theoretical text-book is of very doubtful value; many teachers will maintain, however, that the dependence of theory upon experiment cannot be over-emphasised in an exposition of this subject.

The book affords a clear and logical presentation of the fundamentals of organic chemistry which will appeal to the beginner, particularly if he leave for a second reading such topics as the synthetic uses of acetoacetic ester, the ethylene isomerism, space formulæ of sugars, γ-fructose, and the molecular structure of starch.

Annales de l'Institut Henri Poincaré: recueil de conférences et mémoires de calcul des probabilités et physique théorique. Vol. 1, Fasc. 3: *Quelques problèmes de mécanique quantique,* par M. Born; *Quelques propriétés d'une équation aux dérivées partielles hyperbolique,* par Marcel Brillouin; *Sur quelques problèmes non résolus de la physique mathématique classique, Propagation de la fusion,* par Marcel Brillouin. Pp. 205-308. (Paris: Les Presses universitaires de France, 1931.) 35 francs.

The third fascicule of volume one of the *Annales* of the Henri Poincaré Institute is devoted to the lectures given at the Institute by Prof. M. Born and by Prof. M. Brillouin in 1929 and 1930. Prof. Born deals with quantum mechanics, using the matrix method to show, for example, how naturally the statistical interpretation of quantum mechanics may be developed, how it may be applied to the disintegration of the radioactive atom and to the difficult problem of the width of spectral lines, which has recently been dealt with by his pupil Dr. V. Weisskopf. Prof. Brillouin directs attention to the difficulties in the way of solutions of the problems of the motion of a uniform ocean acted on by a periodic force, and of the propagation of solidification within the crust of an otherwise molten earth. Neither problem has yet been solved satisfactorily.

Helgoland und die Zerstörung seiner Felsküste durch das Meer. Von O. Pratje. (Geologische Charakterbilder, herausgegeben von Prof. Dr. K. Andrée, Heft 38.) Pp. 15 + 12 Tafeln. (Berlin: Gebrüder Borntraeger, 1930.) 24 gold marks.

The assurance of geographers that Heligoland is bound to disappear by marine abrasion was used by Lord Salisbury in defence of its retrocession to Germany in exchange for the growing asset of the extending Tana delta. The coastal features of Heligoland are illustrated in this brochure by photographs of the picturesque stacks and natural arches, of the plane of marine denudation, of the undercutting of the cliffs and its acceleration by the effect of organisms, and of the faults in the Triassic rocks. One plate shows views of one place before and after a large rock fall. Each illustration has an explanatory title in English as well as the fuller description in German.

Population and Production.*

By Prof. Edwin Cannan.

The economic history of the last hundred years began with developments which threw great discredit on the fundamental assumption of the old school, that the extension of human occupation of land necessarily meant that less fertile and less well-situated land must be occupied as numbers grew. It was easy for men who saw arable cultivation creeping over barren hills in England and stony 'bogs' in Ireland to believe in that theory when Chicago was a collection of Indian huts and Broadway, New York, a rough cart track to a farm, but the application of steam to ships and railways enabled mankind to extend easily over an immense area of land more fertile than much of what was occupied before. As for situation, not only did the improvement in transport, coupled with the violations of natural geography involved in the cutting of the great ship canals, bring the 'more distant' lands nearer the 'market', but it also eventually brought 'the market' to the 'more distant' lands.

Later in the hundred years, scientific discovery in various directions has led to a complete change of emphasis in regard to the importance of what the old economists used to call 'improvements'. Modern science has changed our outlook. We set no bounds to the possibilities of improvement. We expect to make unwholesome areas healthy, and to modify vegetable as well as animal products so that they will better serve our needs. We smile now at the suggestion made from the presidential chair of the British Association in 1898, that very soon the world would be suffering from a shortage of wheat.

Thus, even if we still expected population to increase very rapidly, we should not believe, as J. S. Mill did, that it "everywhere treads close on the heels of agricultural improvement, and effaces its effects as fast as they are produced" ("Principles", Bk. 4, ch. iii. § 5). But, in fact, Cotter Morison's cry, made only a generation ago, that all would be well if only we could stop for a few years "the devastating torrent of babies" now seems grotesque, for we do not now expect rapid increase of population to continue much longer, even if it becomes progressively easier to obtain subsistence.

The approach of reduction in the rate of growth of population began to show itself in England in the second half of the 1871–80 decade, when the annual number of births became nearly stationary after the rapid increase recorded down to 1876. But the public takes little notice of the supply of people furnished by the births. Just in the wooden way in which illiterate farmers and unbusiness-like old ladies look at their balances at the bank, so the public looks at the censuses. The census of 1881 showed an increase of 14·36 per cent in the decade, which was higher than that shown by any of the censuses except those of 1821 and 1831, which were probably unduly swollen by the diminishing incompleteness of the enumerations. In 1881–91, in spite of high emigration, the rate of increase only dropped to 11·65 per cent, so rapid increase of population was still regarded as the normal thing which everyone should expect.

I had noticed, however, that the old rapid increase in the annual number of births seemed to have come to an end, and, working on the ages of the people as recorded in successive censuses, I put before Section F of the British Association, at its meeting in Ipswich in 1895, a paper (afterwards published in the *Economic Journal* for December in that year) in which I estimated the number of persons who would be living at each census up to that of 1951 on the assumptions that migration, mortality, and—not the rate—but the absolute number of births remained stationary. I found that on these hypotheses the population of England and Wales would stop increasing during the present century, and would have only a trifling increase after 1941.

Hostile critics derided what they called my "prophecy", and for some time events were unfavourable to me. Emigration fell off enormously, mortality decreased, and the births increased slightly, so that the census of 1901 showed an increase of 12·17 per cent in the decade, the absolute increase of three and a half millions being the largest recorded. But the situation was not fundamentally altered, since the increase of births was due entirely to the drop in emigration, which had caused a larger proportion of persons of parental age to remain in the country. In the *Fortnightly Review* of March 1902, I returned to the charge with an article on the "Recent Decline of Natality in Great Britain", in which, using a method of weighting the annual numbers of marriages by their proximity to the births recorded for each year—a method which seems to have been beneath the notice of the mathematical statisticians of that period—I was able to show, I think, conclusively, that the number of children resulting from each marriage was falling steadily and rapidly, and insisted with more emphasis than before on the "considerable probability of the disappearance of the natural increase of population—the excess of births over deaths—in Great Britain within the present century".

The decade 1901–11 was indecisive; the ratio of increase was smaller than in any of its ten predecessors, but the absolute amount of increase just topped that of 1891–1901, and the number of births until 1908 or 1909 seemed to indicate some recovery of natality. But this was illusory. Even before the War the births had got down again to the level of 1876. The War sent them tumbling down to about three-quarters of that number, and now, after a wild but very short-lived recovery when the Army returned from abroad, they seem inclined to settle at the War figure—three-quarters of the number attained more than fifty years ago, when the total population was twenty-six millions instead of forty millions, as it is now. The ratio of births, legitimate and illegitimate, to my weighted figure of marriages which was just over 4½ fifty years ago, fell gradually and steadily to 3¼ before the War caused it to collapse.

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* From the presidential address, entitled "The Changed Outlook in Regard to Population, 1831–1931", to Section F (Economic Science and Statistics) of the British Association, delivered in London on Sept. 25.

Diminution of infant mortality mitigates the effect of decline of natality, but the degree in which it can do so obviously decreases as the rate of infant mortality falls. When that rate is 500 per thousand, as it probably was in England in the reign of Queen Anne, and may be still in great parts of Africa, a cutting down of births by 25 per cent can be counteracted completely by a drop of one-third in the infantile mortality rate. But when the infant mortality rate is down to 100 per thousand, it would have to fall to nothing at all in order to counteract a decline of only 10 per cent in the number of births. In fact, the rate has fallen in England and Wales from about 140 to about 70 in the fifty years from 1881, and this drop to one-half only balances about one-fifth of the decline in the number of births.

Though there were eminent dissentients only a few years ago, statisticians are now agreed that, in the absence of some great and unexpected change, the increase of population in England and Wales will come to an end at a very early date. Even the lay public has been to some extent enlightened and rather shocked by the recent census announcements that the population of Scotland has actually decreased in the ten years, and that of England and Wales has increased only 2,061,000, as against 3,543,000 in the ten years from 1901 to 1911, though the emigrants have been 324,000 less.

The same change is observable in some degree in other western European countries and our own oversea offshoots. The cause of it—birth control—will doubtless in time affect the rest of the world, so that while we may expect considerable increase—even an increase much more rapid than at present owing to decrease of huge infant mortality—to take place among the more backward peoples for another half-century at least, there is no reason whatever for expecting the population of the world to " tread close on the heels of subsistence " in the future, even if it may be correctly regarded as having done so in the past.

This change in our expectations involves many changes of emphasis, both in the theory of production and in that of distribution. Two of them are perfectly obvious. First, the need, which J. S. Mill and most of his contemporaries and immediate predecessors felt so strongly, for insisting on the due restriction of population, has completely disappeared in the western countries. Economists do not now require to talk as if the first duty of men and women is to refrain from propagating their race. Secondly, the need for insisting on the desirability of saving has become less pressing. A rapidly increasing population requires a rapidly increasing number of tools, machines, ships, houses, and other articles of material equipment in order merely to maintain without improving its economic condition, while at the same time the maintenance of a larger proportion of children renders it more difficult to make the required additions.

There are, however, other changes of equal importance which are more likely to be overlooked. One is in regard to the weight which we attach to the different kinds of production. In the middle of the eighteenth century ' subsistence '—and what we should consider a very coarse and inadequate subsistence—probably seriously deficient in vitamins, appeared so much the most important economic good that the French *économistes* insisted on calling all labour which did not get something out of the soil *stérile* or barren ; and our own Adam Smith, with all his common sense, while admitting the manufacturing class into the ranks of ' productive ' labourers, insisted on excluding domestic servants, physicians, guardians of law and order, and all other workers who did not make up material objects, or who were not employed for profit (he never was quite sure which criterion he meant to stand by). The great Christian philosopher, Paley, believed that nothing more than a " healthy subsistence " was required for perfect happiness.

All this emphasis on food is now out of date. We no longer look forward to a future in which an increasing population will be forced by the operation of the law of diminishing returns to devote a larger and ever larger proportion of its whole labour force to the production of food. We know that even in the past, with a rapidly increasing population, the returns to agricultural industry have increased so much that civilised mankind has been able to feed itself better and better, while giving a smaller and ever smaller proportion of its whole labour force to the production of bare subsistence ; and we can reasonably expect that the increase in the productiveness of agricultural industry will be at least as great in the future, so that under the combined influence of the " narrow capacity of the individual human stomach " and the stationary number of stomachs, not only a smaller and ever smaller proportion but also a smaller and smaller absolute number of workers will be able to raise food for the whole.

Even the politicians, who for the most part follow the economists with a sixty or seventy years' lag, are beginning to realise the change, and are losing their enthusiasm for schemes for " settling more people on the land ", either in colonies or at home, and thereby increasing the already excessive depreciation of agricultural compared with manufactured products. The numerous subsidies which they still give to agriculture are mostly of an eleemosynary character intended to relieve distress, and the encouragement which they give to agricultural production is only an incidental effect, unintended and often deplored. They are defended, not on the ground that they increase food, but because they are supposed to increase employment.

The necessary change of emphasis applies not only as between food and other things, but also as between most primary and most finishing industries. In face of rapidly growing knowledge and slowly growing or stationary population, it is inevitable that the ' staple ' or ' heavy ' industries which provide materials should decline relatively to those which provide finished goods and services. The demand for each of such things as pig-iron and yards of cloth is easily satiated; and so also is the demand for cricket-bats and chauffeurs. But the minor or 'lighter' industries are susceptible of an indefinite multiplication which makes the demand for their products, taken as a whole, insatiable. Increase a person's power of spending, and he will not increase his purchases in weight or bulk so much as in refinement of form, so that a richer people will devote a less proportion of their labour to producing things like pig-iron and bricks. Moreover, the mere fact of the disappearance of rapid increase of population tends to increase the proportion of demand which can be satisfied from scrap without fresh primary production. So, given a stationary population with rapidly increasing knowledge applied to production, we may expect the already observable tendency towards a less proportion of the whole labour-force being employed in the 'heavy industries' and a larger in the lighter industries to become more pronounced. Perhaps we see this even now in the slight drift of industrial population from the north to the south of England which appears to be taking place.

Another change of emphasis, of little importance on the Continent, where the West-Ricardian theory of rent never took real root, but of great importance in England and other English-speaking areas, is in respect of the landowners' share of the community's income. The disappearing bugbear of diminishing returns carries away with it the vampire rural landlord, who was supposed to prosper exceedingly when diminution of returns made food scarce and dear. The famous passage in which J. S. Mill described the landlords as they appeared to him and the school which he, a little belatedly, represented is well known:

"The ordinary progress of a society which increases in wealth is at all times tending to augment the incomes of landlords; to give them both a greater amount and a greater proportion of the wealth of the community, independently of any trouble or outlay incurred by themselves. They grow richer, as it were, in their sleep, without working, risking, or economising" ("Principles", Bk. 5, ch. ii. § 5).

Perhaps the disciple went a little beyond his master, Ricardo, in asserting so roundly that in a prosperous society the landlords must tend to get a larger and ever larger *proportion* of the whole income, but there can be no doubt that this was the impression which the Ricardian school conveyed to the public, and which formed the foundation for Henry George's scheme of land nationalisation and the agitation for land-value taxation. If the school had only meant to teach that the land became more valuable absolutely—in the sense of being worth a larger absolute amount of commodities rather than a larger proportion of all the commodities and services constituting the community's income—they could not have supposed land so peculiar, since it would share this characteristic with many other things—with anything which was more limited in supply than the generality.

To grasp the completeness of the change of view which has taken place in the last hundred years, we must notice that Mill and the whole school which he represented were thinking not of the few lucky landlords who have inherited land which has been selected by Nature or accident as the site of a city, but of the ordinary rural agricultural landlords. So far have we moved that the land-value taxers of to-day quite cheerfully propose to exempt all 'purely agricultural value' from the imposition which they advocate.

Envy of the happy owners of such urban land as rises in value more than enough to recoup what they and their predecessors in title paid in road making, sewering, and other expenses of 'development' plus loss, if any, in waiting for income, still plays a part in contemporary politics, but the economist foresees that there will be at any rate less of such rise of value when the adult population ceases to increase and the demand for additional houses and gardens consequently disappears. He realises that if any such rise continues, it will be due to the people being not only able, as they doubtless will be, to occupy a larger area with their houses and gardens, but also desirous of doing so. He will think this quite possible, but will not be confident about it, when he reflects that the vast spread of 'villadom' may be only a temporary phenomenon, and that the married couples of the future, childless or with small families, may be more content with flats in towns and little bungalows with tiny curtilages right in the country.

The disappearance from economic theory of the picture of the vampire landlord taking an ever-increasing proportion of the whole produce of industry, which was itself decreasing per head of workers, leaves the theoretical arena open for discussion of the sharing of the whole produce between earnings of work and income derived from possession of property of all kinds.

As to this, the economists of a hundred years ago had nothing to say. The socialists, who followed them in fact the more closely the more they denounced them, failed completely to clear up the confusion, and it dominates the mind of the lay public even now—much, I admit, to the discredit of the economists, who should have taught that public better.

While there are no statistics on the subject worth much, and none covering any considerable area either of place or time, past history is sufficiently known to assure us that increasing civilisation has, in fact, made the aggregate share of property grow faster than that of labour, the obvious cause of this being that useful things constituting property have grown faster than population, and so much faster that what decline of the rate of interest has taken place has not been sufficient to counteract the tendency.

There is nothing to show that this tendency will be either reversed or intensified by a cessation of the growth of population. The cessation will, of course, tend to reduce the desirability of additional equipment; a large part of the additions of the past have been required simply to enable the additional people to be provided with tools, houses, and other instruments of production or enjoyment. But additions to equipment will be made with less sacrifice of immediate enjoyable income than before, so that the increase of quantity may be sufficient to counteract the decline in the value of the units. Moreover, it is quite impossible to say what the tendency of invention may be in the future—whether to enhance or to diminish the value of additional material equipment.

The history of the last hundred years suggests that this question of the division of income between property and labour is losing whatever importance it possessed. The economists and socialists of a hundred years ago were little removed from the time when it was common to talk of ‘ the labouring poor ’, as if society was fairly sharply divided into poor workers on one side and rich owners of property on the other. How innocent the mass of the people were of the crime of owning anything may be realised if we recall that none of the agencies with which we are familiar for enabling them to invest had then got beyond the embryo stage. Friendly societies, co-operative societies, building societies, savings banks, are all modern growths.

The present position is that, while many of the working-class have become property owners, many of the propertied class have become the paid servants of public companies and other institutions. Hence the old sharp distinction between the wage-earner and the capitalist is become a thing of the past, and the division of income between property and labour is no longer a division between two classes composed of different individuals, but a division between two sources of income largely possessed by the same individuals.

Thus, in distribution, emphasis on the old categories of land, capital, and labour is rapidly becoming obsolete and is being replaced by emphasis on individual riches and poverty, however arising. It is no longer the lowness of standard earnings that worries the philanthropic economist, but the fact that so many people are unable to rank themselves among recipients of those wages. Emphasis is on unemployment.

Unemployment is not really a very modern phenomenon. But, so far as I know, it has never been contended that history shows unemployment to be greater when population (or even population of working age) is rapidly increasing. Yet it is common to talk of ‘ the difficulty of providing employment for a rapidly increasing population ’, and some eminent authorities quite recently endeavoured to console the public by alleging that the coming decline in the growth of numbers will greatly alleviate the present situation in regard to unemployment.

I believe this to be a profound error, based on an elementary misconception of the origin of demand. The old proverb “ With every mouth God sends a pair of hands ” is true and valuable, but no more so than its converse, “ With every pair of hands God sends a mouth ”. The demand for the products of industry is not something outside and independent of the amount of products. The demand for each product depends on the supply of products offered in exchange for it, and the demand for all products depends on the supply of all products. Consequently, there is not the slightest danger of the working population ever becoming too great for the demand for its products taken as a whole.

Unemployment arises not from insufficient demand for the products of industry as a whole, but from the number of persons offering to work in particular branches of industry being in excess of the number admissible, having regard to the conditions and wages which are required to satisfy both the would-be workers who are unemployed and the persons already in employment. If the unemployed will not take what employers would offer them, the case is simple, and it is only a little more complicated if they are willing to take, and the employers are willing to give, something less than what is paid to the persons already employed.

Now one of the commonest causes of such a situation is a falling off of demand for the products of a particular branch of industry. The fact that the demand for any product, let us say coal, for example, falls off, is a good reason for fewer persons being employed in that branch of industry and more in other branches. If the diminution of demand is very gradual, the necessary reduction in personnel can be effected by a cessation of recruiting. Many a branch of industry has gradually wilted away in this manner without much inconvenience or hardship to anyone. But if the diminution is more sudden, unemployment results owing to the natural reluctance of persons skilled, or at any rate experienced, in the particular branch of industry to leave it and try for employment in some other.

The thoughtless outsider is apt to say that both the unemployed and those who are still employed in the branch should accept lower wages, and so, by cheapening the product, extend the demand for it. As a temporary palliative this may sometimes be reasonable, but it is evidently never the best final solution of the difficulty. It is not reasonable that a trade should be continuously worse paid than others merely because the demand for its products was once bigger than it has become. What the diminution of demand calls for is a redistribution of labour force, fewer persons being allotted to the branch of industry of which the products are less in demand, and more persons to the other branches.

When population is increasing, absolute diminutions of demand are likely to be somewhat fewer, and somewhat less acute when they do occur, than when population is stationary. If, for example, by the introduction of oil, or more economical consumption, the average person's demand for coal is reduced by one-tenth, in a stationary population the total demand for coal would be reduced by one-tenth ; but if the population in the same time increased 12 per cent, the total demand would be not reduced but slightly increased, and there would be no employment difficulty.

We ought, therefore, not to imagine that a stationary or declining population will rid us of the trouble of unemployment. It will provide more rather than less reason for promoting mobility of labour in place and occupation.

The Recorded Data of Science.

A FAVOURITE simile likens the growth of modern science to the rise of a great edifice which, in its different parts, presents to the world a variously incomplete appearance. The broad foundations have long since been laid, and immense pillars already stand erect upon them, whilst there are sites where excavation has not yet laid bare unyielding rock, and places where surveyors have condemned an unsound structure. It is an inspiring picture, but the architects and the masons need something more than inspiration. Their work cannot be based on impressions; it requires plans, records, specifications, quantities, and the clerks and draughtsmen in an obscure office contribute in full measure to the success of the enterprise. The picture is incomplete unless it exposes the weakness of what appears to be strong and discloses the content of what might be taken for hollow space; moreover, if it has regard for truth, it must give due prominence to the dust of time which lies heavily on the joints and conceals their true relation to the frame. Only the written records reveal the exact condition and the manner of construction of the building, and the written record affords, after all, the essential preparation for every scientific expedition.

Knowledge cannot safely move forward without first retracing its steps and surveying its path; the searcher cannot safely plunge into the unknown until he has acquainted himself with the known. We are not for the moment concerned with the adequacy or otherwise of that acquaintance, although a survey of scientific journals would quickly provide material for discussion; we have in mind the bibliography of the literature of science, the service of abstraction and compilation, and the great importance of accessibility, as well as preservation, of scientific records. It is not sufficient to commit results to paper; it is not sufficient to publish them in a widely read journal, even in a widely understood language. When the journal has been placed on a shelf beside its fellows, and a more recent issue takes its place on the desk, it is the turn of bibliographers, abstractors, and indexers to make their essential, if unpretentious, contribution. The work has to be performed without intermission, and it should be entrusted to those who are able to combine an appreciation of the significance of the subject matter with experience in the art of its treatment.

This desideratum applies not only to the preparation of standard publications of reference, but also to that of reports for the use of individuals and of scientific and industrial corporations. If the results attained by former investigators are to be of service in future research, they must be sought, identified, collected, and preserved, and this is a task of great and increasing magnitude. It is satisfactory, however, that the wider need for expert assembly and use of such records is being realised, and that the growth of libraries is being accompanied by the establishment of a branch of the profession of librarianship trained and exercised in the functions of special libraries and information bureaux. The efficiency of such organisations, and the solution of their special problems, cannot fail to be influenced by the establishment of appropriate facilities for training and practice; neither can it be denied that scientific research and industrial progress must inevitably reap the advantage.

We have been led to discuss special librarianship by our reflections on the position of scientific literature as a tool in research, reflections which originated from our having occasion to refer to the "Annual Tables of Constants and Numerical Data for Chemistry, Physics, Biology, and Technology", a publication based on work which has been in progress internationally for twenty years. The origin and history of the enterprise, which is at the same time an outstanding addition to the literature of science and a demonstration of international co-operation in the cause of science, were fully explained by the secretary-general, M. C. Marie, in a lecture delivered in 1928 before the Swiss Chemical and Physical Societies. Dr. Marie then pointed out how much important numerical information is buried in papers the titles of which gave no indication of its presence, and hence is easily overlooked. On his report to the seventh International Congress of Pure and Applied Chemistry held in London in 1909, a commission was appointed and immediately commenced its labours. At first the literature was examined by a large number of collaborators, but this method proved inexpedient, so that since 1912 a different procedure has been employed. There is now appointed in each important country at least one representative, who prepares slips referring to numerical data and forwards them quarterly, together with parts of the relevant literature of that country, to the editors who (with the assistance of experts in each subject class) are responsible for the extraction of the data; hence the inhomogeneity of the earlier volumes is largely avoided.

The publication was at first confined to the data of physical chemistry, but it soon became obvious that its scope must be extended to include pure and applied sciences specified in the title, which still does not refer to important sections such as mineralogy and crystallography. Only data concerning substances or definite systems are recorded, data lacking adequate precision being referred to only in the bibliographies; for it is useless to record figures which have no significance. Obviously, there can be no invariable rule, and the limits must be fixed by experience, but with this provision the aim is "to publish everything in the physical and natural sciences and their applications that can be represented by numbers". Apparent inhomogeneity due to the coexistence of two forms of classification—according to the nature of the constant, and according to the nature of the substance—is retained in order that information of particular interest to groups of specialists may be presented in a convenient form. Thus the properties of rubber are conveniently found in the same part of the engineering section, and not dispersed among the chapters on density, viscosity, etc. As befitted an international work published in Paris (Gauthier-Villars et Cie), the tables were originally printed in French, although certain introductory pages bore translations in English, German, and Italian. Commencing with volume 7, however, the international character of the work has been emphasised by the presentation of the complete text in both English and French, whereby its sphere of usefulness will naturally be extended.

The convenience not only of English-speaking peoples, but also of specialist groups, has been considered. To an increasingly great extent, workers in particular branches of the tree of knowledge require special assemblies of numerical data to facilitate their researches and to save them wearisome hours in sifting their particular needs from those of their colleagues. This demand has been supplied by the publication of separate sections on spectroscopy, electricity, magnetism, electrochemistry, mineralogy, crystallography, etc., the possession of which may in many cases render superfluous that of the complete volumes.

Research workers themselves require no admonition to secure access to works of reference such as the "Annual Tables", which derive their value not only from their contents, but also from their lacunæ. These gaps may be due to commission or omission. As Dr. Marie points out, inadequate specification of the conditions of measurement may render the results of that measurement completely worthless; moreover, it is only when scientific information concerning the properties of matter is arranged in an orderly manner that missing and weak links in the chain can be quickly detected. Hence the work of compilation of a complete record, when carefully performed, must to a certain extent stimulate criticism, and must therefore lead directly to advances in our knowledge concerning the material criticised. So also the record itself is a source from which critical tables may be, and have been, derived. Dr. Marie refers to the snare of those values which merely masquerade with an air of 'precision', but he is careful to insist that incompatibility must never be condemned unexamined, and cites as a cogent example the unsuspected reason for such incompatibility in determinations of the density of nitrogen. On the other hand, the "Tables" are not selective, although the service rendered by similar selective compilations is not overlooked by their editor, who, however, aims at catholicity.

The first three volumes surveyed the data published during 1910, 1911, and 1912, but the early progress of the undertaking was soon to be interrupted by the outbreak of the War, and inevitable delay resulted; nevertheless, by 1922 the fourth volume (1913–1916) was published, and was followed in 1925 by the fifth (1917–1922), in 1928 by the sixth (1923–1924), and in 1930 by the seventh (1925–1926) volumes; the first part of volume 8 (1927–1928) and volume 9 (1929) are due to appear in 1931, and the second part of volume 8 early in 1932. In February last the work was enriched by the publication of a collective index to the first series (vols. 1-5), and a similar index to the second series is announced for 1933. The index is tripartite, comprising an analytical, an alphabetical, and a formula index; with its aid numerical data published between 1910 and 1922 for more than 20,000 substances can be readily traced under the French name; whenever necessary, English, German, and Italian names are also given. Thus recovery from the War and its aftermath is all but complete, and the delay in the accessibility of the data will soon be no greater than the natural hysteresis between original and collective publication. Even such delay as is now imposed can be circumvented, for the editorial organisation necessarily constitutes a bureau of information, to which individual application for assembled but unpublished information may be made.

In his lecture, Dr. Marie gave some account of the financial basis of this international enterprise. An early conviction that independence of commercial interests was essential led to the refusal of an attractive proposal made by a German publisher; of the subscriptions received at this period, specially honourable mention is made of two: a modest sum from a society of students in Uppsala and a substantial donation from the Imperial Academy of Sciences of Vienna, the good example of which was followed by other scientific bodies. In 1918, with the view of the publication of the fourth volume, a French fund was established; in 1922 the financial basis was broadened by the creation, at the instance of the Union Internationale de la Chimie pure et appliquée, of an international scheme providing for subvention in relation to population. So far as is possible, the government of each respective country sponsors the subscription; the British contribution is provided by the Royal Society. In this way sums sufficient to permit the publication of vol. 5 were gradually collected, whilst the preparation of certain subsequent volumes was facilitated by subventions from the International Education Board and from French industrial organisations; in 1928 Dr. Marie was able to announce that the financial undertakings given by various countries would, so far as could be seen, permit the "liquidation of the past".

It would be ungrateful to describe the work and the organisation in so nearly impersonal terms; Dr. Marie's present collaborators—E. Cohen (Utrecht), P. Dutoit (Lausanne), A. Egerton (Oxford), O. Scarpa (Milan), F. K. Richtmyer (Ithaca), and C. J. West (Washington)—deserve the thanks of the scientific community, which will remember also with equal appreciation the names of Abegg, Bodenstein, Bruni, Stieglitz, Washburn, and Wilsmore in connexion with the creation of what is equally a worthy example of international work and a work of international worth.

Cancer Research.*

THE British Empire Cancer Campaign continues to subsidise a great variety of investigations into the cause and treatment of cancer, and the progress which is being made is summarised fairly fully in the recent annual report.

The greatest practical advance in the cancer problem which has been made in recent years is the cumulative demonstration that tar and soot and, generally, the products of burned coal, together with certain mineral oils, have an exceptional efficiency in causing malignant tumours when they are applied to the tissues of men and animals over long periods of time. The evidence comes partly from experiments on animals and partly from studying the relation of cancer to occupation and mode of life. The two lines of inquiry are entirely concordant in implicating burnt coal, and they provide sanitarians with a clear indication for preventing some forms of cancer.

For experimental purposes tar has generally been used as a carcinogenic agent, and a good deal of research has gone into the obvious question as to what particular substance in that complicated mixture is responsible. Most of the components have been tried and found to be inert, and no pure substance has been found which had anything like the effect of tar. It seems now, however, that Mr. I. Hieger and Dr. J. W. Cook, at the Fulham Cancer Hospital, have made substantial progress by following up the observation that benzanthracene and cancer-producing tar have similar fluorescent spectra. They have since found that 1 : 2 : 5 : 6-dibenzanthracene in a high state of chemical purity readily produces cancer when applied in quite small concentrations to the skin of mice, and they have thus provided a most valuable method for the analysis of the precise mechanism by which such cancers are produced. Whether this or some analogous compound is in fact the active agent in tars and mineral oils is not known.

There is at any rate no obvious justification for the statement made in the Report of the Grand Council (though not, we notice, by the workers themselves) that " the essential molecular structure of the cancer-producing agent in tar and other cancer-producing substances " has been determined. It may well be that the agent is not the same in all tars and carcinogenic oils. Cancer of the skin may be produced experimentally by X-rays, freezing, burning, acids, and other procedures which irritate the skin and have no 'substance' in common, though they may be similarly active because they all lead to the tissues producing the same active agent.

Another inquiry which relates the chemical constitution of a substance to its capacity to cause the growth of cells has been carried out by Dr. J. S. Young at Leeds. Solutions of simple salts injected into the pleural sac stimulate the cells lining the marginal alveoli of the lung to proliferate, and their efficiency in a general way varies with the valency of the metal: aluminium is more effective than calcium, and calcium than sodium. To these interesting facts he has now added the observation that cells which have reacted once are refractory to a further application of the stimulating salt for about three weeks. This resistance may also be induced by a series of injections of gradually increasing strength such that no reaction is at any time produced: ultimately the cells tolerate a concentration of the salt twice as great as that required to cause a reaction in a normal animal. This kind of cellular immunity to irritating substances is little understood and needs further investigation, possibly on simpler material than that used by Dr. Young.

While these and other data indicate quite clearly that cancer is essentially a local disease due to local causes, it is also evident that general or constitutional factors may be involved. In the present report, for example, it is shown that some strains of mice respond more quickly to the application of tar than others, and mention is made of a breed in which tumours appear 'spontaneously' in an extraordinarily large percentage of animals. Dr. C. E. Dukes also presents the pedigrees of a number of human families in which a hereditary predisposition to the development of multiple innocent tumours of the bowel is plainly shown: in many cases these growths form the starting point of cancers which appear at an exceptionally early age. It may probably be presumed that by deliberate dysgenic mating, strains of men might be produced with a special tendency to respond to external irritants by the growth of cancers, but there is no evidence that the constitutional factor is of any substantial importance in an ordinary human society, except in a few special instances such as that studied by Dr. Dukes.

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* British Empire Cancer Campaign, Eighth Annual Report of the Grand Council, presented at the meeting held at the House of Lords on July 20. (London: British Empire Cancer Campaign.)

Obituary.

DR. JOAN B. PROCTER.

SELDOM has the triumph of force of mind over physical weakness been more vividly illustrated than in the case of Dr. Joan Beauchamp Procter, curator of reptiles and amphibians in the Gardens of the Zoological Society of London, who died at her residence in Regent's Park on Sept. 20, at the age of thirty-four years. Fragile from birth, she still persisted in her duties, first at the Natural History Museum and later at the Zoo, when the majority in like position would excusably have retired.

From quite early days she had dedicated her abilities to the subject which was to become her life's work. As a child she showed an extraordinary interest in reptile and amphibian life, snakes, lizards, and frogs taking the place of diversions more usually associated with the nursery—and often causing consternation and alarm amongst her relatives and visitors. Whilst still at St. Paul's Girls' School, she called upon my father, Dr. G. A. Boulenger, F.R.S., who at that time was in charge of the reptile and amphibian collections at the British Museum. He at once perceived in her the makings of a brilliant herpetologist, and when she left school he invited her to work under his direction. Her special capabilities found full vent, and so valuable was her assistance that when my father retired, in 1920, Miss Procter was given the management of the vast collection. She proved not only an admirable systematist, but also an accomplished draughtswoman and modeller, and was responsible for some of the showcases in the Reptile Gallery in the Natural History Museum, and for a large series of coloured postcards of reptiles on sale at the Museum.

In 1923, Sir Peter Chalmers Mitchell, secretary of the Zoological Society, asked her to assist me in the design of the rockwork of the new Aquarium, then in course of construction, and later invited her to take over the curatorship of the Reptile House—the Aquarium at the time monopolising all my attention. As curator of reptiles she was an unqualified success, her great knowledge of reptiles coupled with her remarkable manual dexterity enabling her to perform many surgical operations on her charges that had not hitherto been attempted. The new Reptile House, opened in 1927, may fairly be regarded as a lasting monument to Miss Procter and her work. It combines the most modern developments of heating, lighting, and general hygiene, all of which she was quick to appreciate. The house, moreover, blends scientific requirements with artistic embellishment in a manner that had not hitherto been attempted in any zoological collection. During her curatorship at the Zoo she turned her artistic abilities to full account, and the majority of the more modern buildings and enclosures in the Regent's Park menagerie bear her stamp. The Reptile House, however, is preeminently her achievement and a worthy climax to an all too brief career.

Amongst her many contributions to scientific literature, her monograph on that remarkable tortoise *Testudo loveridgei*, published in the *Proceedings of the Zoological Society* in 1922, may be specially mentioned.

Miss Procter will be mourned by all those who were privileged to come into personal contact with her. A larger number outside her immediate circle will miss an artist and a valuable contributor to knowledge—one who did so much and in so brief a period. E. G. Boulenger.

Sir Gregory Foster, Bt.

Sir Gregory Foster, whose death occurred on Sept. 24, at the age of sixty-five years, was a singularly able and devoted worker in the cause of education and of university education in particular. He entered University College, London, as a student in the 'eighties, graduating in 1888. He studied afterwards under ten Brink at Strasbourg, obtaining the degree of Ph.D. He was for some time professor of English at Bedford College, which was then situated in Baker Street, London, and he returned to University College as secretary and lecturer, becoming principal (afterwards provost) of the College in 1900, and holding that appointment until his retirement in 1929. In 1928 he was elected vice-chancellor of the University of London and was re-elected to that office in 1929. The greater part of his life was therefore spent in connexion with University College and the University of London.

The period during which Foster was provost of University College was one of the most notable in its history. The status of the College was altered by its incorporation in the University in 1907. Under his guidance its position was extended and consolidated in a remarkable degree. Existing departments were strengthened and new departments created, new chairs were established, and many additions of great importance were made to the curricula. The School of Librarianship and the Department of Scandinavian Languages owe much to him. The magnificent range of laboratories in connexion with the Department of Chemistry, the great buildings devoted to the medical sciences, and the Architectural and Engineering Departments are among the most important university buildings erected in England in recent years. Foster would have been the last to claim that he was primarily responsible for this remarkable growth in the equipment and resources of the College, for he preferred to give the credit to others. The College is not likely, however, when honouring his memory, to forget the part he played or the great gifts of leadership which he displayed.

Foster was devoted to the interests of the students, and he carried on and developed the work begun by Henry Morley, for whom he had a great admiration, in fostering a corporate life in the College. He was a strict disciplinarian, but his innate kindness brought instant and unobtrusive help to many, of all nationalities, who were in difficulty. Thus, in spite of the reserve which gave him his dignity of bearing, he won the popularity which comes to fearless and humane men who do not seek it. He gave himself without stint to the College, and its welfare and advancement were ever in his thoughts. He never spared himself. Possibly he worked too hard, for he was unwilling to delegate to others any duty that he thought important, and in the opinion of his friends he would have been wise to have 'let go' when, a few years ago, his health showed serious signs of strain. He never lost his early interest in philological studies, in which he doubtless would have made his mark had not other duties engrossed his attention.

Although primarily concerned with University College, Foster was interested in many educational questions generally. He was always a staunch friend to the cause of women's education, and when he became vice-chancellor of the University of

London he was concerned with the facilities offered to medical women and generally with improving residential and social facilities for London students. Until quite recently, as chairman of the Council, he was endeavouring to raise funds for College Hall for Women in Bloomsbury. He had always been a prominent advocate of reform in the constitution of the University, of which he was a devoted son, and the University was fortunate in that at the difficult period of transition from the old statutes to the new he was, in the position of vice-chancellor, able to bring about the necessary changes with the least possible friction.

His health had not been good for some little time, but he endured the pain and inconvenience of illness with fortitude and fine courage. He will be greatly missed and not soon forgotten. E. D.

MR. J. W. TAYLOR, of Leeds, who died on Sept. 2, in his eighty-seventh year, was the doyen of British conchologists and was responsible, more than anyone else, for the intensive study of our land and freshwater Mollusca. He founded the *Journal of Conchology* in 1874, and with some of his friends (of whom Mr. H. Crowther still survives) established the Conchological Society in 1876. In 1894 he began the publication of his "Monograph of the Land and Fresh-water Mollusca of the British Isles", probably the most complete account of any group of animals which has been attempted, and beautifully illustrated by himself. The second volume, written in conjunction with W. D. Roebuck, is the only satisfactory description of British slugs. Unfortunately, with less than half completed, publication has been suspended since 1921. Mr. Taylor was a printer, and received the degree of M.Sc. from the University of Leeds in 1915.

WE regret to announce the following deaths:

Dr. Francis Barnard, honorary curator of coins and medals in the University of Oxford and formerly professor of medieval archæology in the University of Liverpool, on Oct. 9, aged seventy-six years.

Prof. C. L. Bristol, emeritus professor of biology in the University of New York, known for his researches on the marine fauna of Bermuda, on Aug. 27, aged seventy-two years.

Sir Arthur E. Cowley, fellow of Magdalen College, Oxford, and late Bodley's librarian, on Oct. 12, aged sixty-nine years.

Prof. J. B. Goesse, *S.J.*, emeritus professor of geophysical observations in the Saint Louis University and founder of the geophysical observatory of the University, on July 25, aged sixty-two years.

Prof. J. Long, formerly professor of dairy farming at the Royal Agricultural College, Cirencester, a well-known agricultural writer, on Oct. 1, aged eighty-five years.

Prof. Richard A. F. Penrose, jr., formerly professor of geology in the University of Chicago, and formerly a member of several State geological surveys and also of the U.S. Geological Survey, on July 31, aged sixty-eight years.

Prof. James T. Porter, head of the Department of Physics in the University of Tennessee, on Aug. 27, aged fifty-seven years.

News and Views.

IT was widely believed in the seventeenth century, even by Otto von Guericke for example, that air could be condensed into a watery liquid by compression. The origin of this belief is discussed in a note by Prof. E. O. von Lippmann in the *Chemiker Zeitung* for Sept. 5. He points out that the transformation of air into water is implied in early Greek philosophy and in Aristotle's theory of the elements, but he thinks the transmission of the belief is to be ascribed to Lucian (second century A.D.), who, in his satirical "True History", relates how a ship was blown by a whirlwind on to a star, from which the shipwrecked travellers saw the earth below as a shining sphere. The inhabitants of this star took as food only the vapours of flying frogs roasted over fires, and as drink, air condensed to a liquid in vessels by pressure. Lucian, who is generally supposed to have no claim to originality, may have derived the idea from some unknown earlier writer. In amplification of Prof. Lippmann's interesting note, it may be added that the writings of Lucian (available in an excellent English translation by H. W. and F. G. Fowler: Oxford, 1905) contain many such hints, concealed by the very artificial style of the author. Lucian refers, for example, in the same "True History", to a peace treaty between the inhabitants of the sun and moon, engraved on a tablet of electrum and set up on the frontier between their territories. This undoubtedly refers to the use of electrum, as an alloy of gold and silver, as a kind of neutral material combining the properties of both gold and silver, which are associated with the sun and moon respectively. Electrum, however, is referred by contemporary and later neo-Platonic writers to a separate planet, Jupiter or Mars, and the date of its removal from the list of planetary metals and replacement by the metal mercury has been discussed (for example, by Berthelot) without mention of Lucian's hint. There are several other similar references made by this author which are of interest in the history of science.

DR. H. MARTIN LEAKE, in the *Contemporary Review* for September, voices a plea for the establishment of biology on the basis of a real profession. Of late years there has arisen a widespread demand for trained biologists, due to the post-War development of the Colonies, which lie mainly in the tropics. The demand exceeds the supply, and this is not adequately explained by lack of educational facilities. The basal trouble appears to be the lack of that security of tenure and emolument which is essential if workers of the right calibre are to be attracted to biological study. At present the biologist has such a restricted and specialised market for his services that security is attained only under the wing of other professions. His work is chiefly needed in connexion with agriculture, which is beginning to substitute a firm scientific foundation for the empiricism which has hitherto been the guiding principle for the majority of those practising agriculture as a profession.

As Dr. Martin Leake remarks, the upsetting of the balance of Nature in colonial development has raised a multiplicity of field problems needing investigation by trained research workers, and under present conditions it is only the Government which is in a position to provide the necessary funds, which will thus entail a single employer, the Colonial Office. A few other interests, especially tea and rubber, have begun to employ biologists, but so far the demand from such quarters is too small to affect the professional question. Dr. Leake indicates the need for a link between research and practice, the fact that the generalisations of research frequently need interpretation with local requirements, and that the research organisation does not replace, but complements, the technical staff within the commercial unit. Such a development, if it took place on a scale materially to affect the system of agricultural production in the tropical Empire, would do much to improve the status of biology as a profession, would increase the demand for trained biologists, would provide security and adequate remuneration, and would remove the dangers inherent in the concentration of demand for services in the hands of a single employer.

AT the opening of the School of Pharmacy of the Pharmaceutical Society, which is also the School of Pharmacy of the University of London, on Oct. 7, an address to the students was delivered by Prof. G. E. Gask, of St. Bartholomew's Hospital Medical School and dean of the faculty of medicine of the University of London. Prof. Gask spoke on the decline of traditionalism. The address dealt in the main with the evolution of pharmaceutical education in Great Britain, indicating how in pharmacy as in other sciences there has been a progressive departure from old-established traditions, a process which has in recent years proceeded with increasing speed. It is the duty of the universities to encourage this. For hundreds of years the mind of man has been fettered by tradition. Advances were made in the nineteenth century, but they seem likely to be eclipsed by the achievements of this twentieth century, when the biochemist, the physicist, and the bacteriologist are daily contributing to the knowledge of the healing powers of Nature. Prof. Gask regards even these present advances as being transitional and as preceding even greater advances in the near future. The conditions of the present day do not favour a stereotyped, unprogressive civilisation, and to meet its requirements adjustment of thought and inventiveness are called for, and repeated criticisms of ourselves and our institutions.

AFTER Prof. Gask's address, a number of medals and prizes were presented by the president of the Society, Mr. A. R. Melhuish. The Hanbury Memorial Medal was presented to Prof. Hermann Thoms, of the University of Berlin. The medal, which is of gold, was instituted to commemorate Daniel Hanbury, whose name was well-known throughout Europe in the early half of last century for his accurate and painstaking investigations into the sources of vegetable drugs. The medal is awarded biennially by a Committee consisting of the presidents of the Pharmaceutical, Linnean, and Chemical Societies, the chairman of the British Pharmaceutical Conference, and one other member. The award is made " for high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs ". Prof. Thoms, who is the twenty-third recipient of the medal and the first German to receive it for twenty-six years, commenced his academic career with his appointment to the Pharmaceutical Department of the Friedrich Wilhelm University in Berlin in 1895. In 1900 he was entrusted by the Ministry of Education with the planning of the Pharmaceutical Institute of the University of Berlin, which was completed in 1902, and of which he was the director until 1927. Throughout his life Prof. Thoms has been an assiduous and prolific research worker, specialising in the chemistry of naturally occurring drugs. He was the founder of the Deutscher Apotheker Verein and for many years its president. The Pereira medal, which is regarded as the *cordon bleu* of pharmacy, was presented to Horace G. Rolfe. This medal is awarded annually by the Pharmaceutical Society as the result of a competition among recently qualified pharmaceutical chemists. It was founded to perpetuate the memory of Jonathan Pereira, at one time professor of materia medica to the Royal College of Physicians and also to the Pharmaceutical Society.

THE annual paper-reading conference of the Agricultural Meteorological Scheme organised by the Ministry of Agriculture and Fisheries was held at the Meteorological Office, Exhibition Road, South Kensington, on Oct. 8 and 9—Sir Napier Shaw being chairman, as in previous years. The meeting was well attended by research workers in various branches of agriculture. It is customary for a member of the staff of the Meteorological Office to read the opening paper. On this occasion Mr. E. G. Bilham, superintendent of the section of the Meteorological Office concerned with British climatology, opened with an account of various meteorological developments having importance for agricultural research, including an account of work that is being carried out with the view of obtaining a very much more complete representation of the distribution of monthly normal mean temperature over the British Isles than has been available hitherto. The underlying principle of this work is that a comparatively short period suffices to fix the differences between the normal mean temperatures of neighbouring places ; consequently, by comparing five-year means, of which a large number is available, using the indications furnished by a comparatively small number of places for which long-period normals are available as to the extent to which the monthly means for the five years in question were abnormal, a large number of comparable normals are obtained. As was pointed out, in estimating the effects of temperature on various agricultural phenomena by modern statistical methods, it is essential to be able to state the former variable as a departure from the normal.

THE nine papers that followed were contributed by agricultural research workers, and covered a large range of subjects, from the influence of climate on soil composition to the effects of light, moisture, and temperature on the growth of various pests and vegetable disease organisms as well as that of the crops on which these are parasitic. Among these may be mentioned a paper by Mr. L. Iorwerth Jones, in which the interesting experiment was described of interchanging samples of the soils at two different Welsh research stations of very different altitude in order to test the effect of mere climatic influences upon the growth of various grasses. The results suggested that comparatively slight changes of temperature and rainfall suffice in order to pass from conditions highly favourable to a particular grass to those so unfavourable that germination cannot even be achieved. These matters are obviously of the first importance in the choice of suitable grasses for laying down pasture, for which considerations of soil can clearly be given too much weight. The general tendency of the researches described in these meetings was to establish humidity as being one of the most vital meteorological factors in controlling plant growth as well as plant pests, but in one or two of the papers the light factor took the first place.

THE Report for 1930 of the Botanical Society and Exchange Club of the British Isles, by the secretary, Dr. G. C. Druce, gives an account of the activities of the Society during the year, including excursions to Galway, Co. Clare, and other places of special botanical interest. Sir Maurice Abbot-Anderson contributes an appreciation of the late Princess Royal, patroness of the Society; "she was a great lover of wild flowers and made many delightful paintings of them". Her place as patroness has been taken by H.R.H. Princess Mary, Countess of Harewood. "Plant Notes" for the year by the secretary and other members of the Society include reference to plants new to the British Isles, with critical notes, partly original and partly culled from other publications; and a list of new county and other records occupies fifty pages. A hundred pages are devoted to several original papers. These include a monographic revision of the larger British pondweeds, by Dr. W. H. Pearsall, which will be invaluable to students of this difficult genus; critical notes on brambles by William Watson; and some notes on British orchids by P. M. Hall. A supplement of special interest to British botanists is an account by H. A. Hyde of Samuel Brewer and a copy of his diary made during his botanical exploration in North Wales in 1727. This has been compiled from the transcript in the Banksian collections at the Natural History Museum, compared with one by Hugh Davies (1776) which has recently been acquired by the National Museum of Wales. The secretary also contributes a number of notes on new publications, and obituary notices of botanists, mainly British, who have died during the past year; there is also a full account of Dr. Druce's eightieth birthday celebrations.

THE Report is a remarkable tribute to the virility and inexhaustible energy of the octogenarian secretary. The Botanical Society was founded by Dr. Druce to extend and amplify the work of the old Botanical Exchange Club, and under his fostering care has developed to become a valuable helpmeet to British field botany and a record of results achieved. Anxiety as to what might happen when, in the course of Nature, the secretary lays down his work is, to some extent, allayed by an announcement in the Report. Dr. Druce states that he has left his "house, herbarium, library, paintings and furniture, with an endowment and a curator, as a Botanical Institute for the use of Botanists and a help to our own Society". An advisory committee which has been appointed contains the names of several well-known British botanists.

FIFTY years ago the Field Naturalists' Club of Victoria, Australia, was founded by a small body of enthusiasts, and at its jubilee celebrations in July it properly congratulated itself on the progress made during the years. The Club has kept in the forefront the ideals of the field naturalist, although it has had many members whose work lay along more specialised lines, such as Sir F. McCoy the palæontologist, Sir Baldwin Spencer, zoologist and ethnologist, and the members of the biological departments of the University of Melbourne. By popular evenings for talk and discussion, wild-flower and wild-nature shows, by championing the conservation of fauna and flora, its members have encouraged, with practical results, a love for Nature in the State. It has successfully advocated reservations as sanctuaries for fauna and flora, and owing to its suggestions and influence, in spite of indifference and opposition, Wilson's Promontory was set aside as a national park for the people. The record is a good one, and we share with the editor of the Club's magazine, the *Victoria Naturalist*, the wish that the centenary of the Club may be celebrated, not in a rented building, but in its own building, a hall of natural history on a central site in Melbourne.

THE sensational recovery of a homing pigeon, liberated in France in August, at Saigon on Sept. 9, has been attracting considerable attention in the press, and the episode is certainly a remarkable one, because the bird was a yearling on its first trial flight, and yearlings are not expected even to take part in any long-distance races, to say nothing of crossing a couple of continents. There is no doubt about the identity of the bird, the wing of which, says the Paris correspondent of the *Daily Mail* in the issue of Sept. 28, was stamped with the name and town of its owner, M. Louis Rasson, Dottignies. The bird must, of course, have gone hopelessly astray at the start, and may have got out to sea and been kept, or domiciled itself upon, an east-bound steamer; an Indian house-crow (*Corvus splendens*) has been known to board a homeward-bound steamer at Colombo, and remain with it until captured near Suez. But even if the passage were not assisted, the bird might work its way overland by consorting from time to time with other domestic pigeons and with the ancestral rock-doves, and thus learning how to find food and rest. In connexion with the long flights performed by these homing pigeons in races, it is a curious fact that the breed, which is, as opposed to the old black carunculated carrier, a composite one evolved in the last century, should show a decided tendency to have shorter wings than the sedentary dove-cot pigeon. The wood-pigeon, however, though largely migratory, has wings very much shorter than the rock-dove, a very sedentary bird.

SIZE fascinates, so we read with interest a new account of the habits of the largest of the 1800 known species of earthworms, *Megascolides australis*. We thought them to be rare, but Charles Barrett (*Australian Museum Mag.*, July 1931, p. 238) says that the rich dairy lands and potato fields of the lower Bass Valley are so thickly populated that thousands are turned up by the plough, and there the dark brown egg-capsules, buried from a few inches to several feet, are most easily found. It is not known in what form the soil swallowed by the worm is ejected, but the progress of the creature through its burrow is marked by gurgling and sucking sounds sufficient to startle the hearer. This is partly due to the lubrication of the tunnel walls by cœlomic fluid, ejaculated from dorsal pores, and this also appears in thin milky-coloured jets when the worm is irritated. Only one bird, the kookaburra, has been known to eat the giant worms, and even for it the meal is unusual. The worms may be three-quarters of an inch in diameter; the average length is a little more than four feet, but an hour's digging may produce several specimens six or seven feet long; and the largest actually measured was 11 ft. long. Several excellent photographs illustrate the size and habitat of the worm, which was filmed by the author.

A GOOD deal of misapprehension as to the commercial value of linking up large electric power stations so that they can mutually help one another still exists. This misunderstanding seems to be the basis of much criticism of the 'grid' in Great Britain. In the *Journal of the Franklin Institute* for August, N. E. Funk, the engineer of the Philadelphia Company, which is connected to two other huge companies by a 220-kilovolt link, gives a clear statement of the economic advantages of interconnexion. Five years ago, eleven companies extending from Chicago, Ill., to Boston, Mass., were interconnected. This led to many misconceptions in the press. For example, one paper said "1000-mile hook-up gives Boston light. Electric power interchange between New England city and Chicago; test is step in the development of single line from coast to coast!" It is pointed out that if power were transmitted from Chicago to Boston the cost of transmission would be about 5*d.* a unit, which is many times larger than the cost of generation in Boston. Interconnexion between power stations is desirable for several economic reasons. It increases the trustworthiness of the supply and decreases the number of dynamos that have to be held in reserve. As a rule also, the maximum demands of the various linked stations occur at different times, and this diminishes appreciably the amount of plant required. Mr. Funk proves that substantial savings can be effected by considering the case of his own company. The Pennsylvania Company with which it is linked supplies a mining, industrial, and farming section of the State. The Philadelphia Company and the Electric and Gas Company supply densely populated districts with very diversified demands. A chart is given showing the flow of current in a link with the power station during the course of a day.

MESSRS. Lanchester's Laboratories, Ltd., of Spring Road, Birmingham, have issued a pamphlet describing their loud speakers designed suitably for different purposes. In a picture theatre, for example, an instrument of great power is required. Its acoustical distribution also must be practically perfect and must have no directional bias. The firm make a large public address outfit which will broadcast speech over a radius of a hundred yards in the open, every syllable being distinctly heard and the identity of the speaker being recognised. They also make a smaller model suitable for a small receiving set or a radio-gramophone in the home. When compared with the loud speakers on the market a few years ago, they show great improvements and a very considerable reduction in price. A helpful attempt is made to explain exactly what is meant by a 'decibel'. It is pointed out that this is the logarithm of a ratio and so is incorrectly described as a unit. In the appreciation of sound it takes a drop of twenty per cent in the intensity as received by the ear before it is noted that there is a drop of volume. Plus or minus one decibel is the least change of intensity that the ear will notice under the most favourable conditions. Without special attention, plus or minus three decibels is about the smallest difference that is noticeable. This corresponds to the wide difference of two-to-one in the energy received. It is fortunate that this is so, for when listening to an orchestra some of the audience owing to their positions hear the various instruments in widely different proportions. If it were not for the adaptability of the ear, the music would sound very differently in various positions. Very simple home tests are given for testing a loud speaker.

IN response to many urgent appeals from those interested in archæology and anthropology, the exhibitions arranged in connexion with the centenary meeting of the British Association, at the Wellcome Historical Medical Museum, 54 Wigmore Street, London, W.1, will remain open until Oct. 31. The Museum will be open each day, excluding Sundays, from 10.30 A.M. until 5.30 P.M., admission free. The Egyptian Exhibition includes the results of past seasons' excavations carried out by the Egypt Exploration Society at Tell el Amarna and Armant, under the leadership of Mr. J. D. S. Pendlebury and Mr. O. H. Myers. A remarkable collection of ancient, rare, and precious jewels and ornaments from Egypt has been lent by foreign and British museums, as well as numerous collectors at home and abroad, in response to requests made by Dr. Robert Mond. Realistic models are extensively employed for the first time to illustrate the structure and character of ancient Egyptian palaces, tombs, and methods of excavation. In the Amarna Section, the head of a princess is a distinct acquisition to the art of the period; while the model of a nobleman's palace, like the reconstruction of a sacred bull burial from Armant, tells at a glance what hours of reading and study would not make clear. Associated with the Egyptian Exhibition is a noteworthy collection of photographic studies of various phases of South African life by Mr. Duggan-Cronin and Dr. L. Cipriani, of Italy. There is also the interesting exhibit from the English Folk Dance Society, illustrating customs of past centuries in England.

A number of very successful transmissions by television were recently carried out from a portable transmitter installed in a studio of the British Broadcasting Company. Arrangements have been made by the B.B.C. and the Baird Company to investigate whether a wire link can be used to carry the television signals in sufficient strength and purity to enable the North Regional Station at Slaithwaite to repeat the transmissions. Should these experiments be satisfactory, then it will be possible for owners of 'televisors' in the north to obtain very much better reception of television broadcasts than they have had up to the present. We learn from the October number of *Television* that the B.B.C. has agreed to admit television within the recognised programme hours. The transmission is being broadcast from a B.B.C. studio on one evening every week. Some of the radio artistes at the B.B.C. form the studio 'subjects', so that the owners of televisors are able to see them on the screen.

Negretti and Zambra's new catalogue of meteorological instruments (List M.2) is a worthy successor to the firm's monumental catalogue of engineering and industrial instruments (List E.5) published about two years ago. It contains much useful information in regard to points of practical importance in the design and use of instruments and a number of references to published work. In the foreword it is made clear that very harmonious relationships exist between our biggest firm of meteorological instrument makers and the Meteorological Office. Without close and sympathetic co-operation between the official meteorological service and the instrument makers little could be achieved, and it is all to the good that there should be a free interchange of ideas. The result is that the ordinary purchaser can obtain from the maker instruments similar in every respect to those supplied for use at official stations, and can feel assured that they represent the result of years of endeavour to produce the most suitable type of instrument for the purpose it is to serve. Besides an ample choice of the usual instruments for meteorology, particulars will be found of aircraft and upper air instruments and also of test apparatus—a particularly useful section. In connexion with tube anemographs (pp. 16-17) mention should be made of the fact that a Meteorological Office certificate in respect to the recording unit can be supplied at a small extra cost. In the thermometer section the 'sheathed' pattern instruments M.2135, M.2136, and M.2176 are of special interest. The numerous advantages conferred by this type of construction have recently been recognised by the Meteorological Office and it has been adopted as the official pattern for use on land. It is due to Messrs. Negretti and Zambra to point out that they have listed similar instruments for many years. Prospective purchasers should note, however, that the Stevenson screen requires special fittings to support them.

The Annual Congress of Radiology and Radiological Exhibition will be held at the Central Hall, Westminster, on Dec. 2-4.

The following appointments have recently been made by the Secretary of State for the Colonies: Mr. J. A. Baker, to be agricultural field officer, Malaya; Mr. J. N. Clothier, to be agricultural officer, Northern Rhodesia; Mr. H. M. Stent, to be assistant agricultural research officer, Northern Rhodesia; Mr. L. E. W. Codd, to be plant breeder, British Guiana; Mr. W. J. M. Irving, to be agricultural officer, Uganda; Mr. L. N. H. Larter, to be geneticist, Agricultural Department, Jamaica; Mr. P. Morrison, to be manager of the Government Fruit and Vegetable Bureau and supervisor of Agricultural Credit Societies, St. Vincent.

The memory of the late Mr. Andrew Laing as one of the great engineers of this century, and of his activities in the cause of the advancement of the sciences of engineering and shipbuilding, are to be perpetuated by an annual memorial lecture to be given under the auspices of the North-East Coast Institution of Engineers and Shipbuilders. Mr. Laing, who died on Jan. 24, 1931, was the general manager and a director of the Wallsend Slipway and Engineering Co., Ltd. The memorial lecture is made possible through the munificence of the Misses Jeannie and Catherine Laing, who, being desirous that a special fund should be founded to perpetuate the memory of their brother, have transferred into the name of the Institution the sum of £2000 for the purposes of the lecture.

In recognition of his outstanding work in the science of ornithology, particularly as applied to bird migration, Dr. Witmer Stone, vice-president of the Academy of Natural Sciences of Philadelphia, and curator of its department of vertebrate zoology, has been awarded the Otto Hermann medal of the Hungarian Ornithological Society, the highest honour conferred by that organisation, and one of the most significant of its kind. This medal commemorates the distinguished achievements of Dr. Otto Hermann, whose research in bird migration gave him high rank among ornithologists, and whose death in 1914 was a world loss to this science. For many years he had devoted his entire time to an intensive study of zoology, especially bird life and habits, and it was largely through his efforts that the Museum in Budapest was developed to its present excellence.

THE ninth International Congress of the History of Medicine will be held at Bucharest, under the presidency of Dr. V. Gomoiu, next September, when the principal subjects for discussion will be (1) the evolution of medicine in the Balkan States and (2) the protection of Europe against bubonic plague. Those wishing to contribute papers on these or other subjects are requested to forward the title and a typed copy of a summary of their paper to the office of the Congress, Str. Stirbey Voda 86, Bucharest II, without delay. The official languages will be English, French, German, Italian, and Spanish. Members of the Congress can take the direct route to Bucharest or meet at Trieste, whence visits will be paid to Athens, Constantinople, and Constantza, where local committees will be arranged for their reception. The meetings of the Congress will occupy four days, and the following three days will be devoted to a tour of Bucharest and excursions in the neighbourhood. A programme will be issued later giving the exact date of the Congress and the amount of the subscriptions.

THE journal entitled *La Géographie*, published by the Société de Géographie of Paris, has had a career of more than a century in one form or another. It has now undergone another change, and with the September issue appears with the title of *Terre Air Mer*. In its new form it is to treat more of descriptive and economic geography; and to adopt a more popular outlook than of old. The illustrations are increased in number, and the detailed bibliographies seem to have been given up. An article on the influence of Pierre d'Ailly on Columbus is of interest.

ANOTHER series of the excellent post-cards illustrating British trees has been issued by the British Museum (Natural History), S.W.7, each set containing photographs showing the habits of the tree in summer and winter and coloured illustrations of the flower and fruit. With each set there is a description of the tree and of characteristics that have given its timber or other products a practical interest. These sets of four cards in a neat envelope at sixpence should find wide use in schools, and are well worth purchase by those interested in the common trees of the countryside. The term 'British' is employed to include various well-known and common trees which are, strictly speaking, not native; thus, the larch is included in these new issues. Now the number issued is becoming so extensive, it would be a desirable innovation if, with each set of four, a list of the trees available in the series were included.

UNDER the title of "Orthoptera Celebica Sarasiniana I." the supplement to Vol. 12 of *Treubia* (May 1931) contains a series of papers on the saltatorial Orthoptera of the Celebes. It deals with material obtained by the Sarasins a number of years ago, besides later discoveries made by others. The most extensive contribution is by Mr. H. H. Karny on the grasshoppers of the family Tettigoniidæ and their geographical distribution. This same authority also deals with the family Gryllacridæ, while Mr. L. Chopard writes on the Achetidæ and Gryllotalpidæ, and Mr. C. Willemse discusses the Acrididæ. While a number of new species are described, those already known and their respective genera are diagnosed in detail, and the descriptions are accompanied by numerous text figures illustrating various morphological features. The whole work, when completed, will form a comprehensive monograph of the Orthoptera of the Celebes, and will prove valuable both to students of the order and to entomologists interested in problems of geographical distribution.

THE Medical Research Council has issued a third edition of the "Catalogue of the National Collection of Type Cultures" (Special Rep. Series, No. 64. H.M. Stationery Office; 2*s*. net). The collection is maintained by the Council at the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W., Dr. St. John-Brooks and Miss Rhodes being the curator and assistant curator respectively. The collection now exceeds 3000 different strains of micro-organisms, and cultures will be supplied so far as possible on application to the curator, a small charge being made to defray costs. The co-operation of microbiologists is invited, and they are asked to deposit in the collection not only new species or important strains of organisms but also strains of recent origin of the commonest types. Some particulars are given in the preface on the present position of bacterial classification and nomenclature and of the Nomenclature Committee of the International Society for Microbiology.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in mathematics at the Training College for Teachers, University of Rangoon—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Oct. 22). A headmaster of the Euclid Street, Swindon, Secondary Co-Educational School—The Secretary to the Swindon Education Committee, Clarence House, Clarence Street, Swindon (Oct. 31). A professor of zoology in the University of Sheffield —The Registrar, University, Sheffield (Nov. 4). A Geoffrey Duveen travelling student in oto-rhino-laryngology at the University of London — The Academic Registrar, University of London, South Kensington, S.W.7 (Dec. 31). A chief lecturer in chemistry at the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18. A teacher in charge of the chemical department of the Barnsley Mining and Technical College—The Principal, Mining and Technical College, Barnsley. A head of the department of civil and mechanical engineering of the Huddersfield Technical College—The Director of Education, Education Offices, Peel Street, Huddersfield.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The 'Lapides palmati' mentioned in the "Historia Naturalis" of the Elder Pliny.

Pliny, in Book 36, par. 134, in the course of a description of various minerals, says, "Palmati (sc. lapides) circa Mundam in Hispania, ubi Caesar dictator Pompeium vicit, reperiuntur, idque quotiens fregeris". (Stones marked with the pattern of a palm, which appears however often you break the stone, are discovered near Munda in Spain, where Cæsar, during his dictatorship, defeated Pompey.)

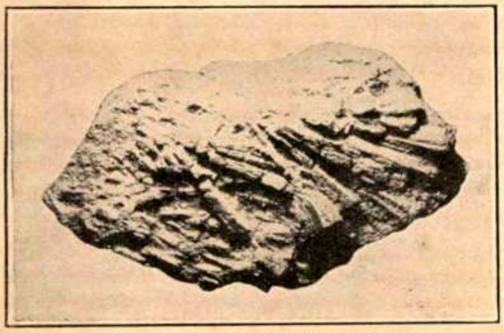

Fig. 1.—Andalusite in mica schist.

So far as I am aware, no attempt has been made to identify these stones, beyond the almost certainly incorrect suggestion that they were fossils of palm leaves. Munda, near which Cæsar defeated Labienus and Cneius Pompeius in 45 B.C., was situated in the province of Spain called Andalusia, and the aluminium silicate, andalusite, which derives its name from that locality, answers Pliny's description well and in two different ways.

In the first place, occurring in argillaceous schist, mica schist, and other rocks, it often forms radiating groups of prisms which bear a remarkable resemblance to branches with thin spiky leaves. Fig. 1 shows a specimen in mica schist from the Geological Museum of Trinity College, Dublin. Although, however, the words "idque quotiens fregeris" might describe the finding of a palm-like pattern of crystals when the parent rock is broken, it seems more probable that they refer to a still stranger property of the mineral. A variety of andalusite known as chiastolite (χιαστός, arranged diagonally) or macle (*macula*, a spot) consists of "stout crystals having the axis and angles of a different colour from the rest, owing to a regular arrangement of carbonaceous impurities through the interior, and hence exhibiting a coloured cross, or a tesselated appearance in a transverse section". The pattern is discovered wherever the crystal is split ("quotiens fregeris"), and Fig. 2, taken from Miers' "Mineralogy", p. 50 (second ed.), shows that the pattern may sometimes bear a great resemblance to palm branches. The chiastolite variety occurs, among other places, at Morbihan in Brittany, and Andalusian specimens, found in Pliny's day, may well have shown the phenomenon. Dana ("System Min.", 1904, p. 497), from whom the words in quotation marks are taken, reproduces pictures of other chiastolite patterns.

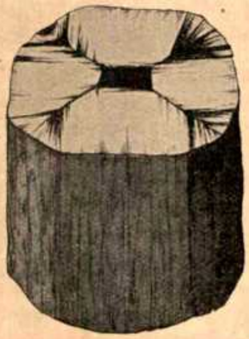

Fig. 2.—Chiastolite pattern. From Miers' "Mineralogy" (by kind permission of Macmillan and Co.).

My thanks are due to Dr. Louis B. Smyth, and to my wife, for suggestions and assistance in arriving at this identification.

Kenneth C. Bailey.

University Chemical Laboratory,
Trinity College, Dublin.

Eclipse Plumage in the Mallard.

The reasons for the changes of pattern, colour, and type in the plumage of fowls have been the subject of investigation by many workers and the parts played by testis, ovary, and thyroid shown. Work has also been carried out on ducks, the reactions of testis and ovary receiving most attention. Goodale,[1] Seligmann and Shattock,[2] Kuhn,[3] and others found little correlation between the eclipse plumage of the mallard and testis size and function or ovarian influence.

The experiments on ducks which I describe briefly below were undertaken because it was thought that a wider study of the relation between the endocrines and plumage modification would be profitable.

The mallard (*Anas boscas*) was chosen as being the most responsive material, the drake having two regular changes of plumage type during the year—eclipse plumage from May to September and mating or normal plumage from October to April.

The aim of these experiments was to produce the eclipse plumage in these drakes during their mating plumage season, October to April. Before each experiment, areas of feathers were plucked on breast and belly, and, in the pituitary work, on the flanks.

A start was made with thyroid, on the lines of the experiments of Greenwood and Blyth,[4] and others in which the colour of the neck hackles of the Brown Leghorn cock was changed from gold to black by the feeding of thyroid. No parallel change occurred in the mallards though a similar preparation was used and the amounts fed approximated to the higher dosages given to the fowl. The thyroid feeding appeared to cause only an alteration in the pattern rhythm of the growing belly feathers—their colour was unaltered and the breast feathers showed no change. It was noticed also that large single doses of thyroid that caused precipitate moulting in cocks had no similar effect on the drakes.

Pituitary was next tried. Desiccated anterior lobe suspended in saline was injected subcutaneously into drakes, with the result that the growing feathers in all plucked areas showed modifications in pattern and colour. Except in the breast feathers of two drakes, these modifications approximated to the normal eclipse plumage exhibited later by each drake.

At the same time other drakes were given subcutaneous injections of dried posterior lobe suspended in saline. Here, though there was modification in pattern and colour, the modified pattern and colour differed from the normal eclipse feathers shown later by each drake, from those produced by the anterior lobe injections, and from the modified pattern of the belly feathers produced by the thyroid feeding referred to above. There appeared to be a change of the pattern rhythm and intensity of pigment deposition.

Injections of whole pituitary gave varied results, and further work on this is being done.

These isolated results can contribute nothing conclusive to our knowledge as to the cause of eclipse plumage. Further experiments are in progress on the relation of the other endocrines to eclipse, mating, and female plumage. When these further experiments have been carried out and the full analysis is completed, it is hoped that interesting results on the subject of the endocrine modifications of plumage expression within the range of gênetic determination will be obtained. VIOLET K. TALLENT.

National Institute of Poultry Husbandry,
Newport, Salop.

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[1] *Biol. Bull.*, 1910.
[2] *Proc. Zool. Soc. Lond.*, 1914.
[3] *Arch. fur Geflug.*, 1930.
[4] *Proc. Roy. Soc. Edin.*, 1929.

Change of Density of Carbon Disulphide with Temperature.

THE investigations of Isnardi[1] have shown that the value of the dielectric constant of carbon disulphide falls suddenly at −90°. This drop appears at a considerable distance from the freezing point (−112°), so the phenomenon shows an analogy to the change of the dielectric constant of ethyl ether with temperature. On the basis of this analogy, it might be reasonably supposed that the values of other physical properties of carbon disulphide would show similar abrupt if less marked changes at −90°.

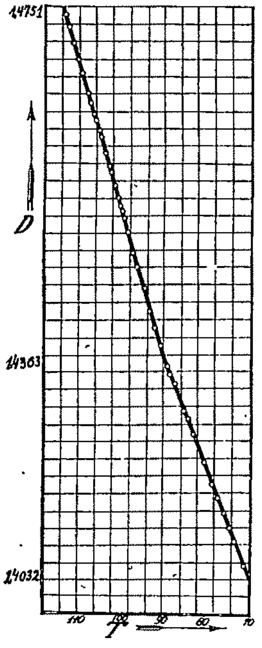

FIG. 1.

Experimental investigation has shown that on the heating curve of carbon disulphide there appears at −90° a distinct slowing down of rate of change of temperature. This suggests a change of the substance at this point from one liquid modification into another liquid modification. The analysis of the heating curve has enabled us to evaluate the latent heat for this change.[2]

The next step consisted in a study of the changes of density of carbon disulphide with temperature, with special attention to the neighbourhood of −90°. I have therefore measured the density of carbon disulphide, using the method described by Kamerlingh Onnes and I. D. Boks. The details of the experiment have been described by me in the communications concerning the densities of ethyl ether and nitrobenzene.[3]

The temperatures were determined with an error not greater than 0·003°. The position of the meniscus of liquid could be read with an error of about 0·2 mm.; this corresponds to an uncertainty of 1·5 mm.^{3} in the value of volume of the liquid, so that, taking into account the volume of the dilatometer bulb, the relative error in the value of volume was about 0·1° per cent. The mass of the substance was determined with an error of about 0·0001 gm.; it follows that the values of the density were certain up to the fourth or even fifth figure.

As a freezing liquid I have used a mixture of ethyl ether and ethyl alcohol, mixed in a certain proportion. This mixture remains clear with the lowering of temperature, and it does not impede the motion of the stirrer even at −120°.

I may mention that the values of temperature were determined by means of the platinum resistance thermometers placed in the Dewar vessel at different depths. The determinations of temperature were made only after it was certain that the temperature was stationary throughout the volume of the freezing liquid. When the temperature of the freezing liquid was lowered down to −120° C., further cooling was stopped, whereas the stirrer remained in motion. Under the influence of the heat of the surroundings, the temperature of the carbon disulphide in the Dewar vessel increased slowly at the rate of about 1° per hour.

The carbon disulphide used in this investigation was very carefully purified, starting from the pure Cl_2 " pro analysi " delivered by Schering-Kahlbaum. The accompanying curve (Fig. 1) shows the change of density of carbon disulphide in the interval of temperatures between 112° C. and 70° C. It appears that with the lowering of temperature the density of carbon disulphide increases from the value 1·2628 at 20° up to 1·4363 at 90°. At this temperature there begins a more rapid increase of density with lowering of temperature. In the neighbourhood of the freezing point the density has the value 1·4751.

It appears, therefore, that at the point of change from one to the other liquid modification of carbon disulphide the density curve shows a distinct change of slope. J. MAZUR.

Physical Laboratory, Technical Institute,
Warsaw, July 20.

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[1] *Zeit. fur Phys.*, **9**, 153; 1922.
[2] M. Wolfke and J. Mazur, NATURE, **127**, 926; 1931.
[3] J. Mazur, NATURE, **127**, 270; 1931; and **127**, 893; 1931.

Deep-Focus Earthquakes.

MR. F. J. SCRASE[1] has recently found confirmation of the great depth assigned to certain earthquakes by the late Prof. H. H. Turner by recognising, in the data of the International Seismological Summary, the two separate branches of PR_1 and SR_1 that are to be expected if the focus be deep, and by observing the substantial agreement of their travel-times with the expected times calculated on the basis of the Zoeppritz-Turner tables. It may be of value to note in this connexion that we may, by the use of these reflected pulses, arrive at what is certainly a minimum value of the depth of focus, and this independently of any previous travel-time tables and even of any error in the assumed time of origin. This would eliminate any objection that might possibly be made to the use of the Zoeppritz-Turner tables.

All that is needed is good curves, derived from the data of the earthquake being investigated, showing the arrival times for P and for pP (this latter being the notation suggested by Scrase for a P wave reflected close to the epicentre). It will be seen from such curves that the interval $pP-P$ gradually increases with increasing epicentral distance, though the two curves soon become nearly parallel. At a distance of 180°, where the slope of the two curves becomes equal to zero, the interval would represent exactly twice the time required for a wave to travel from focus to epicentre. Curves extending to that distance are not generally obtainable. However, we may choose a point where the two curves are almost parallel, say at 90°, and the perpendicular distance from a point on the P curve to the pP curve will approximate to the distance between the curves at 180°. By a suitable correction this approximation can be made still more exact. Hence, if this given distance corresponds to a time interval of 100 sec., we know that the focus is at least at such a depth that a P wave requires 50 sec. to travel to the epicentre. Multiplying this time by an average value of the velocity at moderate depths, we arrive at a value for the depth of focus. The above-mentioned interval of 100 sec. would thus indicate a focal depth of approximately 400 km.

Records from observatories throughout the world for an earthquake of March 29, 1928, have yielded very satisfactory curves for P and pP, for S and sS, as also for other pulses. The uncorrected distance between the P and pP curves corresponds to an interval of 92 sec., so that great depth of focus seems well established. Several other features of the records point in the same direction. This conclusion is further confirmed by Wadati's assignment,[2] on the basis of the records from the nearby Japanese stations, of extraordinary depth to this shock.

It is felt that the admission of the occurrence of earthquakes at depths of the order indicated must entail interesting consequences for speculations in regard to the earth's structure and constitution.

V. C. STECHSCHULTE.

University of California,
Berkeley, California,
Aug. 31.

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[1] *Proc Roy. Soc.*, A, 132, 213-236, July 1931. See NATURE, 128, p. 228, Aug. 8, 1931.

[2] *Geophysical Magazine* (Tokyo), 2, p. 18, March 1929.

A Counting Device for Use with the Geiger Counter.

THE most trustworthy instrument for recording the impulses delivered by a Geiger counter is no doubt a string electrometer. Since, however, the counting of the deflections on a photographic record requires a good deal of time, a mechanical summation will in general be preferred. The arrangement to be described here has the advantage of being so simple that it does not require any watching, even throughout long series of observation.

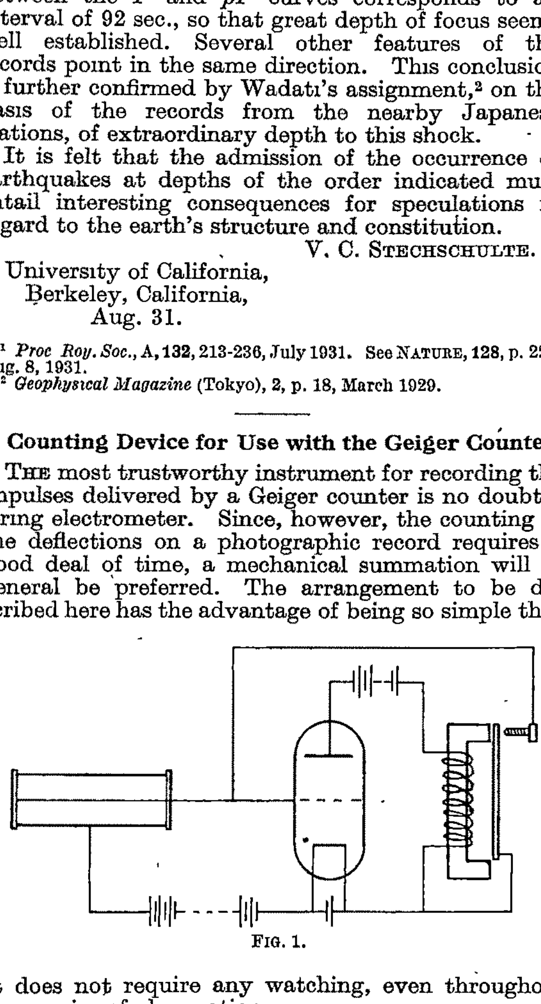

FIG. 1.

The positive (central) electrode of the counter is connected to the grid of an ordinary 3-electrode valve giving an anode current of 20-30 ma. when the grid is free (Fig. 1). To improve the insulation of the grid, the lead-in wire is pulled out through a hole drilled in the side of the bakelite socket and fixed in a plug of ebonite or amber. The anode current of the valve is sent through the coil of an ordinary telephone call meter; the screw which determines the movement of the yoke is insulated and connected to the grid. The yoke is connected to the negative end of the filament. The voltage swing applied to the grid by an impulse from the counter may easily attain a value of 50 volts and under ordinary working conditions is 20-30 volts, which is sufficient to break the anode current of the valve.

When the whole is at rest, the potential of the grid is nearly the same as the negative end of the filament; the anode current has the corresponding value, and the yoke of the counting machine is attracted by the magnet. Upon the arrival of an impulse from the counter, the anode current is broken, and the yoke is released; as soon as the yoke touches the screw, the anode current is raised again to its normal value.

The connexion of the grid to the insulated screw is necessary; when the grid is brought to a negative potential of 20-30 volts and left to itself, it would remain at this potential for a considerable time, since no grid leak is used.

The number of impulses should generally not exceed 200 per minute; when the number is higher, a considerable number of impulses may be lost. This seems for the main part to arise from the counter itself, a certain restoring time being necessary after each impulse.

J. C. JACOBSEN.

Institute for Theoretical Physics,
Copenhagen.

Effect of Light on the Surface Tension of Boys's Soap Solution.

THE letter of Prof. L. D. Mahajan in NATURE of Sept. 19, p. 496, which brings forth an interesting point, may be slightly misleading, inasmuch as it tends to indicate that time, or rather adsorption as a function of time, is only a negligible factor in the decrease of the surface tension of colloidal solutions, which I pointed out in 1924.

Even before Dr. Mahajan's memoirs are published, I feel that I must remind the reader who is interested in these questions that the conditions of Dr. Mahajan's experiments are quite different from those on which I based my interpretation of the experimental facts, and that consequently it is premature to issue a general statement.

I have shown, indeed, that the 'time-drop' was small for high concentrations, such as 1 per cent, and that it increased as the dilution increased. For example, one sample would give a drop of 2 dynes at 1 per cent and 20 dynes at 1 per hundred thousand, or 10^{-5}. I explained the difference, and studied thereafter only high dilutions up to 10^{-7}, under subdued artificial light.

Now Dr. Mahajan states—without specifically limiting his statement to sodium oleate solutions—that "the decrease in surface tension is a function of the time for which the solution is exposed to light and not a mere function of the time". As the concentration of the *soap solution + glycerin* which he uses is not stated, but may be as high as 2·5 per cent—which should give a very small drop—it is indeed quite possible that illumination plays a part in this case. But this does not substantiate the general statement that even in the case of high dilutions, where the drop is considerable, "a possible reason for this is a chemical action, not adsorption in the surface layers alone".

I shall look forward with much interest to Dr. Mahajan's papers, but as some readers may not see them, I think it advisable to direct their attention to the fact that the experiments reported in his letter cannot suffice to weaken my former interpretation.

P. LECOMTE DU NOÜY.

Institut Pasteur, Paris,
Sept. 23.

Fine Structure in the Arc Spectra of Indium and Thallium.

Indium.—The hyperfine structures of a few indium arc lines have been reported by Jackson[1] and McLennan.[2] Jackson observed that each of the lines $1\,{}^2S_{\frac{1}{2}} - 2\,{}^2P_{\frac{1}{2}}$ and $1\,{}^2S_{\frac{1}{2}} - 2\,{}^2P_{\frac{3}{2}}$ is a quartet; while McLennan observed only three components. McLennan deduced a value $i = \frac{1}{2}$ for the nuclear moment, while Jackson, from intensity considerations and the structures of the lines, inferred $\frac{7}{2}$ as the more probable value of the nuclear spin.

The fine structure patterns are not generally completely resolved, owing to the lack of resolving power in the interferometer and owing to the effect of electric fields and pressures in broadening the spectral lines. The fine structure measurements of the lines 4511, 4101, 3259, and 3256 A. have recently been made by me, using a specially constructed vacuum arc of 2 per cent amalgam of mercury and indium with cathode and anode cooled. Owing to the extremely low partial pressure of indium vapour, the lines were found to be extremely sharp and without self-reversal in this source. The fine structure was examined by a quartz Lummer plate (200 × 30 × 8 mm.) and quartz and glass plate etalons. The photographs clearly show the complex structure found by Jackson. A careful examination of the fine structure and the intensity value of the components indicate that the most probable value of the nuclear movement is $\frac{5}{2}$ or $\frac{7}{2}$.

Thallium.—Fine structure measurements of arc and spark lines have been recently reported by Schuler[3] and McLennan.[4] The fine structure of the arc lines 5350, 3776, 3529, 3819, and 2768 A. has been examined by me by employing experimental arrangements similar to those for indium: 3776, 3524, and 3519 were observed in detail. The structure of 3776 was observed under different conditions of excitation, and it is found to have five components.

3776 and 2768 show more hyperfine structure components than required by theory for $i = \frac{1}{2}$, and there is evidence of a weak isotope with the same nuclear moment. The observations confirm the value $i = \frac{1}{2}$ for the nuclear moment suggested by Schuler and McLennan.

Full details of these fine structure measurements will appear shortly in this Observatory's bulletin.

A. L. Narayan.

Kodaikanal Observatory,
South India, Aug. 19.

[1] *Proc. Roy. Soc.*, **128**, 575; 1930.

[2] *Proc. Roy Soc.*, **129**, 208; 1930.

[3] *Zeit fur Physik*, vol. 55, p. 575.

[4] *Proc. Roy. Soc.*, vol. 125, p 570

The Magneto-Electric Saturation Effect.

As is well known, all previous investigations performed in order to find a magneto-electric saturation effect have led to a negative result. This is of importance for the classical theory of Langevin as well as for the wave theory. It would therefore seem to be of importance to try to find this effect by the help of new methods. In this note we propose to give an outline of the main feature of our method and the results obtained. The theory and the observations will be published later.

According to the new theory of strong electrolytes given by Debye, we know that the electric field of the ions has a great influence, for example, on osmotic phenomena and electric conductivity. At a distance of the same order as the diameter of an ion a field of force is produced of the magnitude 10^6 volts/cm. Let us consider a solution of a strong electrolyte, for example, potassium chloride in water. This electrolyte is separated in K^+ and Cl^+ ions. Add to this solution neutral molecules which are carriers of electric dipole moments. Due to the field they will, for example, in the proximity of a K^+ ion, orient themselves in the direction of this ion; naturally in equilibrium with their thermal motions. Assume that these neutral molecules that have electric dipole moments also possess magnetic moments fixed to the molecules.

The conditions now being clearly stated, the following experiment will be understood. The apparent magnetic moment of molecules which possess fixed magnetic as well as electric moments must be decreased by adding to the solution a strong electrolyte. We have calculated the magnitude of this effect on the basis of the classical magnetic theory. Measurements of the magnetic susceptibility have been performed by aid of Quincke's method improved by Piccard.

The observations have been performed on a solution of $(Cr(NH_3)_3(CNS)_3)$ in acetone by adding KCNS as a strong electrolyte. The results are decidedly negative. The experiments therefore are in favour of the new wave theory of paramagnetism.

O. E. Frivold.

Physical Institute,
University of Oslo.

Sture Koch.

Bureau International des
Poids et Mesures,
Sèvres, Paris.

Electric Circuit Breaker Research.

During the continuation in February, March, and August 1928 of tests commenced in 1926 by the Circuit Breaker Research Section of the British Electrical and Allied Industries Research Association, highly inductive power circuits of 6600 volts carrying more than 1000 amperes were successfully broken in oil, at gaps of from one-fifth to one-eighth of an inch, in an experimental circuit breaker of novel design. It was not found practicable to use smaller gaps, owing to the possibility of beads of copper forming, reducing the arc gap; thus it was not possible with the maximum voltage of 6600 volts then available to determine accurately the true dielectric strength per cm. at arc break.

Recently, through the courtesy of Dr. S. L. Pearce, of the London Power Co., Ltd., we have been able to carry our investigations up to 22 kv.

In these tests, which were carried out from Sept. 8 to Sept. 17, 1931, an arc current of 500 R.M.S. amperes was extinguished in an oil-immersed electrode gap, before the electrodes had separted half an inch (in a highly inductive circuit using power transformer stepping up from 6600 volts to 22,000 volts and giving a recovery voltage of 21,000 R.M.S. volts across the single arc gap in use). Seven repeat tests were made under the same conditions; the arc was in several cases extinguished before the separating electrodes had reached a gap of one-fifth inch, corresponding to a dielectric strength of over 100,000 volts per inch, gained within a few micro-seconds from the time when the arc current had reached a zero in its alternation.

As an indication of the advance made, it may be mentioned that an average figure for the dielectric strength at arc extinction in plain break oil circuit breakers is of the order of 2500 volts per inch at similar currents.

E. B. Wedmore.
A. M. Cassie.
W. Bevan Whitney.

36 and 38 Kingsway,
London, W.C.2, Sept. 28.

Research Items.

An Alleged Moose-Wapiti Hybrid in Montana.—*California Fish and Game* (vol. 17, p. 198; 1931) contains a reference to what is said to be the first known specimen of a 'moose-elk', or in our nomenclature a 'moose-wapiti', hybrid. Known to the United States forest rangers as "the elk with the funny horns", this curious cross was recently killed in the Deerlodge National Forest, Montana. The rangers had for the past five years known of the animal, which associated and grazed with the wapiti, but the horns and the body of which were half moose and half wapiti. When first seen in 1925 he appeared to be about a three-year-old, and his weight when slain was 1100 pounds. Our impression is that so rare and odd a hybrid deserved a much more detailed obituary notice, since experience shows that there is often the possibility of an abnormal member of one species being regarded as a cross with another.

Bird Migration in Switzerland.—An important contribution to the migratory movements of birds in Switzerland, founded upon field-observation and ringing, and summarising in all 16,500 data for the spring movements and 5600 for the autumn, is made by Dr. Konrad Bretscher (*Mém. Soc. Helvét. Sc. Nat.*, vol. 66, mem. 2, 1931). The data cover long periods and refer to sixty-eight species in spring and forty-nine in autumn. There is general agreement between the information gained from the two methods of observation, and the results indicate that the main migratory route lies through the Great Valley between the Alps and the Jura mountains. In spring the journeys run from south-west to north-east, and in autumn take the reverse direction. A second important route lies over the northern Jura, in spring in an eastern, in autumn in a western direction. The northern Alpine valleys are peopled by side movements from the Great Valley, whereas the southern valleys receive their birds from the south, so that both sides of the mountain chain contribute to a cross-migration, in which it is impossible to separate the elements. Further researches, especially by the ringing method, must be made before an understanding can be reached of the movements in the Alps, particularly in the Wallis and Engadine districts.

Weevils of Samoa.—Part 4, Coleoptera, Fascicle 5, of "Insects of Samoa" in course of publication by the British Museum (Natural History), is concerned with the Curculionidæ or weevils of those Islands. Sir Guy Marshall, who is the author of the present contribution, remarks that ten years ago only 22 species of these insects, comprised in 15 genera, were recorded. He is able now, as the result of his studies, to raise these numbers to 86 species belonging to 55 genera, of which 54 species and 15 genera are described for the first time. Only eight of these species are known to occur outside the Pacific islands, and of the remaining 78 species, no less than 80 per cent must, at present, be regarded as being peculiar to Samoa. A study of the different genera of these insects appears to suggest that the Samoan fauna has been derived from the Malay Archipelago by way of New Guinea and not from the south. Since too little is known of the insects of Tonga and Tahiti, it cannot be determined how far they are related to those of Samoa. All that can be said is that the insects of the last-mentioned islands show, on present indications, most affinities with those of Fiji. Sir Guy Marshall's memoir, it may be added, is a noteworthy contribution to a knowledge of the family Curculionidæ, and is admirably illustrated by figures drawn by Mr. A. J. Engel Terzi.

Industrial Shells of the Philippines.—F. Talavera and L. A. Faustino (*Philippine Jour. Sci.*, vol. 45, No. 3; 1931) report on the shells gathered on a commercial scale in the Philippines. The gold-lip pearl shell (*Pinctada maxima*) is utilised primarily in the manufacture of buttons, but other objects, such as knife handles, are made from this shell. Preliminary experiments on culture pearls in 1929 were encouraging; shell-beads 5 mm. in diameter introduced into two-year old 'oysters' had increased at the end of thirteen months to 7 mm. The black-lip pearl shell (*P. margaritifera*) is more widely distributed. The shell, which reaches a diameter of 9 cm., is used for the making of buttons, of inlaid work, cameos, etc. The majority of the *Trochus* shells collected are of *T. niloticus*, and are found chiefly on the islands near the outer edge of the coral reefs. Closely associated with the last species is the green turban shell (*Turbo marmoratus*). Both are used in making buttons and other objects. The window shell (*Placuna placenta*) supports an industry of considerable importance. Although usually found in the littoral zone this species is known to live in water 40 metres deep; it flourishes in mud or sand-mud bottoms in shallow bays and in estuaries. Fishermen in certain regions transplant undersized examples to better grounds. The shell, which reaches a diameter of 55-77 mm. at the end of the first year of growth and about 133 mm. at the end of the second year, is used instead of glass for window panes, shades, etc. The pearly nautilus (*N. pompilius*) is taken in deep sea bamboo traps set to capture bottom fish, and its shell is being used in the manufacture of lamp-shades, spoons, etc.

Life-Cycle of *Moniezia expansa*.—D. F. Sinitsin (*Jour. Parasit.*, 17, June 1931) records observations on the egg of the cestode *Moniezia expansa*. The adult tapeworm lives in the small intestine of sheep, and ripe segments containing the eggs are passed with the excrement. The author describes the three envelopes of the egg, which contains a capsule composed of a spherical body and two tapering horns. In the body of the capsule is the six-hooked embryo and an apparatus for feeding the horns. Experiments extending over forty-five days, during which the eggs were repeatedly dried, showed that the shell provides very efficient protection against desiccation, and the author concludes that under normal conditions in Nature the egg does not reach its prospective host at once, but is destined to be at large rather a long time. In the later period of the experiment the egg shell became very fragile; the slightest touch broke it and freed the capsule with its horns, one of which is twisted round the other at this time. If the horns come in contact with a moist surface they untwist and form a boring apparatus. The mucus of the trachea brings about this boring action, and causes the solution of the capsule in less than thirty minutes. The author concludes that an intermediate host is lacking in the life cycle of *Moniezia expansa*. "The embryo, after a period of about two months' development in moist materials, returns again to the sheep by the air. Perhaps it enters the capillaries of the windpipe or alveoli, and, by the aid of the circulatory system, eventually reaches the intestine."

Mutable Genes in Delphinium.—Two mutable genes in *Delphinium* are the subject of a paper by Demerec (*Jour. of Genetics*, vol. 24, No. 2). The rose-alpha gene is unstable, reverting to the wild purple type of cell both in the sepals and petals (causing purple spots) and in the germ cells. By measuring the sizes of the spots and estimating the number of cell divisions involved, the frequency of the somatic mutations could be estimated. It was found that it was of the order of 267 per million cells both in gametogenesis and in the sepals. This rate was relatively constant in successive cell generations in different parts of the plant through four sexual generations. The lavender-alpha gene also mutates to purple, so that lavender-variegated plants give offspring which may be lavender-variegated, purple, and purple-lavender chimæras. This gene shows a high rate of mutability in early stages of development of the plant (since half the non-purple plants from seed are chimæras), relative stability in the early stages of sepal and petal development, and high mutability towards its end. The author concludes that these phenomena of variegation are not due to the gene being compound and composed of parts which segregate, but to a mutation which tends to occur in the particular gene at the time when it splits in mitosis.

Earthquakes and Mineral Springs.—The effect of earthquakes on mineral springs has often been noted. Mr. B. M. Radoslavoff traces the relations in Bulgaria as the result of the earthquake of 1928, in *Matériaux pour l'Étude des Calamités*, No. 25, 1931. The thermal springs are all in the neighbourhood of volcanic formations. Some springs dried up and several new ones appeared. The Meritchleri spring was replaced by exhalations of carbon dioxide. The Kovanlak springs ceased for three weeks and then began to reflow. Most of the well-known springs show an increased flow, in some cases as much as 200 per cent. The temperature of the different springs has, on the whole, remained unchanged, while in previous Bulgarian earthquakes the tendency seems to have been for temperatures to increase.

Soil Classification.—The possibilities of an international system for the classification of soils have recently been examined by L. L. Lee, of Rutgers University, the thesis appearing in the *Journal of South-Eastern Agricultural College*, Wye, Kent, 1931, with an extensive bibliography appended. The New Jersey system of classification is discussed at length, and the soils of the New Jersey (U.S.A.) area and of south-eastern England have been classified according to this system, enabling comparisons to be made. In both areas the soils occur in belted zones closely related to the geological formations, and in both cases also a direct relationship exists between the geological formation and climate and the distribution of the soil series, the number of soil classes being greater in central New Jersey. Podsolisation in general is further advanced in the soils of the American areas than is the case in south-eastern England. In both areas the importance of the parent geological materials is such that any system of classification applicable to both regions must be one in which geological factors are dominant, and it is suggested that the New Jersey system based on this foundation might find satisfactory application elsewhere in the British Empire and western Europe. Sandy profiles predominate in New Jersey, and heavy profiles, containing high percentages of silts and clays, in Kent, a direct relation existing between the texture of the soil profile and the geological formation in each district. Climate and soil reaction are also associated. No alkaline soils occur in the American area, whereas they are quite common in south-eastern England, climatic factors having altered the soil reaction more in the former than in the latter case.

A Photoelectric Relay.—The issue of the *Physikalische Zeitschrift* for Sept. 1 contains a note by Dr. L. Bergmann, of the University of Breslau, describing the arrangement he has devised for measuring small movements such as those of a galvanometer mirror by means of a relay depending on the sensitive selenium cell he described in the issue of the *Zeitschrift* for April 1. The cell consists of a thin layer of selenium in its conducting state, on an iron surface and covered by a semi-transparent film of gold or silver, deposited by cathode spluttering. In the relay a square of the cell of 1·5 cm. side is partially exposed, through a grating of ten parallel opaque strips, to light reflected from the mirror, the movement of which is to be measured. The incident beam forms on the grating an image of a similar grating, in such a way that a narrow strip of cell on one side of each strip of grating is illuminated, and motion of the mirror alters the width of this strip. The deflection of the galvanometer mirror in the cell circuit has by this arrangement been increased to 5000 times that of the mirror from which the reflection takes place.

Negative Ions.—Prof. H. D. Smyth has contributed an article to the July number of *Reviews of Modern Physics* upon the products and processes of ionisation by slow speed electrons. The principle of all the methods which have been employed is much the same; the gas is subject to a controlled source of ionisation, usually electrons, and the products are examined by one of the standard methods of magnetic analysis, or by the more recent electrostatic methods. Perhaps the most remarkable fact which emerges from this report is the scanty knowledge which we possess of the properties of negative ions. With a few exceptions, the usual statement which is made about any particular gas is that negative ions have been observed, but that practically nothing is known about the conditions governing their formation. Even in the case of the strongly electronegative substance iodine there is much uncertainty. I^-, I_2^-, and I_3^- occur in quantities comparable with those of the positive ions, but it is apparently as yet undecided what part is played by primary processes and what part by secondary processes in their formation. Perhaps the most significant observation is that to produce negative hydrogen atom ions by electron bombardment in water vapour, the electron energy has to be very closely either 6·6 volts or 8·8 volts; a similar law of formation is known for certain excited states of atoms, but is not found with positive ions.

Electrokinetics and the Interpretation of Surface Conductivity.—McBain and Du Bois, in the *Zeitschrift für Elektrochemie*, vol. 37, p. 651, point out that Helmholtz's theory of electroendosmose as due to the motion of the inner portion of the double layer should be replaced by the explanation put forward by McBain in 1924 and confirmed by experiments of Laing and others. The ions, water, and wall of the tube are all in motion relative to one another; the double layer is seldom complete, and the greater part of it plays no part in electrokinetics. All ions, walls, colloid particles, gels, diaphragms, etc., according to Laing, take part in the transport of current in the proportion of their actual conductivities, so that if μ is the total conductivity, the ion transport is of the form $c'u'/\mu$, where c = conductivity and u = mobility; and the wall, colloid, etc., transport is of the form $c_1 m_1 f_1/\mu$, where m_1 is the number of chemical equivalents carrying a faraday of charge and f the mobility. The formula of Smoluchowski has been disproved by experiments of McBain and Peaker on the increase in conductivity of solutions in contact with optically polished glass or quartz, and stearic acid on water: the results would give impossible values of the thickness of the electrical double layer. The classical formulæ of electrokinetics appear to be quite incorrect.

The British Heavy Steel Industry.

THE present position of the British heavy steel industry was reviewed by Prof. H. Stanley Jevons in a paper read on Sept. 30 to Section F (Economic Science and Statistics) of the British Association during the centenary meeting in London. Prof. Jevons said that the heavy steel industry is probably the weakest part of our industrial fabric at the present time, though it presents the greatest possibilities for development among the older British industries. The present depression is largely due to the effects of the War, as it has led to a 50 per cent increase in steel-making capacity, but the new plants erected during the War were erected at high costs and were not located or planned to the best advantage for peace-time operation. Since the War, production has remained stationary, and more recently has actually fallen off. Exports also have declined, but imports have increased somewhat. We are now surpassed by Germany as a steel-exporting country. Britain, however, is still pre-eminent in the production of high quality steels, and in this section of the industry Sheffield still leads the way. It is characteristic of the British steel industry, as of the other older British industries, that quality has been put first and low cost of production made entirely secondary.

German steelworks generally secure a larger output per hour with lower fuel consumption per ton, while their superior mechanical equipment reduces their costs of handling materials below those in British works. In Britain the cost of pig-iron is high, mainly on account of the small size of our furnaces. Wages also are somewhat higher than the rates paid in Germany and much higher than those in France and Belgium. This disparity might be counteracted by means of better equipment or improved business organisation, but so far this has not been achieved. The price policy adopted by the majority of firms in the British iron and steel industry is probably responsible for the high rate of unemployment, which has now risen to 43 per cent of those engaged in the industry. Even allowing for rebates given by British steel producers to contractors who regularly use British steel, imported steel is much cheaper than that produced at home. Thus, Belgian steel joists delivered in the Birmingham district are £4 6*s*. per ton and billets £3 16*s*., as against British prices of £8 and £5 per ton respectively. Prof. Jevons doubts if the rebate scheme is, on the whole, well advised, because it tends to limit the number of contractors employing British steel to those who agreed to the conditions of the rebate.

Among the various remedies which have been proposed as a cure for the post-War depression in the industry, the most prominent is the demand for a safeguarding duty. Foreign competition and severe unemployment in the industry can be advanced as arguments in favour of this policy, but, on the other hand, it might happen that a protective duty would merely bolster up inefficiency and might retard a necessary reorganisation of the industry. If a tariff is imposed, it will therefore be necessary to ensure that the industry will not raise home prices, but will only seek to work plants up to their capacity.

A committee appointed by the Government to investigate the condition of the industry recommended reorganisation on a regional basis, whereby heavy steel production would be concentrated in four districts. The committee considered that ten million pounds would be required to modernise existing plant. The Iron and Steel Trades Confederation—a trade union organisation—following to some extent the lead of this committee, proposed that a public utility corporation should be set up for the purpose of reorganisation on a regional basis.

Prof. Jevons pointed out that Britain was the first country to develop a great iron and steel industry, and, as compared with her competitors, she has still many valuable natural advantages, such as an abundant supply of coal. Moreover, these islands are peculiarly well situated for the export trade to all parts of the world. It is reasonable to expect a considerable growth in the demand for steel during the next twenty years if prices can be reduced, since steel is an essential requirement nowadays in the building industry, mining, railway wagon and carriage construction, and in many other industries. There is also a large potential export market in our colonies and undeveloped tropical dependencies.

Prof. Jevons recommends that the whole heavy steel industry in Britain should be replanned and rebuilt on a national scale with plants larger than any yet constructed in Europe. New plants of the latest type would have to be erected in South Wales, on the Clyde, on the north-east coast, and near Liverpool or London, with the view of facilitating the export trade. The industry should set itself to raise the annual production of steel from the present figure of about nine million tons and exports of four million tons to a total production of twenty-five million tons per annum, of which about ten million tons should be regarded as for export. This extension of the industry, though at first sight it might seem to be too ambitious a project, would make it no larger than the present size of the United States Steel Corporation. Prof. Jevons admits that the establishment of such an extensive reorganisation would require to be financed by the State, or at least interest on the capital would have to be guaranteed by the Government, but it is in the public interest to use the credit of the State in some manner to re-establish and enlarge the industry.

Applied Chemistry in Technical Colleges.

THE Board of Education has recently issued a report, prepared by H.M. Inspectors,[*] on the provision of instruction in applied chemistry in technical schools and colleges (except junior technical schools) in England and Wales which are in receipt of grants from the Board. It does not deal with instruction in universities. The survey has not been extended in an attempt to cover questions of provision and requirement wherever chemists are employed; the term 'applied chemistry' has been limited to the chief branches of chemical industry, which for this purpose is regarded as an industry in which raw material changes its composition as it passes through the works.

A table shows that more than 5500 students attended these courses; but the significance of the statistical information does not lie in the number of individuals receiving the instruction. A fact of greater importance is the wide adoption of the provision of well-balanced curricula instead of instruction in single and unrelated subjects. Many of the students who are not following such grouped courses are doing work of an advanced and sometimes post-graduate standard. Less than twenty per cent of the total number of students are receiving elementary instruction in single subjects, and a considerable proportion of these are attending lectures of a non-professional type and standard.

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[*] Board of Education, Educational Pamphlets, No. 85 (Industry Series, No. 10): Report by H.M. Inspectors on the Provision of Instruction in Chemistry in Technical Schools and Colleges in England and Wales. Pp. 55. (London: H.M. Stationery Office.) 1*s*. net.

The report describes the general character and distribution of the facilities offered for the study in these institutions of applied chemistry, the information being grouped under the headings: fuel industries; chemical engineering and chemical technology; metallurgy; pottery and refractories; bleaching and dyeing; leather manufacture, rubber technology, and paper-making; foods and drugs; oils, fats, and waxes; painters' colours and varnishes; coal tar colours; synthetic resins and cellulose industries. While the tendency to defer the teaching of applied chemistry until an adequate knowledge of pure chemistry and ancillary subjects has been obtained is commended, it is stated that beyond the elementary stage the instruction provided in physics is rarely what is required—it is either too narrow or too wide. On the other hand, a few schools seek to meet the needs of a small number of students of varied requirements by offering lectures in certain subjects which all attend, the main differentiation being achieved by individual instruction in the laboratory. The wisdom of attempting such an "almost impossible task" is, however, doubted.

The attitude of employers has entered on a new phase, passing from individual benevolence to a clearly defined collective policy, and being associated with a closer interest, so that the training "is tending to become a definite element of industrial organisation". The position which has now arisen is that expanding knowledge renders necessary a higher standard of training, which can be given more satisfactorily and under less onerous conditions in part-time day courses than in classes held exclusively in the evenings. While the difficulty of interrupting routine work by releasing employees for this purpose is acknowledged, the wide adoption of such a plan by the engineering industry and other industries is quoted as an example which might with advantage be copied more frequently in applied chemistry. Not only is co-operation in the use of facilities desirable, but also the achievement of completely co-ordinated schemes of technical education is a matter which requires closer co-operation between educational administration and industry.

A relatively new problem is the provision of instruction suitable for men, engaged on plant or process, who control apparatus or machinery without sharing the chemist's responsibility or ambitions. The well-informed worker finds greater interest in his work, and renders more efficient service to his employer; but "the traditional method of approach is not likely to be successful. A new technique in teaching is required." Another type of instruction which seems desirable is the commercial training of men who are primarily chemists or technicians.

A Monument to Henri Moissan.

HENRI MOISSAN was born in Paris on Sept. 28, 1852, and died there, at the age of fifty-four, on Feb. 20, 1907. He is remembered to-day for his successful work on the isolation of fluorine, his experiments on the manufacture of artificial diamonds and the development of the electric furnace.

Moissan's isolation of fluorine in 1886 was accomplished by electrolysing a solution of potassium hydrogen fluoride in anhydrous hydrofluoric acid contained in a platinum tube. He was led to his researches on diamonds by the study of the allotropic modifications of carbon, and the minute diamonds he made were obtained by melting iron and carbon in a crucible and dropping the fused mass into water. The electric furnace which he used in these experiments consisted of a scooped-out block of marble, covered by a marble lid having two horizontal passages for the carbon electrodes, the current being obtained from a small dynamo.

Moissan's whole life was passed in Paris. He entered the laboratory of Fremy at the Muséum national d'Histoire naturelle at the age of twenty; at thirty-four he was appointed professor of toxicology in the École Supérieure de Pharmacie, in 1899 was transferred to the chair of mineral chemistry, and the following year became professor of general chemistry at the Sorbonne. Elected a member of the Paris Academy of Sciences in 1891, he was made a foreign member of the Royal Society and awarded the Davy Medal, and in 1906 received the Nobel Prize for chemistry. His son, Louis Moissan, an assistant at the École Supérieure de Pharmacie, who was killed in action on Aug. 10, 1914, left funds for founding prizes in memory of both his father and mother.

A fête in honour of Moissan was celebrated on Oct. 4, in brilliant autumn sunshine, in the cathedral town of Meaux, picturesquely situated on the banks of the Marne. The delegates were received on Saturday afternoon, Oct. 3, at the Ministry of Foreign Affairs on the Quai d'Orsay, and on the following morning nearly three hundred were taken by special train to Meaux to take part in the ceremonies there.

These ceremonies included the formal presentation to the Communal College (of which Moissan was a pupil from 1864 until 1870) of a plaque on the wall of the entrance hall, and in the afternoon the unveiling, by Mme. Jean Gerard, of a monument in a small square by the side of the town hall. The monument is in the form of an obelisk, from the upper part of which the rugged features of Moissan emerge from the solid stone, whilst on the side are sculptured diagrammatic representations of his electric furnace and of the apparatus with the help of which he isolated fluorine, with quotations from his own writings.

Discourses appropriate to the occasion were delivered, in a natural theatre formed by the surrounding buildings and gardens, under the direction of Prof. Behal, representing the Minister of Public Instruction. The first three discourses were by the president of the organising committee, by the mayor of Meaux, and by the president of the old students' association of the College of Meaux; the others were by M. Lebeau, the assistant and colleague of Moissan, representing the friends and students who had worked in Moissan's laboratory, by Prof. Honigschmid of Munich (himself an old student of Moissan) on behalf of the foreign delegates, and by Prof. Behal on behalf of the Government. Prof. Behal was supported by the presence, also in full dress, of his fellow academicians, Bertrand and Délépine, and by many of their French colleagues.

The list of foreign delegates included sixty-three names, but of those actually present the three representatives from Great Britain constituted as large a group as from any other country except Belgium and Italy. The ceremonies were associated with the eleventh meeting of the Société de Chimie industrielle, and owed much of their success to its vice-president, M. Jean Gerard, who has been responsible for the organisation of so many international gatherings.

Universal Decimal Classification.

THE fifth report of the International Committee on the Decimal Classification was presented by F. Donker Duyvis to the Tenth Conference of the Institut international de Bibliographie at the Hague on Aug. 25–29, and indicates the growing value and increasing use of the Universal Decimal Classification in the interchange of technical and scientific information. A translation of the chapter on electrotechnics has now appeared in Germany, and an extensive abridged manual of the classification is in preparation under the leadership of Dr. Günther. Further translations and expansions in progress in Germany were reported on by Herr C. Walther, the main interest being directed to the technical sciences, whereas in Great Britain progress has been mainly with the pure sciences, medical sciences, and agriculture. This lack of progress, as indicated by Mr. B. M. Headicar in a paper describing the construction of the "London Bibliography of the Social Sciences", is largely due to the absence of an English translation. Nevertheless, in meteorology, plant genetics, agriculture, and general biology, progress has been made, and Dr. J. G. Priestley in reviewing the position of bibliography in physiology indicated the value of the decimal system in constructing the complete card index of physiological and allied subjects which is a fundamental need. As a first step, *Physiological Abstracts* has already commenced to reprint decimal numbers from original papers in which they are used.

Many of the papers presented at the Conference afforded further evidence of the wide use of the decimal classification and the efforts being made to improve and extend the system by international co-operation. Its value in the organisation and documentation required for the *Révue générale de l'Électricité* was described by E. Beinet. O. Frank and C. Walther reviewed German developments in further detail, in which country it has been adopted by the German National Committee for the power and fuel bulletin initiated by the World Power Conference, and important libraries such as those of the Technical High School, Aachen, the I. G. Farbenindustrie A.-G, Leverkusen, the Central Technical Library, Frankfurt, the German Industrial Safety Museum, Berlin, the German Patent Office, and the Berufsgenossenschaft der Chemische Industrie, etc., while a full account of its use by the A.G. vormals Skodawerke in Pilsen was contributed by F. Kondelak.

In a report on "Documentation in Medicine" presented by Dr. Rene Sand, secretary of the League of Red Cross Societies, adoption of the decimal classification as a means of expediting the much-needed international co-operation in the organisation of documentation and bibliography in medicine was strongly urged, and the application of the decimal classification in the aluminium industry was discussed in a report presented by the S. A. pour l'Industrie de l'Aluminium à Neuheusen. A paper by J. Cenek described its use in industry in Czechoslovakia, and difficulties encountered by Polish engineers in adopting the system were described in a further paper from the Bibliographical Section of the Society of Polish Technicians, Varsovie. Other papers dealing with the decimal classification included J. Gevers' review of thirty years' experience with the system in the Belgian Patent Office, the application of the decimal system in local administration and social problems, and in public administration archives (L. Wouters), while G. A. A. de Voogd, chief of the Organisation Department of Bataafsche Petroleum Maatschappig, in a paper on rationalisation in documentary administration, described the extension of the decimal classification to meet the stringent demands of scientific management in the head office of a world-wide organisation.

Other papers presented at the Conference included one by Dr. M. Pflücke, principal editor of the *Chemisches Zentralblatt*, describing the organisation of abstracting and indexing of the *Chemisches Zentralblatt*, co-operation between libraries (J. W. Pafford), the standardisation of sizes (Frank), the use of addressographing machines with the decimal classification (W. Schümeyer), and international abstracting and indexing of scientific literature (Sir Frederic Nathan), and reports on the progress of the *Repertorium Technicum*, the *Index Bibliographicus*, and the Commission on Cataloguing Rules.

The Behaviour of Electrolytes in Solution.

A DISCUSSION on the influence of the medium on the properties of electrolytes initiated by Sir Harold Hartley on Sept. 24, in Section B (Chemistry) of the British Association during its centenary meeting in London, gained further interest from the presence of several distinguished foreign men of science whose investigations have largely contributed to recent developments in this field. Striking success has attended the application to dilute solutions of the Bjerrum hypothesis of complete ionisation. With the Debye treatment of the interionic forces, this has induced the extended study of other solvents with the object of testing the validity of the theory.

In the discussion, Prof. P. Debye described the results of experiments to determine the effect of alterations in frequency on the electrical conductivity of solutions in different solvents. This effect is due to the finite time (of the order of 10^{-7} sec.) which is required for the formation of an ionic atmosphere round an ion, and at very high frequencies or in very viscous media marked increases in conductivity can be obtained. For example, with a solution of calcium ferrocyanide in a mixture of 96 per cent glycerol and 4 per cent water, the conductivity is increased 500 per cent when a frequency of 10^4 cycles is employed. No values are obtained for the equivalent conductivity which are greater than the limiting value for infinite dilution, and this, according to Prof. Debye, implies that interionic forces are mainly operative.

Profs. N. J. Bjerrum and J. N. Brönsted discussed the solubilities of salts in different solvents and the agreement between experimental data and calculations based on Born's formula. Prof. Bjerrum, dealing with the forces between ions and solvent molecules in relation to the solubility of electrolytes, considers that the agreement is as good as can be expected on the basic assumptions made.

Evidence of the existence of strong specific forces between the ions and the solvent molecules was advanced by Sir Harold Hartley from the conductivity of salts in different solvents and by Prof. J. C. Philip from a comparative study of the nitriles as solvents. While in water and to a lesser degree in the alcohols simple univalent salts conform fairly closely with the requirements of the Debye-Onsager equation, in non-hydroxylic solvents, for example, acetone, nitromethane, and the nitriles, there are marked divergencies, which can most readily be interpreted by the assumption that the ions carry with them sheaths of solvent molecules. Dr. J. A. V. Butler has reached a similar conclusion from a study of the behaviour of electrolytes in mixed solvents, for example, alcohol-water mixtures, and showed that by the comparison of different properties conclusions can be drawn as to the nature of the molecules in contact with the ions. Dr. E. A. Guggenheim showed that this experimental evidence of ionic solvation is in agreement with theoretical requirements. Thus the dissociation constant of sodium chloride calculated by the methods of statistical mechanics is too small to account for the apparently complete dissociation of the salt in solution. If, however, hydration of the ions be postulated, a plausible value is obtained for the dissociation constant.

University and Educational Intelligence.

Oxford.—In his speech on the conclusion of his second year of office, the vice-chancellor (Dr. Homes Dudden, Master of Pembroke) explained why no election has yet been made to the vacant Savilian chair of astronomy. This, he said, is due to the fact that the whole problem of the future of astronomy in Oxford has been under review. A detailed scheme has now been prepared, which includes the construction of a new and thoroughly equipped observatory on a suitable site near Oxford; the representation of both positional astronomy and astrophysics on the professional staff; and an extension of facilities, in close connexion with the new observatory, for the teaching and study of meteorology and geophysics. The completion of the scheme is waiting for the provision of the necessary funds.

The University of Berne has conferred doctorates *honoris causa* on Sir Charles Sherrington, Waynflete professor of physiology in the University of Oxford, and Prof. Harvey Cushing, professor of surgery in Harvard University.

A special course of lectures on "Some Applications of Biochemistry to Modern Pharmaceutical Problems" will be given by Messrs. Frank Wokes and F. J. Dyer, in the Lecture Theatre of the Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, on Oct. 22 and succeeding Thursdays, at 5.30 p.m. Admission to the first lecture is free without ticket. The subject will be "Physical and Chemical Conditions Necessary for Life".

The council of University College, Southampton, has appointed to the chair of engineering Wing Commander T. R. Cave-Browne-Cave, who was responsible for the machinery installation of the *R101*. Mr. H. Leech, who, with Wing Commander Cave, made every trial flight in the *R101*, and was lately foreman of the Engine Department at the Royal Airship Works, has been appointed experimental engineer.

Education in India cost in 1929, the latest year for which statistics have been published, 270 million rupees, of which nearly two-thirds was provided by government and local authorities. This expenditure has been frequently criticised, on the ground that it maintains a system of education appropriate enough for the small minority of pupils destined for employment in government and private offices and the learned professions, but quite unsuitable for the needs of the general population, which is mainly rural. In a pamphlet entitled "The Indian Education Problem: a Solution", Mr. J. C. Ghosh, principal of the School of Chemical Technology, Calcutta, sketches an alternative system designed to divert a due proportion of educational effort into channels tending to improvement of agricultural and manufacturing industries and the public health. In the forefront of his suggestions is a plan for rural education on practical lines by teachers who would be maintained by the well-to-do villagers in rotation, "according to traditional custom and hospitality". In urban areas, boys and girls would start their education at home in conjunction with manual labour "in ancestral or family occupation", municipal and other free primary schools being maintained only for the children of parents too poor to undertake this home training. All pupils up to fourteen years of age would be scouts, and their efficiency in scouting, literacy, manual and physical training would be tested in camps of exercise, the existing expensive system of formal inspections being abolished. Literary education in secondary schools and universities would be ordinarily restricted to the rich and to exceptionally gifted boys and girls.

Birthdays and Research Centres.

Oct. 20, 1862.—Prof. Thomas H. Bryce, F.R.S., regius professor of anatomy in the University of Glasgow.

The chief investigations in progress in my laboratory are: first, it is impossible in some cases to reach decisive interpretations—by ordinary methods of investigation—of the appearances seen in serial sections of the free mammalian blastocyst just before implantation. A special technique is therefore being developed by Dr. Maclaren for the observation of the living blastocyst and for recording the results. Some success has already been obtained. Second, it was discovered by Dr. Nicol that in the intravitam staining of the tissues by trypan blue, the uterine mucosa (in *Cavia*) at certain stages was densely stained, due to the accumulation of certain cells packed with blue granules. This has been followed up, suggestive results are being obtained, and an interesting line of research is opened.

Oct. 20, 1891.—Dr. James Chadwick, F.R.S., fellow of Gonville and Caius College, and assistant director of radioactive research, Cavendish Laboratory, Cambridge.

I am studying, with the help of collaborators, the effects of bombarding elements by α-particles, in particular, the emission of protons and γ-radiations from the atomic nuclei and the scattering of the α-particles. The wave mechanics has given a clearer view of these problems, and the application of new experimental methods is giving new and detailed information. I hope that in a short time we shall be able to describe completely the interaction between an α-particle and an atomic nucleus, and have a reasonable picture of the structure of the nuclei of some elements.

Oct. 22, 1876.—Prof. Harold Hilton, professor of mathematics, Bedford College, University of London.

At the request of the Clarendon Press, I have been engaged lately in the preparation of a second edition of my book on "Plane Algebraic Curves". Time not absorbed by this task and the duties of my professorial work is mainly devoted to the study of problems in affine and projective differential geometry.

Societies and Academies.

Paris.

Academy of Sciences, Aug. 24.—**Georges Giraud**: Extension of the notion of principal elementary solution and applications.—**G. Nadjakoff**: The capacity of the quadrant electrometer.—**Adolfo T. Williams**: Ultimate lines and absorption lines. Absorption lines are not all ultimate lines, and very few of the latter are absorption lines.—**Norbert Casteret**: The communication of the Trou du Toro with the Goueils de Jouéou, the source of the Garonne. The Trou du Toro and the Goueils de Jouéou communicate. The underground flow, as shown by fluorescin used in large amounts, is very rapid, 400 metres per hour. The negative results obtained by E. Belloc in 1896–1900 were due to the fact that the dye was added in insufficient quantities.—**J. Bougault** and **G. Schuster**: The composition of karité butter. By the application of Hilditch's method of oxidation by potassium permanganate in alkaline solution, it was shown that karité butter contains 7·3 per cent of saturated glycerides, the unsaturated glycerides representing 92·7 per cent.—**Maurice Nicloux**: The combustion of alcohol by the pœcilotherm: the value of the temperature quotient. An account of experiments on the combustion of alcohol in the frog at temperatures ranging between 1° C. and 29° C. Within these temperature limits the quantity of alcohol burnt in 24 hours varied from 14 to 97 per cent of the amount injected. The temperature quotient of the biochemical reaction equals 2.—**Georges Bourguignon**: The technique of the measurement of large chronaxies, 0·3 to 1·5 sec.—**J. E. Abelous** and **R. Argaud**: The formation of adrenaline in the suprarenal gland. It is generally held that adrenaline is formed exclusively in the medullary substance; the small amounts found in the cortical substance have been regarded as due either to post-mortem diffusion or to the presence of stray islands of medullary substance. The author's experiments contradict this view, and show that the elaboration of adrenaline takes place in the cortical substance.—**Léon Velluz**: The antitoxic properties of certain diphenols and their mode of action.—**Georges Blanc** and **J. Caminopetros**: The sensibility of the spermophil (*Citillus citillus*) to the virus of exanthematic fever.

Aug. 31.—The president announced the death of Jean Effront, *correspondant* for the section of rural economy.—**H. Douvillé**: A curious meteorological phenomenon. A description of a form of globular lightning producing mechanical effects but showing no sign of electrical action.—**E. Bataillon** and **Tchou Su**: Activation, the elimination of a polar globule, and polyvoltinism in the *Bombyx* of the mulberry tree.—**Paul Delens**: The projective geometry of congruences of curves.—**E. Kogbetliantz**: The series of Hermite and of Laguerre.—**G. Kolossoff**: An application of the formulæ of Schwarz, Villat, and Dini to a plane problem of elasticity.—**Tournayre**: The calculation of secondary ribs in reinforced concrete.—**Ch. Bertin**: The determination of the point by radiogoniometry.—**J. Fallou**: The transmission of polyphase high frequency currents along cables for the transport of energy and the selective protection of electric networks.—**L. Hackspill** and **R. Lauffenburger**: The action of heat on the alkaline diacid phosphates. The salts studied ($NaH_2(PO_4)2H_2O$, $Na_2H_2P_2O_7 . 6H_2O$, $LiH_2(PO_4)$, $KHPO_4$, $K_2H_2P_2O_7$) lose water of crystallisation in a vacuum at well defined temperatures. The dehydration of ortho into metaphosphate generally takes place with intermediate formation of pyrophosphate, and in certain cases through tetraphosphate. — **André Meyer** and **Robert Vittenet**: The homophthalimides substituted in the nitrogen by aromatic radicals.—**Louis Bounoure**: The existence of a germinal determinant in the undivided egg of the russet frog.—**C. Levaditi** and **P. Lépine**: The study of 45 elements from the point of view of their curative properties in spirilloses, syphilis, and the trypanosomiases. Only 10 of the 45 elements studied have therapeutic properties as regards such diseases.

Cape Town.

Royal Society of South Africa, July 15.—**W. Pugh**: The influence of fluoride ions upon the reduction of potassium permanganate. (1) Reduction with antimonious salts. In an attempt to overcome the difficulty of the fading of the end point in the estimation of antimony by the permanganate method, the effect of potassium fluoride was investigated. The consumption of permanganate increased by 25 per cent, and the solutions developed colours characteristic of manganic ion. The end point was, however, sharply distinguishable.—**P. R. v. d. R. Copeman** and **F. J. Dillman**: Decomposition of guano. During storage in an air-dry condition there is a loss of total nitrogen due to the loss of ammonia from guano. In a moist condition the uric acid in guano becomes converted into ammonium compounds and on subsequent drying there is an increased loss of nitrogen.—**A. C. Leeman**: The antimony electrode as a means for *p*H measurements. The antimony electrode was tested on various buffers and soil solutions under controllable temperature conditions. It has been found that the potentials are not reproducible, showing a constant drift and extraordinary differences in potential when the same liquid is tested on different days.

Geneva.

Society of Physics and Natural History, June 4.—**Georges Tiercy**: The variation of the radial velocity of U Aquilæ. The author has employed an indirect method of determining the curve of radial velocities of the star U Aquilæ. He compares the result obtained with that given by the Mount Wilson Observatory obtained from direct measurement of spectrograms.—**R. Wavre**: (1) The theory of potential. The author shows that two distinct bodies having the connexion of the massive sphere cannot create the same potential, either round a point common to them if they have a small portion of common surface, or at any point in space if they are separated.—(2) Small vibrations of fluid stars. The author shows that the uniform method for research on the planetary figures applies also to stars which alter their shape in course of time; he applies it in particular to small movements and to the phenomena of tides on a perfectly fluid star.

Leningrad.

Academy of Sciences, *Comptes Rendus*, 1931, No. 4.—**B. Gerasimovic**: Probability theorems connected with the discovery of variable stars by a photographic method. Formulæ are given for cepheids and long-period variables, for eclipsing variables and for the probable number of variables in the field.—**V. Barovskii**: Description of a new species of the genus *Malthodes* Kiesw. (Coleoptera, Cantharididæ). *Malthodes kiritchenkoi* sp. n. is described from the Ussuri province.—**G. Nadson** and **G. Burgwitz**: Yeasts from the North Polar ocean. Yeasts belonging to the genus *Torula* have been found on the surface of sea-weeds *Laminaria saccharina*, *Alaria esculenta*, *Fucus vesicolosus* and *Rhodymenia palmata*. The yeasts can develop at the temperature of 2°-4° C. The addition to the nutritive medium of 3 per cent of salt from the sea water depressed the intensity of the development of the yeasts. This suggests that the marine yeasts originated on land and only adapted themselves to life in sea.—**A. Krylov**: One of the main causes of the loss of airships *R* 38, *R* 101, and others. The author believes that the reason for airships breaking across the middle is the insufficient area of the rudder, which is therefore unable to withstand lateral forces when turning.—**A. Fersman**: A new law on the composition of granitic pegmatites. Pegmatite processes may be regarded as a series of systems in equilibrium subjected to fundamental physico-chemical laws. Pegmatite solutions must be considered as closed systems.

MELBOURNE.

Royal Society of Victoria, July 9.—L. A. Thomas: The readvancement of the vegetation over the mined areas of Bendigo.—**F. Chapman and Irene Crespin**: New species of *Lepidocyclina*, *L. hamiltonensis* and *L. howchini*, are described from a bore at Hamilton, Western Victoria. Other species hitherto found only in the East Indies, namely, *Lepidocyclina martini* and *L. radiata*, are illustrated from bores at Hamilton and Gippsland. *L. sumatrensis* var. *mirabilis*, lately described from the island of Formosa, is recorded from the Lower Miocene of Victoria. *Miogypsina mamillata* and *M. saitoi*, recently described from Formosa, are illustrated from borings and outcrops at Matapau, New Guinea.—**F. Chapman**: Two new Australian fossil king-crabs.—These belong to the orders Xiphosura and Synxiphosura respectively. *Pincombella belmontensis*, gen. et sp. nov., is a small though interesting predecessor of the living king-crabs and allied to the Carboniferous genus *Belinurus*; it was discovered at Belmont, Newcastle, N.S. Wales, and is of Permian age. The second form, *Hemiaspis tunnecliffei*, is related to one of the four species hitherto known from the Silurian of Scotland.

ROME.

Royal National Academy of the Lincei, March 15.—U. Cisotti: Determination of the function of a regular complex variable in a known circular corona: the real part on the external circumference and the imaginary part on the interior.—**M. La Rosa**: New proof of the influence of motion of the source on the velocity of light: ballistic explanation of Miss Leavitt's law (1).—**L. Cambi and A. Gagnasso**: Cobalt nitrosodithiocarbamates. In aqueous or aqueous-alcoholic suspension, and in absence of air, cobaltous dithiocarbamates actively absorb nitric oxide with formation of complexes of the type $[(R_2N.CS_2)Co.NO]$, which are in all respects analogous to those of iron. The nitroso -*N*:*N*-dimethyldithiocarbamate and the nitroso -*N*-piperidyldithiocarbamate are described.—**F. Tricomi**: The distribution of the baricentres of plane sections of a body.—**T. Boggio**: Laplace's operator and equations of elasticity in curved spaces.—**R. Calapso**: Wilczynski's prime directrix and problems connected therewith.—**Ugo Broggi**: The integration of linear equations to the differences with constant coefficients.—**G. Racah**: Characteristics of Dirac's equations and the principle of indetermination.—**Angelina Cabras**: The expression of the work in generalised spaces.—**G. A. Barbieri**: Contribution to the knowledge of rhodium compounds. The preparation and properties of a number of rhodiothiocyanates and rhodiocyanides are described.—**M. Airoldi**: Certain fossil Corallinaceæ of the Canaries.—**Amelia Tonon**: The structure of buds of the mulberry and their development.

Official Publications Received.

BRITISH.

Chelsea Polytechnic. Prospectus, Session 1931-32. Pp. 68. Chelsea School of Horticulture and Agriculture. Prospectus, Session 1931-32. Pp. 20. Chelsea School of Art. Prospectus, Session 1931-32. Pp. 15. Chelsea School of Chiropody. Prospectus, Session 1931-32. Pp. 8. Chelsea School of Cookery, Housecraft, Dressmaking and Millinery. Prospectus, Session 1931-32. Pp. 8. Chelsea School of Metallurgy. Prospectus, Session 1931-32. Pp. 14. Chelsea School of Pharmacy. Prospectus, Session 1931-32. Pp. 18. Chelsea College of Physical Education. Session 1931-32. Pp. 11. (London.)

Department of Agriculture, Trinidad and Tobago. Flora of Trinidad and Tobago Vol. 1, Part 4: Rosales (Pars). By R. O. Williams. Pp. 197-308. (Trinidad: Government Printing Office.) *4s. 6d.*

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Vincent, for the Year 1930. Pp. iv+29. (Trinidad.) *6d.*

Trinidad and Tobago: Forest Department. Administration Report of the Conservator for the Year 1930. Pp. 22. (Trinidad: Government Printing Office.) *1s.*

Society for the Promotion of Nature Preserves. Handbook 1931. Pp. 24. (London: British Museum (Natural History).)

FOREIGN.

Bulletin of the American Museum of Natural History. Vol. 62: The Auditory Bulla in some Fossil Mammals; with a General Introduction to this Region of the Skull. By C. J. van der Klaauw. Pp. 352. (New York City.)

Pacific Science Association. Proceedings of the Fourth Pacific Science Congress, Java, May-June 1929; held under the Auspices of the Netherlands Indies Science Council and supported by the high patronage of the Netherlands Indies Government. Vol. 1: General Part and Reports on Oceanography. Pp. x+379+iv+133+15 plates. Vol. 2A: Physical Papers. Pp. x+482. Vol. 2B: Physical Papers. Pp iv+483-1093. Vol. 3: Biological Papers. Vol. vi+552. Vol. 4: Agricultural Papers. Pp. v+611. (The Hague: Martinus Nijhoff.) 60 guilders, £5; 25 dollars.

Rubber Research Institute of Malaya. Annual Report, 1930. Pp. 134. (Kuala Lumpur.) 1 dollar.

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol 31, Part 2: Beitrag zur physikalischen Chemie der Chromgerbung. Von Satoshi Sawayama. Pp 19-164. (Tokyo: Maruzen Co., Ltd)

Proceedings of the Imperial Academy. Vol. 7, No. 7, July. Pp. xix-xx+241-290. (Tokyo.)

CATALOGUES.

A List of Books: being Publishers' Remainders and other Purchases in New Condition as Published on sale at Greatly Reduced Prices. (No. 531.) Pp. 96. (London: William Glaisher, Ltd.)

Aerograph Finishing Equipment for the Electrical Industry. Pp. 8. (London: The Aerograph Co., Ltd.)

Coal Saving, the Key to Furnace Efficiency: some Simple Instruments for Fuel Economy. Pp. 8. Flow Operated Cut-Out. Pp. 2. Improved Absolute Vacuum Recorder. Pp. 4. Improved Level Gauge for Fuel Oil Tanks, Central Heating Installations and Water Storage Tanks. Pp. 2. Automatic Temperature Regulator. Pp. 8. Edgewise Thermometers for Diesel Exhaust Temperatures. Pp. 4. (London: Negretti and Zambra.)

Parsons Uniplane Turbo Generating Plant. Pp. 4. (Newcastle-on-Tyne: C. A. Parsons and Co., Ltd.)

Diary of Societies.

FRIDAY, OCTOBER 16.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—G. A. Wedgwood: Young's Modulus for Steel in Two Directions in a Bar.—Dr. N. W. McLachlan: On the Effective Mass of Flexible Discs and Conical Diaphragms used for Sound Reproduction.—A. T. McKay: Further Study of Diffusion for the Infinite Plane Sheet.—Miss Theresa Dillon and Miss C. Lovett: Demonstration of the Effects of Mechanical Disturbance on a Neon Lamp.

HISTORICAL ASSOCIATION (at 22 Russell Square), at 5.30.—Sir Bernard Pares: Russia since the War.

INSTITUTION OF MECHANICAL ENGINEERS (Special General Meeting), at 6.—Approval of Draft By-Laws.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Annual General Meeting) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—J McGovern: Presidential Address.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at 36 George Street, Manchester), at 7.—Dr. A. F. Kertess: The Chemical Development of Modern Textile Finishing Products.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.15.—J. Bird: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with Institute of Chemistry) (at Thomas' Café, Swansea), at 7.30.—C. M. W. Grieb and R. H. Jones: The Influence of Sulphur Compounds on the Extraction of Nickel by the Carbonyl Process (Lecture).

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION (at Royal Society of Arts), at 7.30.—Dr. W. Beaumont: Light Therapy, with particular reference to Ultra-Violet Irradiation.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—C. C. Berger: The Characteristics of Commercially Pure Iron.

NELSON TEXTILE SOCIETY (at Nelson Technical College), at 7.30.—J. Loxham: Wonderful Products from Coal.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology, Medicine, and Psychiatry Sections), at 8.15.—Discussion on Medical Indications for Premature Termination of Pregnancy.

Royal Society of Medicine (Physical Medicine and Radiology Sections), at 8.30.—Dr. F. G. Thomson and Prof. W. Morison: Presidential Addresses.

SATURDAY, October 17.

Institution of Municipal and County Engineers (Southern District) (at Municipal Buildings, Newbury), at 11.15.

Institute of British Foundrymen (Lancashire Branch, Burnley Section) (at Technical School, Accrington), at 6.30.—F. J. Cook: Cylinders, for Steam, Diesels, and Compressors.

MONDAY, October 19.

Genetical Society (at Linnean Society), at 3.30.—Dr. C. B. Bridges: Genic Balance and Related Problems.

Royal College of Physicians of London, at 4.—Dr. R. Hutchison: Harveian Oration.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—P. M. Hogg: Chairman's Address.

Institute of Brewing (London Section) (at First Avenue Hotel).—T. R. Dixon: Acids as Enzymic Activators in Malt and their Effect on Mashing Operations.

TUESDAY, October 20.

Royal Society of Medicine, at 5.30.—General Meeting.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of May, June, July, August, and September 1931.—S. L. Hora: Biological Notes on a Loricariid Fish from Brazil in the Society's Aquarium.—Dr. Ida Mann: Iris Pattern in the Vertebrates.—Margaret H. Fullarton: Notes on the Respiration of the Lungfish, *Lepidosiren*.—A. G. Lowndes: A Small Collection of Entomostraca from Uganda collected by Mr. G. L. R. Hancock.—V. V. Hickman: A New Family of Spiders.—G. Jennison: Cobras bred at Belle Vue Zoological Gardens, Manchester.

Institute of Fuel (at Institution of Mechanical Engineers), at 6.—Sir Hugo Hirst, Bart.: Presidential Address.—B. Pochobradsky: Selected Problems relative to the Coal Industry.

Institute of Transport (at Institution of Electrical Engineers), at 6.—H. W. Payne: Some Present Limitations in the Transport of Freight Traffic by Railway, with Suggestions.

Illuminating Engineering Society (at Lighting Service Bureau, 15 Savoy Street), at 6.30.—Report on Progress in Illuminating Engineering; Exhibits of Photometric Apparatus, Novel Lighting Fittings, etc.

London Natural History Society (at London School of Hygiene and Tropical Medicine), at 6.30.—Dr. G. Carmichael Low: Some Structural Observations on the Waders (*Scolopacidæ*) and their Bearings on the Classification of the Family.

Institution of Electrical Engineers (North-Western Centre) (at Midland Hotel, Manchester), at 7.—L. Romero: Chairman's Address.

Institution of Electrical Engineers (Scottish Centre) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof. G. W. O. Howe: Chairman's Address.

Iron and Steel Institute (jointly with Sheffield Metallurgical Association) (at Sheffield Metallurgical Club, Sheffield), at 7.30.—J. H. Andrew, W. R. Maddocks, D. Howat, and E. A. Fowler: Equilibrium of Certain Non-Metallic Systems.—W. H. Cunningham and J. S. Ashbury: Surface Hardening by Nitrogen of Special Aluminium-Chromium-Molybdenum Steels on a Production Basis.—G. A. Hankins and M. L. Becker: Effect of Surface Conditions produced by Heat Treatment on the Fatigue Resistance of Spring Steels.—B. Matuschka: Solidification and Crystallisation of Steel Ingots: The Influence of the Casting Temperature and the Undercooling Capacity of the Steel.

Royal Aeronautical Society (Bristol Branch) (at Bristol).—E. G. Gordon England: Soaring Flight; its Function in Aviation.

Institute of Brewing (Scottish Section) (at Caledonian Hotel, Edinburgh).—G. H. Gemmell and R. G. Thin: Some Notes on Water Analysis.

WEDNESDAY, October 21.

Royal Microscopical Society (at B.M.A. House, Tavistock Square), at 5.30.—Dr. R. S. Clay and T. H. Court: Some Early Achromatic Microscopes—Fraunhofer's Microscopes.—Dr. G. M. Findlay: Virus Inclusions in Mice Livers.

Iron and Steel Institute (jointly with Manchester Metallurgical Society) (at Engineers' Club, Manchester), at 7.—G. A. Hankins and M. L. Becker: Effect of Surface Conditions produced by Heat Treatment on the Fatigue Resistance of Spring Steels.—Prof. F. C. Thompson and R. Willows: A Critical Study of the Origin of the Banded Structure of a Hot-worked Hypo-eutectoid Steel.

Institution of Production Engineers (Birmingham Section) (at Grand Hotel, Birmingham), at 7.—T. G. Heckles: Control of Factory Production.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—I. Scott Mackenzie: Chairman's Address.

Folk-Lore Society (at Cecil Sharp House, 2 Regent's Park Road), at 8.—Miss Maud Karpeles: English Folk Dances, their Survival and Revival (with Illustrations by members of the English Folk Dance Society).

St. Paul's Ecclesiological Society (at Royal Institute of British Architects), at 8.—N. H. Baynes: The Sacred Picture in the Greek Church.

Society of Glass Technology (at Science Museum), at 8.—E. Meigh: The Future of Glass Melting (Presidential Inaugural Address).

THURSDAY, October 22.

Society of Glass Technology (at Science Museum), at 4.45.—Prof. W. E. S. Turner: Modern Artistic Glass (Lecture).

Linnean Society of London, at 5.—P. R. Lowe: Exhibit illustrating Structural Diversity in Charadriine Genera Correlated with Similarity of Colour-pattern.—S. H. Lele: The Circulation of Blood in the Air-breathing Chambers of *Ophiocephalus punctatus* Bloch.—Rev. H. J. Riddelsdell: Exhibit of Dried Specimens of the Yellow-flowered Privet.—Dr. L. Cockayne and Dr. W. A. Sledge: A Study of the Changes Following the Removal of Subalpine Forest in the Vicinity of Arthur's Pass, Southern Alps, New Zealand.

Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. A. F. Tredgold: Some Observations on Mental Development (Cockburn Memorial Lecture).

Institution of Electrical Engineers, at 6.—Capt. J. M. Donaldson: Presidential Inaugural Address.

Institute of Marine Engineers (jointly with other Societies) (at Institution of Mechanical Engineers), at 6.—A. Bjorklund: Marine Reciprocating Steam Plants: Some Outstanding Factors of Economy.

Institute of Metals (Birmingham Local Section) (at Birmingham University), at 7.—Sir William Larke: Inaugural Address.

Royal Aeronautical Society (Gloucester and Cheltenham Branch).—Nickel and its Alloys (Lecture).

FRIDAY, October 23.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Nature and Extent of the Changes which have Affected the Jaws of English People in Recent Centuries.

Institution of Mechanical Engineers, at 6.—Lt.-Col. E. Kitson Clark: Presidential Address.

Junior Institution of Engineers, at 7.30.—I. Fagelston: Some Instruments used in connexion with Power Plant.

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.—Prof. Major Greenwood: The General Register Office (Presidential Address).

Royal Aeronautical Society (at Merchant Taylors' School).—C. R. Fairey: Lecture.

PUBLIC LECTURES.

FRIDAY, October 16.

University College, at 5.—Dr. L. E. Bayliss: The Respiratory Functions of the Blood. (Succeeding Lectures on Oct. 23 and 30 and Nov. 6.)

Institution of Electrical Engineers, at 5.30.—E. C. Crittenden: The Measurement of Light: its Basis and its Significance. (Succeeding Lectures on Oct. 21, 23, 26, and 28.)

SATURDAY, October 17.

Royal Institute of British Architects, at 3.—H. S. Goodhart-Rendel: Some Opinions upon Furniture and Decoration.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Success and Failure in the Animal World.

MONDAY, October 19

London School of Economics, at 5.—Prof. P. Denis: Some Geographical Problems in South America. (Succeeding Lectures on Oct. 20 and 21.)

University College, at 5.15.—Prof. F. Tobler: The Development of the Organism of Lichens: An Introduction to General Lichenology. (Succeeding Lectures on Oct. 20 and 22.)—At 5.30.—Prof. F. W. Thomas: Kings and Emperors of Ancient India.

University of Leeds, at 8.—Prof. J. W. Cobb: The Kitchen Grate.

TUESDAY, October 20.

University of Leeds, at 5.—Prof. T. T. Read: The Rôle of Dentistry in Preventive Medicine.

King's College, London, at 5.30.—Sir Bernard Pares: Russian History to 1861: Kiev and the Water Road.

Gresham College, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lecturers on Oct. 21, 22, and 23.)

WEDNESDAY, October 21.

Royal Institute of Public Health, at 4.—Sir Leonard Hill: Light and Air and the Health of the Citizen.

London School of Hygiene and Tropical Medicine, at 5.—Lt.-Col. G. E. F. Stammers: Tropical Hygiene. (Succeeding Lectures until Oct. 30.)

Armstrong College (Newcastle-upon-Tyne), at 5.30.—Prof. Irvine Masson: Problems in the Teaching of Science (Alexander Pedler Lecture).

THURSDAY, October 22.

King's College, London, at 5.30.—Dr. Eveline Martin: West Africa of To-day: Southern Nigeria: the Country, the People, and some Education Problems.

Pharmaceutical Society of Great Britain, at 5.30.—F. Wokes and F. J. Dyer: Some Applications of Bio-chemistry to Modern Pharmaceutical Problems.

SATURDAY, October 24.

Royal Institute of British Architects, at 3.—A. S. G. Butler: Tendencies in Modern Buildings.

Horniman Museum (Forest Hill), at 3.30.—F. A. Rudd: The Legacy of Antiquity.

EXHIBITION.

October 21 to December 31.

Exhibition of Modern Technical and Artistic Glasses (at Science Museum, South Kensington). (Formal opening by Sir Richard Gregory, Bart., on Wednesday, Oct. 21, at 4.)

ANNUAL MEETING.

October 31 to November 2.

International Society of Medical Hydrology (at American Hotel, Amsterdam).—Discussions on the Influence of Chill in the Causation of Disease, opened by Profs. Schade and van Loghem, and on Factors in Marine Treatment, opened by Prof. Moll and Dr. Haberlin.

NATURE

SATURDAY, OCTOBER 24, 1931.

CONTENTS.

PAGE

Native Administration in Africa 685
London and the British Association . . 687
Insects and Climate. By F. A. D. 689
Short Reviews 690
Maxwell and Modern Theoretical Physics. By Prof. Niels Bohr, For.Mem.R.S. 691
The Temples of Yucatan: Work of the Scientific Restorer 692

Obituary:

Prof. Percy Groom, M.B.E., F.R.S. By J. B. F. 695
Sir William Simpson, C.M.G By Prof. R. T. Hewlett 695
News and Views 696

Letters to the Editor:

Age of the Oldoway Bone Beds, Tanganyika Territory.—L. S. B. Leakey, Arthur T. Hopwood, and Prof. Hans Reck 724
The Mercury Band Spectrum in Fluorescence.—The Right Hon. Lord Rayleigh, F.R.S. . . 724
Constitution of Thallium and Uranium.—Dr. F. W. Aston, F.R.S. 725
Raman Lines due to Co-ordination Bond.—Prof. D. M. Bose and S. Datta 725
Melting Points of Nitrobenzene and of Benzene.—Prof. Irvine Masson 726
Spectrum of Glow-worm.—Dr. L. A. Ramdas and L. P. Venkiteshwaran 726
The Viscosity of Liquids.—Prof. G. W. Stewart . 727
Nature of Viruses.—Prof. A. E. Boycott, F.R.S. 727
Spin of Light Quanta.—Sir C. V. Raman, F.R.S., and S. Bhagavantam 727
Research Items 728
Astronomical Topics 729
Africa in Transition 730
Control of Finance 730
The Unit of Atomic Weight 731
The Greenland Cod. By G. A. S. 731
The Fortin Barometer 732
University and Educational Intelligence . . . 732
Birthdays and Research Centres 733
Societies and Academies 733
Official Publications Received 735
Diary of Societies 736

SUPPLEMENT

The Evolution of the Universe. By H. D. . . 699

Contributions to a British Association Discussion on the Evolution of the Universe.

Sir James Jeans, F.R.S. 701
Abbé G. Lemaître 704
Prof. W. de Sitter 706
Sir Arthur Eddington, F.R.S. . . 709
Prof. Robert A. Millikan 709
Prof. E. A. Milne, F.R.S. 715
General the Right Hon. J. C. Smuts, P.C., C.H., F.R.S. 718
The Right Rev. E. W. Barnes, F.R.S. . . 719
Sir Oliver Lodge, F.R.S. 722

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Native Administration in Africa.

DURING the past few years, incidents have occurred from time to time in certain parts of the British Empire which suggest that British administrators are losing their hold on the minds, if not the affections, of the indigenous races of the tropics. There can be no doubt that, if greater insight into the feelings and prejudices of the native races had been shown, recent difficulties in India, Burma, and East and West Africa would not have arisen, or would never have reached such an acute stage. There is no excuse for this state of affairs so far as our relations with the African Negro are concerned, since as a rule he started with a great admiration and friendliness for the European, while the workings of his mind are atune to ours and run to a large extent on parallel lines.

It is a truism to say that no people can be efficiently ruled and influenced without sympathy and that true sympathy cannot be given without a more than superficial knowledge of their religious beliefs and old customs. This point was emphasised by Lord Lugard in his recent lecture before Sections E and H of the British Association, an account of which appears elsewhere in this issue. Yet it is still insufficiently grasped by the British people as a whole, and even by those who are engaged in colonial administration. To this must be ascribed very largely the growing dissatisfaction and unrest which have been so evident of late years.

Take, for example, Nigeria, one of the greatest possessions of the British Crown and of immense economic value to the whole world, both from the number (some 20,000,000) and the industrious character of its population and from the great natural resources of the land. There is probably no country where a knowledge of the beliefs and customs of the people is of such paramount importance, and none where the study of these matters has received less consideration. The unhappy change which has there taken place in the feelings of the natives towards the administration, has been to a certain extent brought about by unavoidable causes, such as the world disturbances due to the War and the consequent trade depression; a misunderstanding of the phrase self-government; the departure of a large number of the older and more experienced officers and their replacement by young men (cadets now go out at the age of about twenty-two) of no experience and perhaps of greater inclination to hasty action; and the rapid spread of motor communications, which encourages officials to remain more in central towns and to confine their travelling to quick journeys in cars along the main roads, instead of, as in the old days, going slowly from place to place on foot or by bicycle, visiting even the smallest villages and getting to know the people thoroughly.

The chief cause of dissatisfaction in Southern Nigeria, however, has undoubtedly been the methods employed in the introduction of taxation, which has occupied so large a part of the officials' time since 1926. Unfortunately, the preliminaries for this momentous step were entrusted to officers with little experience of the country or acquaintance with the people. Those who had studied these matters and ventured to suggest the desirability of a longer preparation and further investigation were disregarded. The affair culminated, most regrettably, in the serious riots which took place at the end of 1929, and the old mutual confidence between the administrative officers and the mass of the people is now largely at an end.

It is true that, under the ægis of Sir Hugh Clifford, who was himself interested in native customs, a section on anthropology was included in the 1921 Census reports, and that, since then, two officers have been entirely engaged in anthropological studies ; little consideration, however, seems to have been given to this in the framing of government policy—though, on the Gold Coast, Capt. Rattray's illuminating investigations into the comparatively small but important Ashanti tribe met with considerable encouragement and attention.

During the last decade much stress has been laid on the necessity of learning native languages. This is all to the good, even in the southern provinces of Nigeria, where there are scores of languages and the main three are divided into so many dialects that it is difficult for an officer to become really proficient in any one of them, unless he is always stationed in the same place, which is rarely possible or desirable. The number of Europeans who could give a translation accurate enough for court purposes is very small indeed, while the African is such a remarkable linguist that, as a rule, he acquires a better mastery of English than the average European can hope to do of his tongue. English is being learned throughout Southern Nigeria so quickly that in a few years it will be the lingua franca of the whole country, a position which it has already attained on the main roads. Even so, it is very advantageous for an officer to acquire some knowledge of as many languages as possible so that he can to a certain extent check his interpreter, although this may be best achieved by care in the framing of questions ; it is generally easy to tell from the answers if these, or the statement, have been correctly translated. It is, however, of far greater importance to become conversant with the religion and customs of the people. It is not yet appreciated how largely the Negro is ruled by his religious feelings. His belief in the spiritual world is no 'accident', to be thought of occasionally and then dismissed from the mind, but forms the essence of his being ; he has, for example, to take into consideration the dead as well as the living members of his family. This information can be gained if sought with sympathy and tact and if the few more or less technical words are learned and defined.

It is probably to the new situation created by the taxation troubles, which came to the knowledge of the Secretary of State, that we owe the recent change in the attitude of the Nigerian Government indicated by the publication of three substantial volumes of ethnographical investigations ; it is to be hoped that government efforts in this direction will not cease here, even in the present straitened financial circumstances. The stress laid by Lord Passfield on the importance of anthropology has at last made clear the necessity for the study of this science. As a result, officers are now being encouraged to inquire into the indigenous social organisation before any further steps are undertaken in the way of native administration schemes.

Here, however, another danger has arisen which should be guarded against, since the inquiries have generally been made by junior officers of little experience and training. This gives rise to mistakes, and it is essential that no further changes in administration should be introduced unless all such investigations are carefully checked by men with full knowledge of the country and people—particularly as regards the native courts. The native courts have been the means of providing a very fine system of justice, despite abuses in the way of bribes (partly a relic of the old custom of both sides giving presents to the judges) and pressure by court officials, especially of late years, during which they have not been so closely supervised.

The courts are composed of the chiefs of the various villages and are only an extension of the old indigenous gerontocracies. Fortunately, native law and custom were on the whole fair and reasonable and are still in force except in such matters as witchcraft, where they conflict with European ideas. There are no legal quibbles, and there is no doubt that the common people obtain a greater degree of justice than in those courts which are under indirect rule and the influence of powerful emirs and kings. Bribery was largely checked and a general improvement shown in one province where two reforms were instituted: first, every member is allowed to sit and give judgment at each session, instead of only three or four chiefs in rotation; and secondly, the members take an oath on the strongest local juju to give a just decision—though this would only have effect in areas where the belief in jujus is still strong.

The people themselves would, on the whole, prefer to have their cases tried by the administrative officers—especially in those parts where bribery is much practised—but this is rendered impossible by the immense number of cases, even if it were not desirable that they should gradually develop their institutions in the direction of self-government. A large amount of executive power is also entrusted to the native courts, and, as a matter of fact, the greater part of the administration of the southern provinces is carried on by their means.

In the present state of affairs, the absolute necessity of paying more attention to the study of anthropology cannot be too strongly emphasised. The tropical colonies of the British Empire are vital to its existence, and there is grave danger that these will pass out of its control unless science is brought to bear in their administration.

London and the British Association.

(1) *London and the Advancement of Science.* By Various Authors. Issued by the British Association for the Advancement of Science on the Occasion of its Centenary Meeting in London, 1931. Pp. iii + 321. 3*s*. 6*d*.

(2) *The British Association for the Advancement of Science: a Retrospect, 1831–1931.* By O. J. R. Howarth. Centenary (second) edition. Pp. vii + 330 + 19 plates. 3*s*. 6*d*.

(London: British Association, 1931.)

THE object of the British Association is, and always has been, the advancement of science. By means of its annual meetings at home and in the Dominions, by financial help towards scientific research, and by the printed reports of its yearly assemblies, it has acted as a leaven in the intellectual life of our nation. Now, in its centenary year, it has published two handbooks giving further justification for its honourable and useful existence. The pair are really companion books. The latter work traces the birth, growth, and struggle for recognition in a conservative age—and the subsequent triumph—of the British Association, which has roamed from county to county, and from continent to continent, dispensing its good offices in the promotion of science. This official "Retrospect" has been compiled by Mr. O. J. R. Howarth, the secretary of the Association, and the task of collecting the material and welding it into a coherent, readable mass of information has been well performed.

From this record of the nomadic life of the Association, the first edition of which was reviewed in Nature of Sept. 2, 1922, we turn, perhaps in undue haste, to the story of "London and the Advancement of Science", written by various authors, under the general editorship of Mr. Howarth.

The book originated in a suggestion made by Dr. Allan Ferguson, which was given effect by the Council of the British Association. It contains ten chapters dealing with the learned societies, the education of London, the development of medicine, government and scientific research, and such familiar features of the metropolis as the museums, Kew Gardens, and the Royal Observatory at Greenwich. A brief history of the scientific instrument makers of London concludes the book.

Dr. Ferguson's introductory survey of the outstanding names of London men of science who may be considered the most worthy of mention in such an extended scroll, provides a foretaste of good things to come. He relates the fact, not generally known, that Chaucer was an accomplished astronomer and the author of a treatise on the astrolabe, for a long time a standard work of reference. The other names selected are those of Henry Billingsley, the first translator of Euclid into English, a Lord Mayor who lived in Candlewick Ward—a modified designation of his residential quarter persisting in the name of Cannon Street; William Gilbert, the author of "De Magnete", of whose scientific spirit and achievements Galileo had the greatest esteem; William Harvey the physician, Francis Bacon, Christopher Wren, Henry Cavendish, and William Hyde Wollaston. One other figure is among those narrated in great detail, namely, John Hill, "botanist, apothecary, physician, hackwriter, actor, and playwright". A fairly good case is made out for this man's inclusion in such distinguished company, for, in spite of his mental vagaries and diffuse occupations, "his judgments on specific points were well in advance of his age". An idea of his contemporary renown may be gathered from the fact that when George III. and Dr. Samuel Johnson met in the Queen's library, His Majesty closely questioned the famous lexicographer on what he thought of Dr. Hill. Johnson answered that "he was an ingenious man, but had no veracity". Hill asserted that he had seen objects magnified to a much greater degree by using three or four microscopes at a time than by using one. "Now," added Dr. Johnson, "anyone acquainted with microscopes knows that the more of them he looks through the less of the object appears." "Why," replied the king, "this is not only telling an untruth, but telling it clumsily."

The next two chapters describe the learned societies of London. As a tribute to its eclecticism, a whole chapter is given to the Royal Society. Then follow brief but interesting accounts of the Royal Society of Arts, the Royal Institution, and of nearly sixty other societies severally connected with all the ramifications into which systematised knowledge leads men of science, covering in their entirety close on one hundred pages. The undergraduate might read these chapters with profit, before deciding on a future career, and a thesis might be evolved from them, correlating our economic and contemplative life with the growth of these numerous scientific societies. By the way, no mention is made in the book of the London Institution, at one time the rival of the Royal Institution.

The chapter devoted to government and scientific research describes the various departments that watch continually over the private and public needs of our nation, safeguarding and promoting our welfare in times of peace and defending us in the hour of war. No longer is it left to a Bishop Watson to improve the manufacture of gunpowder, or to undertake private afforestation to demonstrate the latent resources of a vacant countryside. Before Parliament would pay a Mrs. Stephens £5000 for divulging her remedy for stone, a Government analyst would detect the soap and snail shells contained in the nostrum. The problem of the resistance of water to moving vessels is nowadays investigated in the experimental tanks of the National Physical Laboratory and not, as it once was, in the vats of Capt. Beaufoy's brewery.

London's heritage of science is abundantly witnessed in her magnificent museums. They show no signs of diminution either numerically or in popularity. They are not curiosity shops on a large scale, but storehouses of information for the studious and pleasure haunts for the general public. Dr. Bather's record contains descriptions of more than three score of them, as well as an interesting foreword on many which have been absorbed or dispersed. Little did men like Tradescant, Lever, and Bullock dream that museums run for profit would be replaced by free institutions worthy of taking a place among the stateliest buildings of the city.

The volume closes with a brief account of the history of the London makers of scientific instruments, by Mr. R. S. Whipple. Besides being skilled craftsmen with a European reputation for the excellence of their work, many of these men have signed the charter book of the Royal Society. Graham's mercury pendulum still beats out the seconds, Ramsden's eyepiece and his dividing engine are well known to all physicists, and the name of Dollond is a household word. Room might have been found for a few more. The most serious omission, however, is the name of Edward Nairne, who lived in Cornhill. His business premises were the rendezvous of men like Canton, Henly, Ingenhousz, and even the shy, retiring Henry Cavendish. Nairne made an electrical machine for Priestley and was among the first to freeze water with the help of an air pump, the receiver of which contained strong sulphuric acid. He was a fellow of the Royal Society and instrument maker to the Royal Exchange.

Throughout the book, the part that London has played in the advancement of science is generously and entertainingly told. Of course, no single volume could fully encompass the scientific history of the City of London. Indeed, the task of the authors must at times have been one of exclusion rather than of inclusion. Much could be said of London's coffee-houses and inns. At "Rawthmell's" the Royal Society of Arts was founded. Wollaston and Thomas Thomson converted Davy to the atomic theory at the "Crown and Anchor". Think, too, of the experiments that have been carried out in the public parks: Faraday, Woodward, Smeaton, Stanhope, and Tyndall in Hyde Park; Benjamin Franklin on Clapham Common; Hawksbee at White Conduit Fields, and so on. What of the Halls of Delight, the Adelaide Galleries, and the Pantheon, that amused our grandparents with the latest inventions and scientific discoveries?

These and other miscellaneous features that come to mind might form another chapter, but doubtless the task which the Council set out to achieve has been satisfactorily accomplished, and the extensive literature on our wonderful city is the richer for this comprehensive volume. A few errors of orthography have been noted. In "The British Association for the Advancement of Science", page 13, Brewster's address should be Allerly and not Allerby. In "London and the Advancement of Science", page 110, Allan should be Allen; page 168, Dionysius is misspelt Dionysus; and page 259, Carlile should be Carlisle. These mistakes are, of course, repeated in the Index, where other errata occur; thus Sisson's Christian name is given as Johnathan; J. S. Smith should be J. E. Smith; J. Clark Maxwell is obviously incorrect, so is Humphrey Davy, and Leeuwerhoek should be Leeuwenhoek.

Insects and Climate.

The Transactions of the Entomological Society of London. Vol. 79, Part 1, April 24. Pp. 247. (London: Entomological Society of London, 1931.) 21*s.*

SOME two years since, Mr. B. P. Uvarov, well known as a leading authority on insect nutrition and metabolism, and more particularly for his work on the periodicity of locust invasions, undertook at the instance of the Dietetics Committee of the Committee of Civil Research, and under the auspices of the Empire Marketing Board, a survey of insects in relation to climate. This work was carried out by Mr. Uvarov with extraordinary diligence, and the result of his labours is embodied in an important contribution which forms a separate part of the *Transactions of the Entomological Society of London* for the year 1931.

The treatise is divided into two principal parts; in the first of which the physical factors of insect life, namely, heat, humidity, light, atmospheric pressure, and electricity, are considered with special reference to the part they play in insect physiology; while the second part is concerned with the practical bearing of the foregoing data on such insect activities as movements, feeding, reproduction, abundance, and distribution; the whole with an eye to problems of economic entomology in the widest sense. It will be seen that the scope of the work is extensive, and the labour of consulting and summarising the literature of the subject must have been great. The author states that out of 1300 books and papers examined, more than 1150, written in eleven languages, furnished material for his summary.

Throughout the work, Mr. Uvarov is careful to point out the necessity of obtaining, where possible, quantitative data both by experiment and observation; thus he shows that in spite of a well-grounded opinion that the swarming of certain insects is influenced by conditions of atmospheric pressure, no definite conclusion on the matter can be reached in the comparative absence of exact statistical data. The same applies to the alleged influence of the electric state of the atmosphere.

An interesting section is devoted to the consideration of seasonal cycles. Pictet's experiments, showing that in six generations a substantial change in the life-cycle of *Lasiocampa quercus* could be produced in adjustment to new conditions, suggest to the author the direct inheritance of acquired response to climatic influence. It may be remembered that a similar suggestion was made many years ago by Weismann in the case of *Heodes phlœas* and its modification *eleus.* But, as Mr. Uvarov reasonably allows, the subject awaits further experimental investigation. The experiments of Süffert with the well-known butterfly *Araschnia prorsa-levana* are spoken of in the same section as giving an entirely new aspect to the problem of seasonal dimorphism, but it may be questioned whether they have added anything material to what had already been established by Merrifield. The latter investigator, it is true, made no use of the term 'diapause' proposed by Henneguy and adopted by Süffert in the sense of a period of dormancy, but the fact itself, with its implications, appears and is recognised in the work of the older authority.

Attention is also directed to the careful experiments of Sir G. A. Marshall with tropical African butterflies. In these, definite results were obtained by the employment of varying conditions of temperature and humidity separately and in combination. The influence of each of these as a factor was clearly established, but it is not easy to see how the results harmonise, as is alleged by the author, with Süffert's "idea that the production of seasonal forms is connected with the type of development, *i.e.* with the presence or absence of a diapause". This dictum seems to call for expansion.

In the concluding section of the work, the data so assiduously collected are applied, under the comprehensive head of climatic influences, to the practical study of the problems of economic entomology. Various means of control of insect-caused injuries of plants and of insect-borne diseases of man are brought under review, and the importance of exact knowledge of climatal conditions for the destruction or checking of insect pests is duly emphasised. The whole leads up to a discussion of the possibility of forecasting the course of events in the life of insects, especially as to "the seasonal appearance of pests, the years of outbreaks, and the ability of an introduced pest to survive in a new country". This calls for an intimate knowledge of many subjects as to which, as the author says, our information is limited and fragmentary.

Nothing is more noteworthy in this admirable treatise than the discrimination with which, while the existence in some cases of relevant and well-attested data is approved, their absence or insufficiency in others is admitted. We are frequently reminded, by the author's method, of Bacon's unsparing analysis of existing knowledge in his "Advancement of Learning". But it is further to be remarked that although, in the course of investigation of causes, stress is constantly laid on the importance of quantitative estimates, the author is on his guard against "a blind faith in statistical methods", which if used without due caution involve mainly a mechanical process instead of a course of reasoning prompted by the valuation on biological lines of the appropriate and relevant data.

F. A. D.

Short Reviews.

International Research Council: International Astronomical Union (Union Astronomique Internationale). Report of Commission 3: *Atlas céleste.* Par E. Delporte. Pp. 6 + 26 cartes. (Cambridge: At the University Press, 1930.) 5*s.* net.

THE confusion caused by the rather indefinite and entirely irrational delimitation of boundaries between constellations has now been successfully attacked by the International Astronomical Union's commission on notation. No reform could be reasonably expected to ignore entirely the old traditional boundaries, or to transfer important stars into adjacent constellations, and this point has been fully recognised by the commission. The suggested scheme defines boundaries everywhere as portions either of hour circles or parallels of declination, but in such a way as to follow approximately the old boundaries. Nearly all stars with Bayer or Flamsteed designations, and all variables discovered before July 1929, remain in the constellation to which they were previously assigned.

A twofold importance attaches to this work, in that the maximum amount of rationalisation is introduced and also that the boundaries are finally standardised, since the approval of the scheme by the General Assembly of the Union makes it internationally authoritative. Delporte's excellent atlas covers the whole sky in 26 maps, showing stars down to the sixth magnitude with the new constellation boundaries. The printing is good, and the scale resembles that of Norton's atlas, although more stars are depicted than in Norton's or other similar atlases. Opposite each map is a table of all stars down to magnitude 4·5, as well as variables, double stars, and important nebulæ or clusters; giving positions for 1875 and 1925, magnitudes, and spectral types. At the end are given two charts in which are inserted the exact right ascensions or declinations of the boundaries at all points. The atlas deserves to rank high amongst others of its size, quite apart from its indispensability for purposes of reference.

Health and Education in the Nursery. By Victoria E. M. Bennett and Susan Isaacs. Pp. xiv + 308. (London: George Routledge and Sons, Ltd., 1931.) 6*s.* net.

THE scientific study of motherhood and of babyhood has made great headway in recent years, and has made possible the production of such a book as this, a book which combines simplicity of statement with accuracy of fact. Its contents were formerly published as two separate volumes, which are here expanded and united. The old-fashioned 'mother's manual' was usually written by a doctor—of course, a man—who restricted his advice to that which concerned the welfare of the body. It is a sign of the times that this book is written by two women, and that it deals at equal length with the bodily and the mental aspects of healthy growth and development.

In a sense, Miss Bennett's task was the easier, because the facts and principles of physiology and hygiene belong to the realm of positive science. Mrs. Isaacs, on the other hand, sometimes has to handle matters of opinion, as, for example, the time and manner of sex instruction for children, if it is given at all. But readers of Mrs. Isaacs' previous publications on similar subjects will be prepared to find that she is always suggestive and never dogmatic.

The Concentric Method in the Diagnosis of Psychoneurotics. By Prof. M. Laignel-Lavastine. (International Library of Psychology, Philosophy and Scientific Method.) Pp. x + 217. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1931.) 10*s.* 6*d.* net.

IN the book before us, Laignel-Lavastine presents his methods of examination and treatment of the psycho-neurotic in a series of lectures which were originally delivered at La Pitié Hospital, Paris. His method consists of emphasising the manifold aspects of any case of mental disorder. It is not a case of whether this is a psychogenic or a physiogenic disorder, but how much of this disorder is psychogenic and how much is physiogenic. He describes four concentric zones with a "morbific kernel" at the centre. The zones from within, outwards, are the visceral, the endocrine, the nervous, and the psychic. In every case it is essential to investigate these zones and evaluate their respective values in etiology. His attitude towards psychotherapy is essentially that of the French school headed by Janet. For the teaching of Freud he has no great affection. To those who have confession as part of their religious creed there is no great need for Freud—so says Lavastine.

Maxwell and Modern Theoretical Physics.*

By Prof. NIELS BOHR, For.Mem.R.S.

I FEEL greatly honoured in being given this opportunity of paying a tribute of reverence to the memory of James Clerk Maxwell, the creator of the electromagnetic theory, which is of such fundamental importance to the work of every physicist. In this celebration we have heard the Master of Trinity and Sir Joseph Larmor speak, with the greatest authority and charm, of Maxwell's wonderful discoveries and personality, and of the unbroken tradition upheld here in Cambridge connecting his life and his work with our time. Although I have had the great privilege, in the years of my early studies, of coming under the spell of Cambridge and the inspiration of the great English physicists, I fear that it may not be possible for me to add anything of sufficient interest in this respect, but it gives me very great pleasure indeed to be invited to say a few words about the relation between Maxwell's work and the subsequent development of atomic physics.

I shall not speak of Maxwell's fundamental contributions to the development of statistical mechanics and of the kinetic theory of gases, which Prof. Planck has already discussed, especially as regards Maxwell's fruitful co-operation with Boltzmann. It is only my intention to make a few remarks about the application of the electromagnetic theory to the problem of atomic constitution, where Maxwell's theory, besides being extremely fruitful in the interpretation of the phenomena, has yielded the utmost any theory can do, namely, to be instrumental in suggesting and guiding new developments beyond its original scope.

I must, of course, be very brief in commenting upon the application of Maxwell's ideas to atomic theory, which in itself constitutes a whole chapter of physics. I shall just recall how successfully the idea of the atomic nature of electricity was incorporated into Maxwell's theory by Lorentz and Larmor, and especially how it furnished an explanation of the dispersion phenomena, including the remarkable features of the Zeeman effect. I would also like to allude to the important contribution to the electron theory of magnetism made by Prof. Langevin, whom we much regret not to be able to hear to-day. But above all, I think in this connexion of the inspiration given by Maxwell's ideas to Sir Joseph Thomson in his pioneer work on the electronic constitution of matter, from his early introduction of the fundamental idea of the electromagnetic mass of the electron, to his famous method, valid to this day, of counting the electrons in the atom by means of the scattering of Röntgen rays.

The developments of the atomic theory brought us soon, as everybody knows, beyond the limit of direct and consistent application of Maxwell's theory. I wish to emphasise, however, that it was just the possibility of analysing the radiation phenomena provided by the electromagnetic theory of light which led to the recognition of an essentially new feature of the laws of Nature. Planck's fundamental discovery of the quantum of action has necessitated, indeed, a radical revision of all our concepts in natural philosophy. Still, in this situation, Maxwell's theory continued to provide indispensable guidance. Thus the relation between energy and momentum of radiation, which follows from the electromagnetic theory, has found application even in the explanation of the Compton effect, for which Einstein's idea of the photon has been so appropriate a means of accounting for the marked departure from the classical ideas. The use of Maxwell's theory as a guide did not fail either in the later stage of atomic theory. Although Lord Rutherford's fundamental discovery of the atomic nucleus, which brought our picture of the atom to such wonderful completion, showed most strikingly the limitation of ordinary mechanics and electrodynamics, the only way to progress in this field has been to maintain as close contact as possible with the classical ideas of Newton and Maxwell.

At first sight it might perhaps look as if some essential modification of Maxwell's theory was needed here, and it has even been suggested that new terms should be added to his famous equations for electromagnetic fields in free space. But Maxwell's theory has proved far too consistent, far too beautiful, to admit of a modification of this kind. There could only be a question, indeed, of a generalisation of the whole theory, or rather of a translation of it into a new physical language, suited to take into account the essential indivisibility of the elementary processes in such a way that every feature of Maxwell's theory finds a corresponding feature in the new formalism. In the last few years, this aim has actually been attained to a large extent by the wonderful development of the new quantum mechanics or quantum electrodynamics, connected with the names of de Broglie, Heisenberg, Schrödinger, and Dirac.

When one hears physicists talk nowadays about 'electron waves' and 'photons', it might perhaps appear that we have completely left the ground on which Newton and Maxwell built; but we all agree, I think, that such concepts, however fruitful, can never be more than a convenient means of stating characteristic consequences of the quantum theory which cannot be visualised in the ordinary sense. It must not be forgotten that only the classical ideas of material particles and electromagnetic waves have a field of unambiguous application, whereas the concepts of photons and electron waves have not. Their applicability is essentially limited to cases in which, on account of the existence of the quantum of action, it is not possible to consider the phenomena observed as independent of the apparatus utilised for their observation. I would like to mention, as an example, the most conspicuous application of Maxwell's ideas, namely, the electromagnetic waves in wireless transmission. It is a purely formal matter to say that these waves consist of photons, since the conditions under which we control the emission and the reception of the radio waves preclude the possibility of determining the number of photons they should contain. In such a case we may say that all trace of the photon idea, which is essentially one of enumeration of elementary processes, has completely disappeared.

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* Address delivered on the occasion of the Maxwell Centenary Celebrations at Cambridge on Oct 1.

For the sake of illustration, let us imagine for a moment that the recent experimental discoveries of electron diffraction and photonic effects, which fall in so well with the quantum mechanical symbolism, were made before the work of Faraday and Maxwell. Of course, such a situation is unthinkable, since the interpretation of the experiments in question is essentially based on the concepts created by this work. But let us, nevertheless, take such a fanciful view and ask ourselves what the state of science would then be. I think it is not too much to say that we should be farther away from a consistent view of the properties of matter and light than Newton and Huygens were. We must, in fact, realise that the unambiguous interpretation of any measurement must be essentially framed in terms of the classical physical theories, and we may say that in this sense the language of Newton and Maxwell will remain the language of physicists for all time.

I do not think that this is a proper occasion to enter into further details regarding these problems, and to bring new views under discussion. In conclusion, however, I am glad to give expression to the great expectation with which the whole scientific world follows the exploration of an entirely new field of experimental physics, namely, the internal constitution of the nucleus, which is now carried on in Maxwell's laboratory, under the great leadership of the present Cavendish professor. In the fact that nobody here in Cambridge is likely to forget Newton's and Maxwell's work, we see perhaps the very best auguries for the continued success of these endeavours. Even if we must be prepared for a still further renunciation of ordinary visualisation, the basic concepts of physics which we owe to the great masters will certainly prove indispensable in this new field as well.

The Temples of Yucatan: Work of the Scientific Restorer.

ALL the great eastward-jutting promontory of Yucatan and Quintana Roo is covered with the ruins of stone temples, erected by architects of great skill, and often beautifully decorated with carvings and wall paintings. Lying between the Usumacinta River and the Caribbean, the region is a low tableland of limestone, scarcely raised from the sea, its general flatness relieved only by a few hills two or three hundred feet high; no rivers run in all the promontory, the abundant rain falling between May and December soaking through the thin layer of soil—frequently no more than a few inches deep—to the natural limestone hollows that serve Yucatan as wells. Sub-tropical, genial, extremely productive where any soil exists, the country's wild covering is light woodland, with peculiar and beautiful vegetation, sheltering hosts of birds and beasts.

This is the background of one of the great puzzles of the history of mankind. For while the evidence is rich, and almost endless, of the high accomplishments of a brilliantly artistic people, the early origins of these people, the reason of their coming to Yucatan, and the causes for the abandonment of site after site, are still mysterious. The most plausible suggestions are no more than guesses, and none is even reasonably adequate to explain the undoubted fact that the builders of many a splendid complex of pyramids and temples appeared in the region, set to work to cut—with stone tools, for these superb architects and masons did not know the use of metal—huge masses of stone; to transport these masses, by man-labour, since they never had the help of the wheel; to set up and carve and paint great buildings; to house and worship their gods, and to practise their astronomical skill; and that after sometimes no more than a hundred years or so, priests and builders marched away, leaving the stately buildings to become the haunt of wild creatures, to be overgrown with trees and forgotten.

According to the calculations of modern archæologists, the erection by the Maya of stone temples (probably preceded by structures of less enduring materials, such as wood and thatch) began before the Christian era; and certain temples in Yucatan were still in occupation, as great religious and civic centres, in the early part of the sixteenth century, when the first Spaniards arrived. From the time of the Spanish conquest, the Maya and their culture suffered eclipse. A sponge was passed over the long record of their scientific and artistic attainments. With a few exceptions, to which students of American archæology owe a debt, the Spanish conquerors felt no curiosity concerning the ideas and civilisation of the vanquished people of Yucatan. They were heathen, their gods were idols; and the great pyramids merely served, when their uplifted temples were despoiled, as quarries for building material and sites for Christian churches.

The clan of learned men, priest-kings, adepts in astronomy, disappeared. They were not only the political leaders, but also the repositories of historical knowledge, experts in the art of recording. The Maya, alone among native American races, possessed a writing method, developed into an accurate system, concerned with historical and calendrical records. These records were carved in stone, and sometimes in wood, engraved in pottery, and painted upon parchment and upon paper made from the leaf of the maguey plant. The latter, collected sedulously by the Spanish missionaries, were burnt in heaps in the market-place of Merida; so careful was the search for these pagan documents that to-day only three Maya manuscripts are known to survive. The art of writing, and of reading the manuscripts and glyphs carved in stone, was irretrievably lost—although, by the irony of fate, archæologists of to-day have puzzled out the meaning of about one-third of the writing by the aid of notes made by a Bishop of Yucatan, and by that aid alone.

Broadly, it may be said that for three hundred years, between the time of the Spanish conquest and the overthrow of the authority of Ferdinand VII., Maya culture was not only crushed in its development, but also ignored. The great series of temples, extending from Copan in the present Republic of Honduras, through Guatemala, through British Honduras, and spreading all over the Yucatec promontory, remained lost in the silence of the sub-tropical woodland; trees grew in the temples and disintegrated the great stone stairways. Maya speech survived; the humble folk, conforming to Spanish ways near towns, nevertheless retained customs and a large proportion of racial purity, especially in outlying regions; and, underneath and side by side with the Christianity patiently taught by missionary priests of Spain, maintained the cult of the ancient Maya gods.

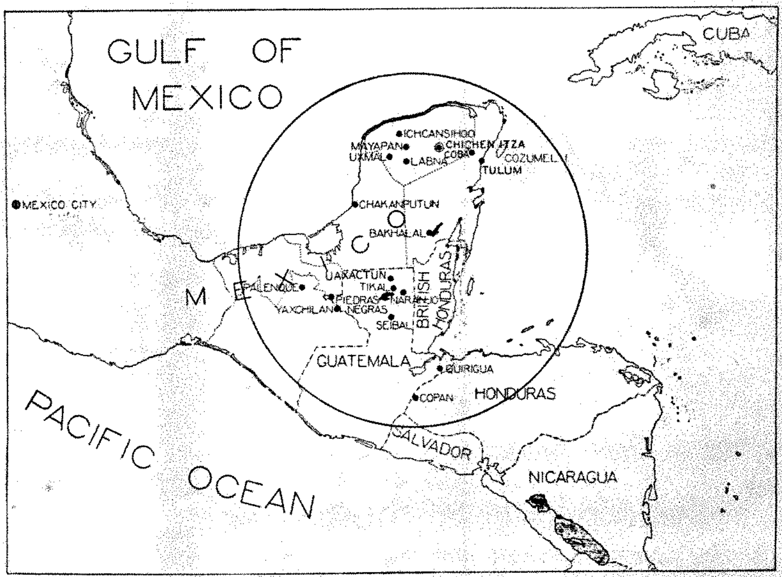

Fig. 1.—Maya region of Middle America.
From "The Temple of the Warriors at Chichen Itzá, Yucatan".

Independence in Spanish America meant the collapse of a fence guarded for three centuries, and travellers came from all parts of the world, and particularly from Europe, to visit the regions formerly forbidden. By the middle of the nineteenth century a few inquisitive and enthusiastic travellers had seen some of the Maya ruins of Central America and Yucatan, and their books had startled a world which up to then regarded Greece and Rome as the chief fountains of romantic antiquity. Most things archæological were measured by these or the Egyptian standard. Even to-day, when ethnology has become a recognised science, it is not always possible to induce the neophyte to consider early American culture as something indigenous, basic, springing from the soil of the New World. If he cannot read Asia into American art, he must have Atlantis as a link.

Nevertheless, John Lloyd Stephens' "Incidents of Travel in Central America and Yucatan" became in the eighteen-forties a 'best-seller'; the drawings of Catherwood, illustrating the genial pen of the author, render this a perennially delightful travel book. The names of the splendid ruins of Copán and Quiriguá, Palenque and Uxmal, became familiar to the English-speaking world. Nothing, however, was done at the time to restore the ruins, or to make scientific examinations; and the work of Maudslay, thirty years later, stands out as the first sustained effort to survey and record certain great sites.

The science of archæology, in fact, was only gradually attaining its stature. The serious worker in the field during the early years was hampered by heavy expenses as well as physical difficulties. The example of Lord Elgin in Greece and of Lord Carnarvon in Egypt was not for some time followed in the Americas by any investigator after Maudslay; but when public interest became extended to—for example—Crete, and Ur of the Chaldees, the time was ripe for enterprise, already engaged in the Old World, to be directed to the untilled fields of the New.

A great step forward was made when the Carnegie Institution of Washington obtained in 1923, from the Government of Mexico, a concession to work for ten years in the magnificent complex of ruins at Chichen Itzá in Yucatan (see Fig. 1).

Work was commenced in 1925, after careful preparations for many branches of scientific study to be followed, as well as for the physical work of clearing and restoration of certain ruins. For the Carnegie Institution, well supplied with funds, studies biology and linguistics side by side with archæological work; scientific surveys and photography are the work of special departments, and the labour of restoring Maya architecture is performed only after careful study. Every tool, thus, is put into the hands of the staff; the Institution has organised one of the best-equipped enterprises that has ever had the good fortune to work in the fascinating field of archæology, east or west.

Not least of the Carnegie Institution's merits is the broad line upon which the department dealing with publications is operated. In all branches of the widely distributed activities of the body, care is taken to make, preserve, and issue records of progress, generously presented to other workers in similar fields, throughout the world. To this department of publications is due a recently issued book invaluable to Americanists, produced in two volumes, dealing with the field work of the Carnegie Institution at the great complex at Chichen Itzá known as the 'Temple of the Warriors'.* The pages measure some 12 in. by 9 in., the first volume containing 485 pages of text and illustrations, while the second consists of plates, of which many are printed in colour. Three persons are responsible for this magnificent record, Earl H. Morris, M. Jean Charlot, and Ann Axtell Morris, and the colleagues are to be congratulated upon work shedding light upon an extraordinary period in the history of Yucatan. When the staff of the Chichen Itzá project began work in January 1925, the slopes of the Temple of the Warriors were densely clothed with bushes, a few axe-cut stumps showing that partial clearing had once been performed. "Presumably, this work was done by Maudslay in 1888. In thirty-seven years the forest would have had ample time to reach this stage of maturity," says Mr. Morris. Dilapidated stone carvings lay on the summit, the stairways were broken, and masses of debris were tangled with vegetation. The original design of the great complex of buildings could scarcely be perceived. To-day, as those fortunate enough to have seen Chichen Itzá lately can say, the whole series of majestic buildings, with fantastic and vivid sculptures in the round, striking reliefs, and mural decorations, stand clear from the surrounding bush. The plan of the series is complicated. From the top of the great main stairway one looks down upon acres of colonnades, while all about the white tops of other pyramids and temples rise from shrubby background under a brilliant blue sky, some still in ruin and others undergoing restoration or completed; the fine pyramid of the Castillo, for example, owes its present dignity to the work of Mexican archæologists commissioned by the Federal Government of Mexico.

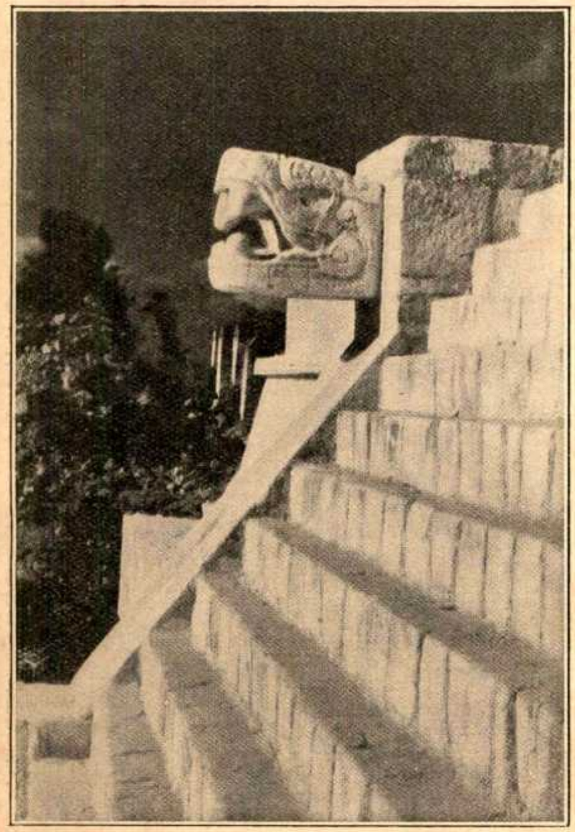

FIG. 2.—Serpent head at the top of north ramp of Warrior's Stairway. Columns of sanctuary of Temple of the Tables in the distance. From "The Temple of the Warriors at Chichen Itzá, Yucatan".

Research, skill, and unlimited patience have made the restoration of the Temple of the Warriors an act of grace. One fears the hand of the restorer, but Chichen has been fortunate; there has been no over-restoration; scrupulous care has been taken to follow ancient lines; and the result is not only satisfying to the eye but also convincing.

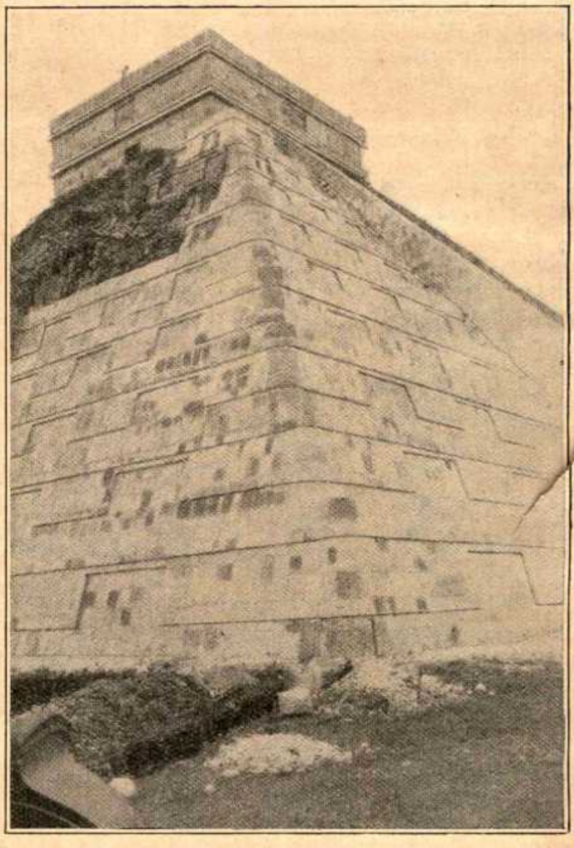

FIG. 3.—North-west corner of Castillo as repaired by Mexican Government. Panelled effect of zones of pyramid is same as finish of substructure of Temple of the Chac Mool. From "The Temple of the Warriors at Chichen Itzá, Yucatan".

The huge serpent columns, the Chac Mool figure, the atlantean altar, the mask panels of the façade, the sculptured bands that run along certain exterior walls, are beautiful examples of Maya art;

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* Carnegie Institution of Washington. Publication No. 406: The Temple of the Warriors at Chichen Itzá, Yucatan. By Earl H. Morris, Jean Charlot, Ann Axtell Morris. Vol. 1. Pp. xix+485. Vol. 2. Pp. viii+170 plates. (Washington, D.C.: Carnegie Institution, 1931.) 20 dollars.

but no less interesting are the evidences of the Maya architect's methods of construction. Stairways and vaulted chambers, columns and platforms, and enormous substructures are eloquent of the skill of these vanished people.

The Chichen Itzá project of the Carnegie Institution had devoted four field seasons of some four and a half months each to work on the Warriors when the present volume was written. Work has been under the direction of Dr. Sylvanus G. Morley throughout, who not only planned but also directed operations at Chichen. During the last twenty years, he has devoted himself to the Maya problem, and valuable results have been exemplified in his publications, as well as in the standing monument of the field work in Yucatan.

Few regions equal this strange promontory of the New World in opportunity for archæological investigation. The surface has only been scratched. Individuals and institutions able to share in the unravelling of problems in Yucatan, a chapter of the history of mankind, are to be envied.

Obituary.

Prof. Percy Groom, M.B.E., F.R.S.

Through the death of Prof. Percy Groom, which occurred at Gerrard's Cross on Sept. 16, there has passed away a man with an outlook and interests somewhat exceptional in the senior ranks of British botanists. He was born on Sept. 12, 1865, and entered Mason College, Birmingham, as a student, from which he passed to Cambridge on being elected to an exhibition at Trinity College. He obtained a first class in Part I. and a second in Part II. of the Tripos in 1887, taking botany as his principal subject. Afterwards he was elected to a Frank Smart studentship in botany at Caius College.

During his student life Groom studied for a time at the University of Bonn, where he enjoyed the friendship of the botanists, headed by the eminent Prof. Strasburger, who were making that university the Mecca of so many of the English-speaking followers of the science. He owed much to A. F. W. Schimper, and a delightful appreciation of that gifted man appears as a foreword to the translation of Schimper's "Plant Geography", revised by Bayley Balfour and himself, which was published by the Clarendon Press in 1903. In 1889 he was appointed to the professorship of botany and arboriculture at the Imperial College of Whampoa, in China, and it was doubtless largely owing to this that he was led to turn his attention to the study of trees, and thence to their diseases and economic products, on which he largely concentrated his attention in after years.

On returning to England in 1892, Groom settled for some years in Oxford, migrating to Edinburgh in 1898 to take charge of the classes in plant-physiology under Prof. Bayley Balfour. His stay there was short, as he was appointed in the following year to the headship of the biological department in the Royal Indian Engineering College at Coopers Hill, in succession to Marshall Ward, and on the closing down of that College he came to London as head of the department of botany at the Northern Polytechnic. In 1908 he joined the staff at the Imperial College of Science and Technology, first as an assistant professor, and was promoted to the chair of the technology of woods and fibres in 1911, an appointment he held to the end of his life.

Groom was the author of several books, and he contributed a number of papers, mainly on the anatomy of flowering plants, to various scientific journals, but as time went on he became more and more identified with the 'applied side' of his subject, publishing many papers in various technical journals on timber and forestry topics, as well as on the various diseases which affect wood under the numerous and diverse conditions under which it is employed. He served as a member of many committees concerned with these various matters, and his assistance was often sought by those engaged in industry, as well as by various government departments. One of his last papers was written for the Public Record Office, entitled "A Preliminary Investigation on the Mildew of Book-covers in Relation to Humidity and Temperature of the Air", and this investigation was still going on when he died. His work was recognised by his election to the fellowship of the Royal Society in 1924.

Groom's lectures at the Imperial College, especially those on timber for engineers and others interested in the technical side of the subject, were valued and were well attended. His place will not easily be filled, and as a colleague he will be held in affectionate remembrance by all who knew him.

J. B. F.

Sir William Simpson, C.M.G.

By the death of Sir William Simpson on Sept. 20, after a few days' illness, a great exponent of tropical hygiene has passed away. William John Ritchie Simpson was born in Aberdeen, in 1855, where, after schooling in Jersey, he became a medical student, qualifying in 1876 and taking the M.D. degree four years later. He determined to choose public health as a career, and soon became the first medical officer of health of his native city and lecturer on hygiene in the University.

These posts were relinquished in 1886, when Simpson was appointed chief health officer in Calcutta, a position he held for twelve years, and thenceforward his life was devoted to the advancement of tropical hygiene and medicine. Returning to England, Simpson was elected, in 1898, professor of hygiene in King's College, London, and in 1899 was associated with the late Sir Patrick Manson and others in the foundation of the London School of Tropical Medicine, of which he became one of the lecturers.

From now onwards Simpson was almost continuously engaged in official inquiries into the health of various parts of the tropical dominions of the British Empire. In 1900–1 he was a member of a commission to inquire into the occurrence of dysentery and enteric fever in South Africa and was chief commissioner dealing with an outbreak of plague in Cape Colony, and in 1902 was asked to report upon the causes and continuance of plague in Hong Kong. In 1906 he studied the sanitary conditions of Singapore, in 1908 those of West Africa, of East Africa, Uganda, and Zanzibar in 1913–14, and of the mines and villages of the Gold Coast in 1924. As the outcome of extensive studies on plague, he delivered the Croonian Lectures on this subject at the Royal College of Physicians, London, in 1907.

Simpson was a prolific writer. In addition to many papers and addresses, he published a treatise on plague, a volume on the principles of hygiene in tropical and subtropical climates—the first authoritative work of its kind—and a smaller popular book on the maintenance of health in the tropics. When in India, he edited the *Indian Medical Gazette*, and afterwards was responsible for the *Journal of Tropical Medicine*. In his later years, Simpson was one of the founders of the Ross Institute for Tropical Diseases, in which he became director of tropical hygiene. Here his last work was done, and he died in its hospital.

The services of Simpson were recognised by the bestowal of numerous distinctions: the C.M.G. in 1909, the Order of St. Sava of Serbia, where he had served during the War, in 1918, and the honour of knighthood in 1923. A genial and kindly man, though a strong one when occasion required, he will be greatly missed by a large circle of fellow-workers. R. T. HEWLETT.

WE regret to announce the following deaths:—

Sir J. Hawtrey Benson, formerly president of the Royal College of Physicians of Ireland, and also medical adviser for Ireland for the Colonial Office, on Oct. 9, aged eighty-eight years.

Dr. Thomas A. Edison, world-renowned for his inventions connected with the phonograph, telegraphic and telephonic communication, and the incandescent electric lamp, on Oct. 18, aged eighty-four years.

Dr. Samuel W. Stratton, president of the Massachusetts Institute of Technology, Boston, Mass., who was Director of the U.S. Bureau of Standards from 1901 until 1923, on Oct. 19, aged seventy years.

News and Views.

IT is reported in the daily Press that Dr. J. Papish, assistant professor of chemical spectroscopy at Cornell University, has identified the element of atomic number 87 in samarskite. It is stated to occur to the extent of one part in two million. This element would appear to be the missing alkali following cæsium. The radioactive properties of the element, if any, should be interesting.

ALTHOUGH the recent agitation against the initiation of girls among the Kikuyu of Kenya has now subsided to a great extent, the causes which lay at its root are still operative. It affords an extremely instructive example of how, in dealing with native peoples, the best intentions may often prove positively harmful if not based on a thorough and sympathetic understanding of the full implication of native custom. For example, one point which was raised in the recent trouble by the missionaries was the excessive 'price' demanded in marriage by parents of native girls, which has led to a decrease in marriage and an increase in prostitution, with a related spread of venereal disease. It is, however, pointed out by Mr. L. S. B. Leakey, who discusses the whole situation in a communication in the *Journal of the Royal Anthropological Institute*, vol. 61, Jan.-June 1931, that to a great extent the missionaries have only themselves to blame, in consequence of the requirement that the parents of the girl should sign a certificate at marriage that the whole of the 'bride-price' has been paid. This departure from native custom of a payment on account at marriage with a subsequent settlement by instalments, instead of protecting the bridegroom from a parent's extortion, as it was intended, has deterred young men from marriage and has forced up the 'bride-price'. Mr. Leakey shows how misunderstanding of the character of the initiation customs and their implications, as well as mistranslation of passages in the Scriptures relating to the Virgin Mary arising out of this misunderstanding, brought about a situation which was politically dangerous and has resulted in the moral and physical deterioration of the native. Unfortunately, in present conditions, difficulties such as these are inevitable, yet they are due to causes which might easily be avoided: when the right course is pointed out by those who have the requisite knowledge, it is usually too late. Once there has been a break in tribal custom it is often impossible, as in the present case, to revert to the old law.

ON Oct. 29 occurs the centenary of the birth of the distinguished American geologist and palæontologist, Othniel Charles Marsh. Born at Lockport, New York, Marsh graduated from Yale College in 1860, and after studying geology and mineralogy at the Sheffield Scientific School, studied palæontology and anatomy in Berlin, Heidelberg, and Breslau, and travelled in various parts of Europe. Returning to America in 1866, he became professor of palæontology at Yale College and also Director of the Geological and Palæontological Department of the Natural History Museum founded by the philanthropist Peabody, who was Marsh's uncle. For many years he was connected with the United States Geological Survey; he organised many expeditions to the far west, then a somewhat inaccessible region, and in 1871 discovered the first pterodactyl remains in America, and afterwards brought to light many new genera and families, including the toothed birds and the flying and swimming reptiles. His great reputation was based on his numerous researches on the vertebrates of the western States. Both at home and abroad he received many scientific honours. He died at New Haven on March 18, 1899. His private collection of fossils was bequeathed to the Peabody Museum.

A LETTER from Faraday to William Jordan, of the *Literary Gazette*, now in the possession of Mrs. Charles A. Faraday, of Birmingham, whose late husband was a member of the Faraday family, recalls an incident in his life and explicitly refers to the knighthood which rumour has joined with his name. In the *Literary Gazette* of Aug. 12, 1837, an announcement appeared headed "Sir Michael Faraday" and expressing pleasure at the recent conferment of the honour. Faraday wrote to Jordan on Aug. 15 stating that although he is not sure whether the statement was made in jest or earnest, "it looks so like the latter that I thought I should be unkind in leaving you in error respecting my condition, which is what I trust it will always remain—plain *Mister*". He concludes by asking that no reference whatever should be made to the matter. The original letter was lent by Mrs. Charles Faraday to a member of the Rochdale Literary and Scientific Society and exhibited at a meeting of the Society, and is being reproduced as a facsimile in vol. 17 of the *Transactions* now about to be issued. Inquiries and search have been made, but so far have not succeeded in tracing any former publication of this letter.

AN exhibition to illustrate the development of glass technological research was opened by Sir Richard Gregory in the Science Museum, South Kensington, on Oct. 21. During his opening remarks, Sir Richard gave an interesting résumé of the history of glass-making. Beads of glass were discovered by Sir Flinders Petrie, in an Egyptian grave, which date so far back as 3400 B.C.; while two thousand years later various kinds of coloured glass were made in Egypt. Faraday carried out an extensive series of researches with the object of improving the manufacture of optical glass, and in his Bakerian lecture for 1829 he described glass containing boric oxide, the forerunner of the modern borosilicate glasses. Despite the antiquity of glass-making, however, systematic research is only a matter of the last sixteen years. Immediate attention to the problem of glass was clearly essential as soon as the War broke out, especially with reference to chemical glassware and optical glasses. The recognition of glass technology as a science may be dated to the founding, in 1915, of the Department of Glass Technology in the University of Sheffield. This led to the formation, in 1916, of the Society of Glass Technology, which has now become international in character. As a result of systematic research, our knowledge of the chemistry and physics of glasses has been greatly extended, resulting in a number of new types of glasses and an improvement of old ones. Mechanical development, too, has taken great strides. Such development in research is well, though not exhaustively, illustrated by the exhibition, which is divided into fourteen sections. There is, however, much of importance still to be learnt, especially about the physics and chemistry of glass. It is hoped to keep the exhibition open until the end of the year, and possibly longer.

THE Babirusa of Celebes, of which a pair has been recently acquired by the Zoological Society of London, has been always rare in captivity, and long unrepresented in the Society's collection. The beast is also interesting in itself in more ways than one; in addition to the curious upgrowth of the upper canines of the male through the skin of the face, it is remarkable for its white iris and practically hairless skin, though this nude condition is approached by the African wart-hog. The upgrowing tusks have the appearance of horns, and in fact the Malay name given above means pig-deer, while the horned boars mentioned by Calpurnius as shown in the Roman arena could not have been anything else but this species. Yet Celebes seems to have been outside the knowledge of ancient geographers, which points to the wide range of trade in the Roman imperial period, since the circus could exhibit animals from lands unknown. On the same occasion were exhibited mountain hares in their white coat, zebus, bisons, an elk, a hippopotamus, and seals "with contending bears". If bears were set on to seals in a flooded arena, these would surely have been polar bears, ice-drifted farther south than now, in a period when the reindeer ranged south as far as Germany.

OF late years attention has been directed to some very remarkable variations that have been appearing in the eggs of common fowls. Formerly only varying as a rule from white, through cream—the colour of those laid by the ancestral red jungle-fowl—to brown, they now display a great variety of spotting in dark brown shades on a creamy ground, ranging from fine speckling, like that seen on the eggs of the guinea-fowl, to the freckling of the turkey's egg, and even to heavily spotted and blotched types mimicking the eggs of rails and birds of prey. The fowls that lay such eggs are chiefly the Dutch breeds of Barnevelders and Welsummers, birds which from their appearance have much blood of birds of the Cochin type, such as is found in most of the popular breeds to-day. Even blue eggs, laid by Chilian fowls called Araucanos, have been reported recently, and Mr. C. A. Finsterbusch gives an account of these birds in the *Feathered World* for Aug. 28 (p. 263), illustrated by his own sketches. From these, and from his statements, it is clear that 'Araucanos' are not a fixed breed, but present a great variety of types, any of which apparently may produce eggs of such unusual tints as bluish, purplish, and greenish, the last sometimes spotted with brown, like the European eggs cited above.

THE South London Botanical Institute celebrated its coming of age at the annual meeting and conversazione of members on Oct. 16. Founded and endowed by the late Allan Octavian Hume in 1910, the Institute has done useful work as a centre of botanical interest in south-east London. The excellent library and extensive herbarium of British plants (which includes the herbaria of William Beeby and Frederick Townsend, in addition to Hume's own collection) are available for use by students daily from 2 until 9 P.M. Demonstrations and lectures by well-known botanists are given at fortnightly intervals, and Saturday rambles are conducted by the curator to places of botanical interest around London. A small garden and conservatory are stocked with a selection of British plants. The Institute is governed by a council of fellows, representing London botany, and elected representatives of the members, with Dr. A. B. Rendle as president. Mr. W. R. Sherrin is the residential curator and secretary. Membership is open to any person interested; there is no subscription beyond a contribution of 2*s*. 6*d*. to cover expenses of printing and postage. The address of the Institute is 323 Norwood Road, S.E., about five minutes' walk from Tulse Hill Station on the Southern Railway.

THE ninth Annual Report of the Safety in Mines Research Board, for the year 1930, has just been published (London: H.M. Stationery Office. 2*s*. net), and contains a record of a very large number of researches which are being carried out under the ægis of the Board. There are no less than fourteen different subjects for research, the progress of which is discussed in the report, whilst detailed reports upon them are to be found in the appendices. It is also most gratifying to find that active progress is being made in co-operating with similar boards in other countries, Belgium, France, and the United States being specially mentioned; there is also a reference to co-operation with Germany in the matter of one research, namely, that on wire ropes, and it might well be desired that co-operation with the various German research boards should be extended. All these researches are of international rather than of national importance; they must be conducted by men exceptionally well qualified for the task, and such men are too scarce in all countries for any of their work to be wasted, as it necessarily would be if the overlapping of effort, which has marked the independent work of such boards in different countries, were to be continued. The subjects covered by this report are of the utmost importance to the miner, ranging from explosions through electrical working to explosives, safety lamps, mechanical appliances, and wire ropes, whilst the subject of falls of ground is beginning to receive the attention which its very grave influence on mining accidents unfortunately renders necessary. The report is published at a very low price, and deserves the careful study of all interested in the safety of miners.

AT a meeting of the Newcomen Society held at the Science Museum on Oct. 14, three short papers were read. The first of these dealt with the work of Jolliffe and Banks, contractors, and was by Mr. H. W. Dickinson. Attention had been directed to the work of the firm by the notices of the centenary of the opening of the present London Bridge, which fell on Aug. 1 this year. London Bridge, Southwark Bridge, and Waterloo Bridge, all constructed within the period 1812–1831, were designed by John Rennie and carried out under the superintendence of him and his son, Sir John Rennie; but Jolliffe and Banks were the contractors for all three works. Little has hitherto been generally known of either partner, but Mr. Dickinson was able to show that they were the principal firm of contractors of their time, executing important harbour and drainage works in various parts of the country. These works included the construction of Sheerness dockyard. Edward Banks began life in the north of England and by the time he was thirty years of age had done much canal work, but his partner, William John Jolliffe, was at first a clergyman. Their partnership lasted about thirty years. They both died in 1835, at Tilgate Lodge, Sussex, and they are buried in adjoining parishes in Surrey, Jolliffe in Merstham Church and Banks in Chipstead Churchyard. Banks was knighted in 1822, being the first professional engineer in the country to receive that honour. There is an account of his life in the "Dictionary of National Biography", but it is meagre and unsatisfactory, and Mr. Dickinson was able to give much interesting information which has hitherto been unavailable.

IN many of the schools which train the blind for various handicrafts and professions, the principles of electricity and magnetism are included in the standard curriculum. One of the difficulties in teaching the blind is to enable them to form mental pictures of the various phenomena. In the *Electrical Times* for Oct. 8, there is a description of Braille models invented by Dr. F. W. Alexander, of Teddington, which have proved a great help to teachers. Using simple materials like plywood and nails, he constructs models which show the positions of the lines of force between magnets in various positions, the current flow in the armature of a dynamo, the magnetic reactions in a simple motor, the amplitude variations of an alternating current, and similar theorems graphically by means of touch. This method of teaching the blind has much to recommend it, and the models are readily understood by those who have been born sightless. We understand that the method is novel and has not been in use before. Blind workmen are sometimes employed in making wireless sets, their affliction developing a marvellous sensitivity of touch.

ON account of the present world-wide economic depression, the sixteenth International Geological Congress, to be held in the United States, has been postponed for one year—to June 1933. A revised circular has now been issued, accompanied by an excellent map showing the routes to be followed on the various excursions before, during, and after the meetings at Washington. As a result of responses to the announcements made in the first circular, the following list of topics for discussion is proposed: measurement of geological time; batholiths and related intrusives; zonal relations of metalliferous

(*Continued on p.* 723.)

Supplement to NATURE

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The Evolution of the Universe.

SUPERFICIALLY the most significant feature of the discussion at the British Association on the evolution of the universe, the contributions to which form our Supplement this week, was the question of the relation of the physical universe to life and mind. Criticisms of the physical arguments gathered so closely round the neglect of consciousness in the physical scheme that Sir James Jeans felt it necessary to explain at the end of the meeting that physicists were not necessarily ignorant of the existence or importance of consciousness in the universe, but, as members of Section A of the Association, they were not called upon to take it into account in considering their own problems.

Sir James's remark was timely and, in view of certain aspects of the discussion, was undoubtedly justified. At the same time, there was perhaps more cogency, implicit if not expressed, in the criticisms in question than was met by his reply. It was undoubtedly the physical universe, and the physical universe only, that was under examination, but that is a big thing and eternity is a long time. Before consciousness can be ignored in considering the indefinite future and past, it must be shown that, throughout the whole history and extent of this physical universe, consciousness can have no possible effect on it. Until that is established, such words as 'inevitable' and 'certain' must be left out of the discussion, and unfortunately they were not.

The universe on its first introduction to the unprejudiced inquirer is a collection of objects of various kinds—large, small, heavy, light, plain, coloured, moving, stationary, animate, inanimate, solid, liquid, gaseous, tangible, intangible, visible, invisible, and so on. There is no obvious reason why the distinction between animate and inanimate should differ in kind from that between any of the other diversities, but in the course of scientific investigation it has been found that all the others can be correlated with one another and expressed as functions of a very few fundamental concepts, while the peculiar characteristics of animate objects remain obstinately and completely outside. Two possible attitudes to this situation immediately suggest themselves: we may assume a fundamental duality between a 'physical world' and a 'world of life', or we may attribute the intractability of life merely to our ignorance of the full potentialities of matter.

Now, these attitudes are clearly incompatible, yet they are often unconsciously adopted by the same thinker. When, like Sir James Jeans (to whom his critics, however much they may disagree with him, must concede the great merit of embodying his ideas in definite phrases at which they can fling their darts), we speak of the evolution of the 'physical universe' as a self-contained problem, we adopt the first; and when, like General Smuts, we speak of the 'origin of life from matter', we adopt the second. It would be interesting to know to what extent the two assumptions were tacitly associated at the backs of the minds of the several speakers.

An attitude which, whether right or wrong, is consistent is the assumption of duality as a temporary expedient, coupled with the effort to interpret the comprehensive universe, starting independently from the two sides of matter and mind. This is what is in practice being done—at least in part. The approach from the side of matter constitutes generalised physics, and the approach from the side of mind constitutes psychology.

From the physical direction of approach it is natural to look for the emergence of life at some time in the past and to express it as a possible function of such physical concepts as time, space, mass, or their equivalents—'the origin of life from matter'. This is a laudable endeavour, although while we remain in ignorance of this mysterious function it must stop short of the final generalisation of a 'physical universe'. The psychological direction of approach, on the other hand, offers a diametrically opposite view. Space-time, mass, energy and the like give place to such concepts as will, purpose, desire; and matter becomes not the source of life but at most its tool and perhaps its creature. Mechanical action is no longer the ground out of which volition has sprung ; it is the ultimate point which volition can reach. Just as such mechanical human actions as breathing and blood-circulation are expressed as mental acts become automatic through age-long practice, so, as soon as psychology realises its cosmic significance, the orderly movements of the physical world must tend to be expressed as the functioning, grown habitual, of a universal consciousness which in its youth may have been as wayward as an irresponsible child and in its old age may exhibit the disturbing effects of 'repressions' associated with such waywardness.

We cannot escape from this possibility in its most general form. If we assert duality, we are confuted by the obvious interaction between mind and matter in living creatures. If, on the other hand, we pursue the study of matter in the hope that an interpretation of mind in physical terms will one day be reached, we cannot deny the right of the psychologist to pursue the study of mind in the hope that an interpretation of matter in mental terms will one day be reached. The 'physical universe' is a convenient fiction for the former pursuit, but we have no right to call it anything else. With appropriate reservations it may be likened to the carrot held before the donkey. It makes him run but it has nothing to do with what awaits him at the end of the road. From this point of view there is a world of meaning in Prof. de Sitter's claim, made on quite other grounds, that the physical universe is a hypothesis.

When we leave these rock-bottom considerations and contemplate the discussion in its purely physical aspect, we again see Prof. de Sitter's suggestion as one of the outstanding points. It is, indeed, so obvious as to be in grave danger of being overlooked : the closed universe has never been observed, but is assumed in order to correlate facts that are observed ; it is therefore a hypothesis. In this respect, as Prof. de Sitter says, it resembles the atom, but there appears to be an essential difference. There is no reason, so far as we know, why, if it is real, it should not be observed in the future if the rate of increase of telescopic power exceeds its rate of expansion. In that event it would cease to be a hypothesis and become a phenomenon. But the atom, by the requirements of its own nature, is inherently unobservable and can never be other than a hypothesis. If, therefore, it has properties which are impossible to phenomena, it has a legitimate defence. But if the universe, which may one day be observed, has such properties, then we can definitely say that it is a hypothesis which is wrong. Possibly "the velocity of change of the quantity . . . which . . . is interpreted as the 'radius of the universe' has nothing to do with the rate of evolutionary change of stars and stellar systems ", but in that case we cannot rest content with the contradiction but must change the interpretation of that quantity, in the sure and certain hope that it has an interpretation in terms of familiar conceptions.

Even apart from this essential difference between the universe and the atom, however, the remarkable and in many ways mysterious parallelism between the details of the atomic hypothesis and direct experience must make us hesitate before concluding that the two types of time-scale in question are inherently irreconcilable. The second law of thermodynamics, the Michelson-Morley experiment, and—perhaps most striking of all—Sir Arthur Eddington's bombshell of a correspondence between the characteristics of the electron and those of the universe, afford sufficient examples of alternative interpretations which appear to be completely equivalent to make us doubt a final incompatibility, even if one were theoretically permissible.

The most profound significance of the discussion as a whole, however, lay in the fact that the various speakers not only had no common starting-point but also made no attempt to find one. Possibly this was inevitable under the conditions of the discussion, but if so, so much the worse for the conditions. We need not return to the basis of scientific thought to see this ; it is only too evident on the higher platform of purely physical ideas. It is an instructive, though exceedingly difficult, task to examine the various contributions in order to discover what was implicitly assumed ; and when we do this, however imperfectly, we find a diversity which not only makes us wonder, but also directs attention to the urgent need of defining what actually is the basis of modern physical theory.

Sir James Jeans paid homage to the second law of thermodynamics, which to Sir Oliver Lodge was an idol against which philosophers were to be warned. General Smuts accepted the law but claimed that life was the result of the odd chance which it allows — a remarkable claim, which implies that the chance of life persisting for a single moment longer is inconceivably small. The Bishop of Birmingham started from particular facts (or statements having the appearance of facts) rather than principles, but the arguments which followed seemed to spring more from independent beliefs and hopes than from the promised source. Those beliefs and hopes had no audible echo in the remarks of the other speakers, and the chief ' facts ' were treated with scant respect by Profs. de Sitter and Millikan respectively. Sir Arthur Eddington and the Abbé Lemaître built on the field equations of relativity, and the former also on the wave equation of an electron—grounds which were not openly challenged, but which were by no means universally shared. Prof. Milne, like Prof. Millikan, gave a very suggestive account of a particular process, but that process can scarcely be said to lie at the heart of the question. C'est magnifique, mais ce n'est pas l'univers. Severely local in time and space, Prof. Milne was perhaps justified in assuming the conservation of energy, but Sir James Jeans, taking a wider outlook, had previously spurned that principle. This difference might be reconciled by a slight change in the definition of the word ' energy ', but only the previous day Prof. Bohr had been telling Section A of the Association that the concept of energy seemed to be inapplicable to atomic phenomena, and that in the sun and stars the energy might come from nothing! What about the evolution of the universe in that case ?

The question that sounds insistently through all this confusion is : What is the fundamental basis of physical thought ? " Give me whereon to stand, and I will move the earth," said Archimedes. Where do we stand in order to move the law of conservation of energy ? It does not matter in the least whether Bohr's suggestion is upheld or not. The fact that it was seriously made shows that there is some foothold, beneath the law in question, which physicists were assumed to share, and that foothold is deeper than anything that was assumed at the discussion we are considering. It is idle to suppose that we can move the universe from a higher level than that necessary to move a physical theory, and the ordinary man, for whom the discussion was primarily intended, might well ask why a company of some of the world's leading thinkers, discussing the world's weightiest problem, should not at least start from common fundamental principles. As it stands at present, the chief value of the discussion lies in the incidental contributions to advanced physical thought which it elicited ; but if it leads ultimately—perhaps by way of an *ad hoc* discussion at some future meeting of the British Association—to a definite formulation of the basic principles of physics, it will perform a service far more in accordance with its original purpose. H. D.

Contributions to a British Association Discussion on the Evolution of the Universe.

By Sir James Jeans, F.R.S.

We are, of course, discussing only the physical universe. Here strict determinism reigns, because even if there is no determinism in the behaviour of individual atoms, there are so many atoms in even the tiniest bit of matter that we may take an average. The laws of probability provide something which is, for our present purpose, equivalent to a strict causal determinism.

It follows that the final state of the universe is inherent in the present state, just as this present state was inherent in the universe at its creation. The physical universe never has any choice—it must inevitably move along a single road to a predestined end. What we are calling evolution is like the rolling of a train along a single-track line, with no junctions of any kind.

The various possible lines of development for the universe are like an enormous number of single-track lines ; and as we do not know which track we are on, it is futile to discuss at what particular spot it ends. But the second law of thermodynamics makes it possible to discover in what kind of country it ends, and this is really the information we want.

Strictly speaking, this law does not deal in certainties, but in probabilities—although of a somewhat unusual kind. The number of particles in the universe is probably of the order of 10^{79}, and all the odds to which we are introduced by the second law involve very high powers of 10^{79}. We need not trouble to differentiate too closely between such long odds and certainties.

This law teaches that the universe will ' evolve ' through a succession of states of ever-increasing entropy, until it ends in the final state of maximum entropy. Beyond this it cannot go ; it must come to rest—not in the sense that every atom in it will have come to rest (for maximum entropy does not involve this), but rather in the sense that its general characteristics cannot change any more. Yet if someone asserts that this will not happen, and that the universe will move to a state of *lower* entropy than the present, we cannot prove him wrong. He is entitled to his opinion, either as a speculation or as a pious hope. All we can say is that the odds against his dream coming true involve a very high power of 10^{79}—in his disfavour.

The question of discovering the final state of the universe is merely that of discovering how far its entropy can increase without violating the physical laws which govern the motions of its smallest parts.

General considerations show that the universe still has a long way to go. It can increase its entropy by distributing its radiant energy more uniformly; at present this is still very far from being uniformly distributed. Out in the farthest depths of space the density of radiant energy corresponds to a temperature of less than one degree above absolute zero: in the interstellar spaces of the galactic system, three or four degrees only; near the earth's orbit about 280 degrees; at the sun's surface about 6000 degrees; at the sun's centre perhaps 40 or 50 million degrees. The entropy is increased by equalising these temperatures: that is why energy flows from the sun's hot centre to its cooler surface, and why it then streams out into space, past the earth's orbit into the cold and dark of interstellar and intergalactic space. There can be no end until all these regions are at the same temperature, with radiant energy diffused uniformly through space.

All radiant energy has its origin in atomic disturbances. Each atom is a sort of storehouse of energy or mass—we now believe the two to be identical—and at intervals, either spontaneously or through interference from outside, an atom may discharge some of its energy or mass into space in the form of radiation. This wanders through space like a sort of bullet of radiation travelling with the velocity of light; we call it a photon. Now the so-called 'cosmic radiation' which falls on to the earth from outer space appears, so far as we can tell, to consist of photons whose masses are comparable with those of complete atoms. Indeed, the two most massive types of photons so far detected in this radiation are found, to within errors of measurement, to have precisely the masses of the helium and hydrogen atom respectively. The simplest interpretation is that these photons originate out of the complete transformation of atoms of helium and hydrogen into radiation. But this is not the only interpretation, nor, I think, the most probable. All atoms consist of protons and electrons in equal numbers, so that their masses are (approximately) exact multiples of the mass of the hydrogen atom, which contains one of each. If an electron and a proton were to neutralise one another in any atom whatever, the atomic weight of the atom would be reduced by unity, and the atom would eject a photon of mass equal to the hydrogen atom. In the same way, if an α-particle were to neutralise itself by combining with two electrons in any atom whatever, the resulting photon would have a mass equal to the helium atom.

Although not everyone agrees, this seems to me the most plausible interpretation of the two most penetrating constituents of the cosmic radiation. I think they provide evidence that matter can be annihilated, and point to a general degradation of complex atoms in the direction of simplified structure and decreasing atomic weight.

On this view, electrons and protons must be regarded as concentrated stores of energy, which are capable of being set loose and dissipated in the form of radiation. The entropy of the universe is increased by this process, and the final state of maximum entropy is one in which every electron and proton which is capable of annihilation has been annihilated.

The question at once arises as to how many of the 10^{79} or so electrons and protons which form the universe are subject to annihilation. They may all be, in which case the final state of the universe will be one in which all matter is dissolved into radiation, and nothing remains but radiation traversing empty space. Or again, only special types of atoms may be liable to annihilation, just as only special types are liable to radioactive disintegration. In this case the final state will be one from which these atoms, like the radioactive atoms, will all have disappeared. There will be a universe of cold inert matter and of uniformly distributed radiation of very feeble intensity.

Amongst a mass of theoretical possibilities, the one certain fact is that if the atoms of our earth are undergoing annihilation, their rate of destruction must be exceedingly slow; their average life must be of the order of 10^{18} years at least, or else the earth would be markedly hotter than it is. This suggests the possibility that annihilation may only occur in types of atoms which are not found on earth—possibly atoms of higher atomic weight than terrestrial atoms.

Many considerations suggest that the stars produce their radiation by the annihilation of their substance. Perhaps the strongest, and certainly the most clear-cut, is that the stars which appear to be the youngest (such as binary stars describing close circular orbits) are statistically the most massive. It looks as though the stars lost a large part of their mass in the course of their lives, and this can only mean that a large number of their atoms, or a large part of these atoms, undergo annihilation. If so, our terrestrial atoms may well be a sort of indestructible ash, the relics of more complex atoms after all that can be annihilated has been—just as lead and helium are the relics of radioactive atoms of greater atomic weight.

There is, however, an alternative possibility. If matter is capable of annihilation, the general principles of the quantum theory show that the total amount of this annihilation must consist of two parts. The first is an annihilation which goes on steadily, regardless of external conditions of temperature and pressure, just as radioactive disintegration does. The second is an annihilation which is incited by high temperature, and whose rate increases with an increase of temperature. Calculation shows that this will only come into play when the temperature begins to approach a million million degrees.

Clearly if the cosmic radiation we receive on earth proceeds from annihilation, it must be annihilation of the first kind; for radiation which had been produced by annihilation of the second kind, and so at a very hot place, would all be absorbed by matter before it could climb down the very long temperature gradient and emerge into outer space. But it is possible that it is mainly radiation of this second kind which, after innumerable absorptions and re-emissions, or repeated softenings, appears as the ordinary light of the sun and stars. Thus many astronomers think that matter is annihilated in appreciable amount at high temperatures only, and that the annihilation at low temperatures is negligible. On their view, terrestrial atoms escape annihilation, not because they are specially indestructible, but because they are specially cool.

Yet this view is confronted by many difficulties. The cosmic radiation cannot be produced by this high temperature annihilation, and yet this is of vast amount—comparable at least with the radiation of all the stars. Also, for the heat of the stars' interiors to produce annihilation, their temperatures must approach a million million degrees. This requires what so far seems to be an impossibly high temperature-gradient inside the star. Again, such high temperatures, and such a mode of generation of energy, would, so far as we can see, make the stars unstable and, indeed, explosive structures. The best simple analogy to such a structure is a keg of gunpowder, with its centre raised to the flash-point of the powder. Nevertheless, it must be admitted that we are far from definite knowledge on these questions, which are still in the stage of very heated discussion.

A further possibility is that stellar light and heat do not result from annihilation of matter at all, but from some less fundamental change in atomic structure. If so, we are no longer compelled to postulate unduly high temperatures at the centres of the stars; this difficulty disappears. If the atomic changes are spontaneous, like radioactive change, the difficulty as to stability also disappears as, indeed, it does whatever the origin of the energy. But these milder changes cannot provide enough energy for the long lives—millions of millions of years—through which the stars have, to all appearances, existed. The equipartition of energy in the motion of the stars in space, as well as in the internal motion of binary systems, and also the small masses of what appear to be the oldest stars, all point to extremely long stellar lives. To provide adequate total radiation, throughout these, we need complete annihilation of matter; nothing less drastic will serve. If we cannot have this, we must conclude that the universe of stars is still quite young, in spite of looking so old; its many appearances of great age must all be deceptive.

This seems far more possible than it did even a year or two ago. Indeed it derives much support from recent developments in the theory of relativity. These suggest, somewhat strongly, that the whole universe may be expanding, while recent astronomical observations, if they have been rightly interpreted, indicate that it actually is expanding, and this at so rapid a rate that it becomes a mere transitory and ephemeral structure compared with what we recently thought: the spectra of the great extra-galactic nebulæ seem to indicate that these bodies are running away from one another so fast that they cannot have been running for long. This reduces the whole life of the universe to a matter of hundreds of thousands of millions of years at most—and incidentally, in so doing, brings almost complete chaos into the already chaotic problem of stellar evolution.

Another possibility—nearly but not quite identical with the foregoing—is that the universe retains its size, while we and all material bodies shrink uniformly. The red shift we observe in the spectra of the nebulæ is then due to the fact that the atoms which emitted the light millions of years ago were larger then than the present-day atoms with which we measure the light—the shift is, of course, proportional to distance. The final end here is a universe in which all matter has shrunk to nothing.

On the other hand, if the universe is expanding, the stars are merely pouring out their radiation into a bottomless pit, since the space to be filled with radiation is for ever increasing in amount. The total energy of the universe is for ever decreasing in amount, because radiation does work in pressing out the boundaries of the universe—just as a gas loses energy and so cools, when it expands and presses back the boundaries of its ' universe '. Thus the mass of the stars is continually changing into energy, while this energy in turn changes into mere additions to the size of the universe. There is conservation neither of mass nor of energy. Nor, if the evidence of the cosmic radiation is to be trusted, is there any conservation of matter. Matter turns into energy and energy into mere bigness of space.

Suppose some infallible oracle offered to give a ' Yes ' or ' No ' answer to two scientific questions for each of us. Personally, I think I might choose as my two questions :

1. Does the main energy of stellar radiation come from the annihilation of matter ?
2. Is the universe expanding at about the rate indicated by the spectra of the nebulæ ?

By Abbé G. Lemaître, Observatory, Louvain.

I PROPOSE to give some answer to the two questions raised by Sir James Jeans, which so clearly summarise the present state of the problem of the evolution of the universe. I will begin with the second question, because I think that its solution may throw some light on the first one : " Is the universe expanding at about the rate indicated by the spectra of the nebulæ ", the atomic constants not being modified by some artificial change of gauge ? I add these words, because it is clear that any artificial expansion could be provided by arbitrarily varying the units of length, time, and mass. Expansion of the universe is in some sense relative : it is relative to the whole set of essential properties of matter being assumed to be constant.

The expansion of the universe is a matter of astronomical facts interpreted by the theory of relativity, with the help of assumptions as to the homogeneity of space, without which any theory seems to be impossible. I shall not discuss the legitimacy of this interpretation, as I do not know any definite objection made against it and this is not the place; and it is not necessary to give a new popular version of the leading principles of the theory of relativity. I shall rather try to show that the universe must be expanding, or rather that the most necessary processes of evolution are contradictory to the view that space is and has always been static.

It has been pointed out by Sir Arthur Eddington that a static universe is unstable, and he proposed the problem of finding the possible causes of its expansion. He suggested that such a cause might be the formation of condensations. I obtained recently a solution of this problem, and the main results are as follows :

When the expansion is already started, the effect of kinetic energy or pressure of radiation is quite negligible. On the contrary, pressure is the chief factor in the question of instability of a static universe. If the pressure were rigorously zero, the expansion could never appear. But, if the pressure (or kinetic energy) is not zero, any diminution of pressure must start the expansion. For example, a world full of radiation starts expanding as soon as the radiation can transform itself into matter.

When condensations exist or are formed, the problem is complicated by gravitational effects ; but it can be shown that the general expansion of the universe depends entirely on the density of kinetic energy or of pressure at the places where the gravitational influences of the condensations cancel one another. I call these places (for brevity) ' neutral zones '. Condensation in itself has no direct effect whatever on the stability of the universe : but condensations would necessarily induce a rarefaction at the neutral zone and so a diminution of the density of kinetic energy at the neutral zone ; and this must induce expansion.

We can conclude that any general process of condensation, occurring in a world where the kinetic energy does not vanish, must induce expansion. Therefore, practically, the expectation of Sir Arthur Eddington is fully confirmed. For example, formation of stars out of a primeval gas starts the expansion ; formation of extra-galactic nebulæ out of a uniform mass of gas or of stars starts the expansion. I think that these results add much weight to the fact that the actual velocity of expansion fixes a limit to the time scale of the evolution, as we must rule out of our speculations every process which would start a premature expansion of space.

Even if we had no experimental evidence of the expansion of space, considerations of stability would fix a limit to the time-scale of evolution. The reason is that, if the universe has existed for too long a time, any general process of condensation would be contradictory to the actual value of the density of matter. Although this quantity is not known with great accuracy, its value may give some idea of the maximum scale of evolution. I find that any general process of condensation, even of very moderate intensity, cannot have happened earlier than a few hundred thousand million years ago.

As stated by Sir James Jeans, this brings almost complete chaos into the already chaotic problem of stellar evolution. A complete revision of our cosmological hypothesis is necessary, the primary condition being the test of rapidity. We want a 'fireworks' theory of evolution. The last two thousand million years are slow evolution: they are ashes and smoke of bright but very rapid fireworks.

I think that the key of the problem is afforded by the discovery of the cosmic rays. Cosmic rays are of enormous energy. Their intensity is estimated to be about one-tenth of that of the light coming to us from the stars. If these rays are really cosmic, their energy is much bigger than that of the light of the stars, because it must be of equal intensity all over space. Simple computation shows that the energy of cosmic rays is comparable in amount to the whole energy of matter, being possibly one thousandth, and at least one hundred thousandth, of the total energy of matter.

If the cosmic rays originated chiefly before the actual expansion of space, their original energy was even bigger, and it has been reduced by the expansion in the ratio of the change of the radius of the universe during the time of their transmission through free space. We get photographs of nebulæ at a distance of about one hundred million light years; light from these nebulæ travelled through space during about one hundredth of the time of expansion. It does not seem improbable that the cosmic rays have travelled around one hundred times longer and were really produced by the process of the formation of the stars. This may give the solution of the puzzle. The only energy we know which is comparable to the energy of the cosmic rays is the matter of the stars. Therefore it seems that the cosmic rays must have originated from the stars.

Now the stars are surrounded by an atmosphere, and an atmosphere would altogether prevent any escape of cosmic rays from the inside of a star. The explanation seems to be that the cosmic rays went off from the stars at a time when the stars had no atmosphere. The stars are born without atmosphere; the atmosphere evolved after the escape of the cosmic rays.

We are thus led to the conclusion that the stars were born some ten thousand million years ago without atmospheres, and that the cosmic rays are outstanding features of the formation of a star.

How could we explain such a phenomenon as that? Sir James Jeans has given strong reasons for admitting the existence of atoms of considerably higher atomic weight than our actual dead atoms. Cosmogony is atomic physics on a large scale—large scale of space and time—why not large scale of atomic weight? Radioactive disintegration is a physical fact, cosmic rays are like the rays from radium. Have they not escaped from a big scale super-radioactive disintegration, the disintegration of an atomic star, the disintegration of an atom of weight comparable to the weight of a star.

The birth of a star would be an atom of weight somewhat greater than the actual weight of the star, and the star would be formed by the super-radioactive disintegration of its original atom. It is conceivable that the greater part of the products of disintegration would be kept back together by the gravitational attraction of such a massive atom, although a considerable part, say one thousandth, should be able to escape into free space at the beginning of the evolution, before the products of disintegration are numerous enough to form an atmosphere. Cosmic rays would be glimpses of the primeval fireworks of the formation of a star from an atom, coming to us after their long journey through free space.

The frequency of cosmic rays is, of course, very high; nevertheless, it may be thought to be too low to be the by-product of such a tremendous disintegration of matter. However, it must be realised that the observed frequency of the cosmic rays is not the original frequency. The original frequency has been reduced in the ratio of the expansion of space, and was at least twenty times greater than the observed frequency.

I think that a possible test of the theory is that, if I am right, cosmic rays cannot be formed uniquely of photons, but must contain, like the radioactive rays, fast beta rays and alpha particles, and even new rays of greater masses and charges. I have shown that the momenta of such rays must be reduced by the expansion in about the same ratio as that of the photons.

The mass of a star should be determined by the weight of its original atom, and it is conceivable that stars might be born with different masses. If the mass of the original atom is too big, the star must be finally broken up by radiation pressure, and the original atom must give birth to a cluster of stars, chiefly formed by stars of maximum mass. If the star comes from an atom, both masses and luminosity are determined by the weight of the original atom. Thus this theory accounts for a mass-luminosity relation.

The actual theory does not completely bring order into the chaotic state of cosmogony imposed by the fact of the expansion of space. Explanation of the approximate equipartition of energy between the stars, or evolution with loss of mass along the Russell diagram, might be dismissed with regret. But I do not see any way to retain these processes of evolution, because they are altogether too slow.

If I had to ask a question of the infallible oracle alluded to by Sir James Jeans, I think I should choose this: "Has the universe ever been at rest, or did the expansion start from the beginning ?" But, I think, I would ask the oracle not to give the answer, in order that a subsequent generation would not be deprived of the pleasure of searching for and of finding the solution.

If the total time of evolution did not exceed, say, ten times the age of the earth, it is quite possible to have a variation of the radius of the universe going on, expanding from zero to the actual value. I would picture the evolution as follows: At the origin, all the mass of the universe would exist in the form of a unique atom ; the radius of the universe, although not strictly zero, being relatively very small. The whole universe would be produced by the disintegration of this primeval atom. It can be shown that the radius of space must increase. Some fragments retain their products of disintegration and form clusters of stars or individual stars of any mass. When the stars are formed, the process of formation of the extragalactic nebulæ out of a gaseous material, proposed by Sir James Jeans, could be retained for the star-gas filling the space. The numerical test works out equally well for this case.

Whether this is wild imagination or physical hypothesis cannot be said at present, but we may hope that the question will not wait too long to be solved.

We want two things. First, a theory of nuclear structure sufficient to be applied to atoms of extreme weights. For these atoms, the problem cannot be separated into a nuclear problem and a problem of surrounding electrons ; because it is easily seen that the K ring would merge into the nucleus. We must wait, but we may trust the physicists that we do not have to wait too long. The second thing we want is a better knowledge of the nature of the cosmic rays. The correlation of the theory of nuclear structure with further observations on the cosmic rays must answer yes or no to our question ; and we shall prefer this answer, however incomplete it may be, to any answer of any infallible oracle.

By Prof. W. de Sitter, Observatory, Leyden.

I HAVE been asked to make a short contribution to this discussion about the evolution of the universe. I hope you will find it short, although its length will, I fear, exceed the diameter of the earth's orbit round the sun. This way of expressing a time in a unit of length is perhaps somewhat unusual. To have a distance expressed in a unit of time is, of course, very familiar. A light-year has become an accepted unit of distance.

I have purposely used the inverse method to direct attention to the fact that the corresponding units of time and of space are so very widely different in relation to actual phenomena. The diameter of the earth's orbit enormously exceeds all lengths that we ever come across in our daily life, whilst a quarter of an hour is considered a short interval. Similarly, a thousand million light-years is a long distance, in fact many times greater than any actual distance of which we have certain cognisance, but a thousand million years is a short time in the evolution of the universe. It is only a third or a quarter of the accepted age of the earth, and I do not think geophysicists will be ready to take off even one single zero. We believe, and so far as I can see on good grounds, that the ages of the sun and the majority of the stars are at least a thousand times longer. The time needed for the development of a double star, or even a quadruple or sextuple system, and that required for the evolution of a stellar system or spiral nebula are at least of the same order.

In the farthest galaxies that we can observe things appear to be very much the same as in our immediate neighbourhood. There seems to be no indication that these far-away systems are in an appreciably earlier state of evolution than our own.

Although, of course, the trustworthiness of this statement decreases very rapidly with the distance, still it seems to show that the lapse of time corresponding to the distance of these systems is only an entirely inappreciable fraction of their whole lifetime. All these considerations consistently lead to the conclusion that the time elapsed since the beginning of the evolution of the universe is to be measured in billions of years, or perhaps in thousands of billions. I do not propose to discuss the question whether there ever was a beginning. It suffices for my argument to define the 'beginning' as that state of the universe and its constituent parts which we are with our present knowledge and theories content to use as a starting point, beyond which we do not wish, or are not able, to extend our investigations.

It is in accordance with this slowness of the evolution of the universe—or I should rather say of the constituent parts of the universe, its galaxies and stars—that the universe was, until very recently, generally assumed to be practically in a state of equilibrium. Accordingly a theory of the universe, in order to find popular favour, had to be static. Some may have felt inclined to disagree with this generally adopted attitude, but if they ventured to confess their dissenting views at all, they did so rather diffidently. A static solution of the fundamental equations of the theory of relativity was required. The choice was between two possible statical solutions, which I have been in the habit of calling the solutions *A* and *B*, but which may be better distinguished by the names of the 'static' and the 'empty' universe. Einstein's solution, the 'static' universe, was a genuine statical solution. The other one was essentially non-static, but, as a consequence of its emptiness, it could parade in the garb of a static one. Both of these, however, failed to represent the observed facts in the actual universe, which is neither empty nor static, since it is full of galactic systems, which are all moving with large and systematic velocities. The way out of this dilemma has been shown by the Abbé Lemaître, whose brilliant solution, the 'expanding universe', was discovered by the scientific world about a year and a half ago, three years after it had been published.

It is not necessary to explain this theory in detail here. It has become widely known by technical and popular expositions in many periodicals. The principal point of it is that it shows the observed radial motions of the spiral nebulæ to be in accordance with an isotropic, homogeneous, but non-static solution of the field equations of the general theory of relativity, or, we can say, to be a pure effect of the inertia of these bodies. The static solution, in which inertia leaves the relative distances of different material bodies (statistically) unchanged, is shown to be unstable. The actual universe must therefore be represented by one of the non-static solutions. In these the change at a certain moment may be either an expansion or a contraction. Observation shows that at the present moment we are on an expanding branch. The solutions are arranged in families. In some, the universe contracts to a finite minimum radius and then starts to expand again, in others this minimum is zero; in other solutions again the radius oscillates between zero and a finite maximum value in a rather short period. These oscillating solutions, however, require a density exceeding what is indicated by our knowledge of the distribution of matter in our neighbourhood.

I must lay stress on the fact that in using the words 'universe', 'radius', 'expansion', etc., we are really speaking metaphorically, putting an interpretation on the equations which is by no means imperative. There occurs in the equations a certain small quantity, which may be either positive, negative, or zero, and which is interpreted as the reciprocal of the square of the radius of curvature. But both this interpretation, and the assumption tacitly made that it is positive, are entirely gratuitous, and not demanded by the theory. I will, however, continue to use this convenient metaphorical speech.

Lemaître's theory not only gives a complete solution of the difficulties it was intended to solve, a solution of such simplicity as to make it appear self-evident, once it is known (like Columbus's famous solution of the problem of how to stand an egg on its small end)—it also incidentally contains the answer to some questions of long standing, such as what becomes of the energy which is continually poured out into space by the stars: it is in fact used up by the work done in the adiabatic expansion of the universe. There can be not the slightest doubt that Lemaître's theory is essentially true, and must be accepted as a very real and important step towards a better understanding of Nature.

Now if we adopt this theory of the expanding universe, it is very tempting to seek a connexion between this expansion and the evolution of the material bodies constituting the universe, and to identify the beginning of the expansion with the beginning of that evolution. But the time elapsed since the beginning of the expansion is only a few thousand million years—an interval that we have learned to consider as very short from the evolutionary point of view. There is no escape from this. We can, in fact, make the interval logarithmically infinite, but that is only a mathematical trick: we call zero minus infinity, but this does not make the interval during which anything really happens any longer. It is a consequence of Lemaître's equations that the time taken by the universe to increase its radius from anywhere near its minimum to its present value is of the order of magnitude of the radius itself, if we adopt corresponding units of space and time, for example, years for time and light-years for space.

The real origin of the difficulty is that the ratio of the natural units of space and time is determined by the velocity of light, whilst the velocities which determine the rate of progress of the evolutionary process, say in the case of a stellar system, are those of material bodies (stars), which are of the order of one ten-thousandth of that of light. Consequently, if we wish to construct a causal connexion between the commencement of the expansion and events which are supposed to have happened at a very early stage of the evolution of the stellar systems—such as the first formation of condensations, or the imprisoning of free energy inside matter called 'stagnation' by Lemaître—we unavoidably meet with the difficulty that the time elapsed since these two beginnings is some thousands of times longer in one chain of events than in the other. I do not think it will ever be found possible to reconcile the two time scales.

We thus come, however reluctantly, to the conclusion that the expansion of the universe on one hand, and the evolution of stellar systems and stars on the other hand, are two different processes, taking place side by side, but without any apparent connexion between them. The expansion has only been going on during an interval of time which is as nothing compared with the duration of the evolution. Leaving the oscillating universes, and those that start from a zero radius, out of account, the universe may have been practically stationary at or very near its minimum size for an infinite time before starting to expand, or it may have contracted during an infinite time and, after passing through a minimum a few thousand million years ago, started to expand again. In both cases there appears to be no causal connexion between the change of size of the universe as a whole and the evolution of the systems which it contains.

It should not be forgotten that all this talk about the universe involves a tremendous extrapolation, which is a very dangerous operation. I have sometimes called the part of the universe of which we know anything with certainty 'our neighbourhood'. The limits of this neighbourhood have been enormously extended in the last ten or fifteen years by the results derived from observations with the large telescopes at Mount Wilson and elsewhere, but still it is presumably only a very small portion of the whole of the universe. All assertions regarding those portions of the universe which lie beyond our neighbourhood either in space or in time are pure extrapolations. In making a theory of the universe we must, however, adopt some extrapolation, and we can choose it so as to suit our philosophical taste. But we have no right to expect it to be confirmed by future observations extending to parts now outside our reach.

The extrapolation that is at the base of the theory of the expanding universe is that our neighbourhood is just an ordinary point, or small area, in the universe, not differing from any other small area in any essential property. This is, of course, a very natural hypothesis to make, and I do not see how we can avoid making it, but it remains a hypothesis and an extrapolation. It involves, of course, the assertion—the axiomatic truth of which can scarcely be doubted by any physicist—that the laws of Nature remain the same at all times and all places. The observed fact is that the spectral lines in the light which reaches us from bodies at a great distance are displaced towards the red, or in other words, that *light is reddened by age.* Now the only interpretation of a reddening of light consistent with the accepted laws of Nature in a homogeneous world is a receding 'velocity' of the source. This is the observational evidence of the 'expanding universe' in a nutshell.

The dilemma that we are in has a certain similarity to that by which atomic physics was confronted some twenty years ago when the necessity became apparent of ascribing to the atom properties which in a finite material body would be contradictory. The concept of the universe as a closed entity is, so far as I can see, a hypothesis, an arbitrary addition to, or extension beyond, the observed phenomena by our imagination. We must be prepared to allow this 'universe', as we have been forced to grant to the atom, the freedom to have contradictory properties, and in particular we must try to accustom ourselves to the idea that the velocity of change of the quantity of the dimension of a length which occurs in the equations, and is interpreted as the 'radius of the universe', has nothing to do with the rate of evolutionary change of stars and stellar systems.

It seems to me that the current interpretation, and the consequent models of the universe as an expanding hypersphere (or elliptical space), may in course of time be found to be too simplistic, and be replaced by one in which the apparent contradictions are more satisfactorily hidden from view. But this does not affect the theory, which will retain its value, independent of the interpretations put upon it.

By Sir ARTHUR EDDINGTON, F.R.S.

DISCUSSION of detailed theories of stellar evolution is overshadowed by the fact that the time-scale is once again in the melting-pot. I think it will be agreed that if Prof. de Sitter is right in regarding the facts as indicating a rapid expansion of the universe or scattering apart of the galaxies, the very long time-scale of billions of years which has been fashionable of late becomes exceedingly incongruous: we should have to accept an age of the order 10^{10} years for the galaxies and presumably also for the stars. But the theory of the expanding universe is in some respects so preposterous that we naturally hesitate before committing ourselves to it. It contains elements apparently so incredible that I feel almost an indignation that anyone should believe in it—except myself. I have had a special reason for believing it which I have referred to from time to time, but it was not until last month that I was able to put it into definite shape.

I believe that from pure physical theory we can not only predict that this phenomenon of expansion will occur but also predict the actual rate of expansion; and the calculated result agrees with the observed recession of the nebulæ. This result comes out of the wave equation for an electron—the fundamental equation of modern quantum theory. When I adapt the wave equation to take account of the curvature of space, I find that it ought to contain a term $\sqrt{N}/R$, that is to say, the square root of the number of electrons in the universe divided by the radius of the universe in its equilibrium state.

I do not suppose that this is a new term to be inserted as a correction to the ordinary equation; it is already in the equation in disguise. It is the term attributed to the mass of the electron and ordinarily written mc^2/e^2. Sir J. J. Thomson was the first person to measure the mass of an electron. I do not think he realised in 1897 that the thing he was after—the constant which was responsible for the effects in the vacuum tubes attributed to mass—was the square root of the number of electrons in the universe divided by the radius of the universe. Really he was poaching on astronomical preserves. He was finding the rate of recession of the spiral nebulæ, or at least a very little calculation will derive it from his measures.

I take the value of $\sqrt{N}/R$ (or as Sir J. J. Thomson mysteriously called it, mc^2/e^2) according to his measurements and those of his successors, and combine it with well-known formulæ of the relativity theory which Prof. de Sitter has described; then I can find at once the principal data about the size of the universe. For example, its original radius was 1070 million light-years, before it started to expand. I find also $N = 1{\cdot}29 \times 10^{79}$; and, what is of special interest, the rate of recession of distant objects can be calculated; the result in the usual units (km. per sec. per megaparsec) is 528. This is the whole expansion effect, which will be reduced a little by the attraction of the galaxies on one another, but the reduction is not likely to be large.

The value found from astronomical observation ranges from 430 to 550 according to various determinations.

Naturally this close accordance of theory and observation has made me believe that both are right and that the observed motions of the nebulæ are genuine; so that we must accept this alarmingly rapid dispersal of the nebulæ with its important consequences in limiting the time available for evolution.

By Prof. ROBERT A. MILLIKAN, California Institute of Technology, Pasadena, Calif.

ANYONE who knows me is quite aware of the fact that I have no qualifications for participating in a discussion of the evolution of the universe, unless perhaps it be because of my interest and activity in the development of our knowledge of the cosmic radiation. Since, however, results in this field now seem destined to exert a profound, if not a determinative, influence upon all theories of stellar evolution, it may not be out of place for me to outline the present status of our experimental findings in it, and to do what I can to show whither they point.

I note first, however, that the opening up of this amazing new field of knowledge is the work solely of the experimentalist. Plentiful as theorists have always been, especially in astronomy, and confident as they have always been in their conclusions, not one of them, so far as I know, who speculated about the nature of the universe, ever predicted cosmic rays, or even dreamed of their existence—certainly not sufficiently definitely to suggest any experiments actually to bring them to light. Prior to 1910 not a trace of evidence had appeared that such rays existed. They had not even been seriously proposed. Apart from a passing suggestion by O. W. Richardson,[1] in 1906, that electroscope-discharge effects observed on earth might possibly have something to do with solar influences—a suggestion quickly negatived by the fact that these effects are as strong at night-time as in day-time —I can find no record of the existence anywhere up to 1910 of any ideas even remotely related to those of the cosmic rays. Indeed, all the work that had been done prior to 1910, even on rays capable of discharging electroscopes through metal walls centimetres, or even inches, thick (so-called penetrating rays), was generally interpreted in terms of earth-rays, or of radioactive emanations getting from the earth into the lower atmosphere, and these are, in fact, responsible for much the greater part of the then observed penetrating rays.

In 1909 all the work that had appeared in this field up to that date was reviewed by Kurz,[2] and careful consideration given to each one of the only three possible origins of the observed effects, namely: (1) the earth, (2) the atmosphere, and (3) the regions beyond the atmosphere. The last two were definitely discarded, and the conclusion drawn that there was not the slightest evidence for the existence of any penetrating rays other than those produced by radioactive substances in the earth—this with full knowledge, too, dwelt upon at length in this very article, that half a mile of the earth's atmosphere would absorb all such radioactive radiations.

When, therefore, in that same year the experimentalist, Gockel,[3] took an electroscope three different times in a balloon to heights which reached four and a half kilometres and found that its rate of discharge was there even higher than on the earth, he had discovered something new and important, namely, that although there are penetrating rays that do originate in the earth and are indeed abundantly given off from practically all the elements of the earth's crust, as Kurz and the other workers prior to 1910 had rightly concluded, yet there must be other rays, abundant at high altitudes, that come in from above, originating either in the remoter regions of the atmosphere or else coming in from outer space; in other words, that one or the other of the two alternatives which Kurz had explicitly considered and definitely discarded had been incorrectly set aside for at least some rays that actually exist. Which one of these two, namely, upper atmosphere or outer space, it took a great deal of work by Hess, by Kolhörster, by v. Schweidler, by Bowen, Otis, Cameron, myself, and others, from 1910 to 1925 definitely to determine, and even in 1927, at the Como conference, one of the most distinguished of living physicists declared himself still a believer in the theory of an upper atmospheric origin.

To-day, however, I think the cosmic origin has been generally conceded, and with that concession it follows from the measurements themselves, not only that in the particular portion of our galaxy immediately around us, the energy carried by the cosmic rays is at least a tenth[4] of that existing in the form of radiant heat and light, but also, since these latter radiations must be diminished greatly in intergalactic space, that the energy carried by the cosmic rays throughout the universe is of the same order of magnitude as, possibly greater than, all other radiant energies combined. In the light of this fact, when one reflects that the second law of thermodynamics, which has, strangely, been thought by some so determinative for theories of the origin and destiny of the universe, and which may be roughly said to be merely a generalisation of the fact always observed *here on earth* that all forms of energy tend to become converted into heat and then to be radiated away from the earth and hence lost to us, one sees *how prone we are to make sweeping generalisations upon insufficient knowledge.* This is why the experimentalist has played and always will play so important a rôle in the progress of science. From the very inception of the experimental method he has continually been bringing to light facts which were not within the theorist's ken even when that theorist had got observational phenomena pieced together, *as he thought,* into a beautifully consistent and 'necessarily related' scheme. With perhaps the largest source of radiant energy as yet unconsidered, may it not possibly be that the thermodynamic theorist has gone too far in his dicta about the origin and destiny of the universe? This is my excuse for forgetting at least for the moment all about theories and asking first: What are the experimental facts in the field of cosmic rays?

There are three main facts that now seem to be quite well established, though discussion is still rife about some of them. I hope, however, that some of the new data that I am now able to present will help to bring about better agreement.

(1) The first fact is the complete uniformity in distribution of the cosmic rays within the present limits of experimental error in the measurement of their intensity. This has been disputed by some, but I should like to show how I have been testing it this summer. I have the results of a continuous month of observation of the intensities of the cosmic rays taken through four daily six-hour periods as follows: 6 A.M. to noon, noon to 6 P.M., 6 P.M. to midnight, and midnight to 6 A.M. None of the means of intensities in these four periods differ by so much as one half of one per cent. The barometer which, as Cameron and I first showed in 1925,[5] influences markedly these intensities, was extraordinarily constant during this summer month in Pasadena, scarcely varying 3 mm. either way from the mean throughout twenty-five days; the barometer readings go through a small minimum each afternoon, due to currents set up by the sun's heat, and a small maximum early each morning. The cosmic rays, on the other hand, go through a small afternoon maximum and an early morning minimum, thus showing quite conclusively, I think, that the minute variations in cosmic ray intensities are not due to radiations from the sun, which is shining during both maxima and minima, but rather to slight variations in the atmospheric blanket induced by the alternate heating and cooling of the gaseous matter through which the rays reach the earth. Further evidence for the correctness of this conclusion is found in the fact that the period from midnight to morning, during which the atmosphere is more quiet than is the case in any of the other three periods, shows the smallest variations in the individual readings, thus appearing to indicate that these, too, are due to atmospheric disturbances. The conclusion is consonant, too, with the latest, very exact measurements of Hoffmann[6] at Halle, though the conditions in central Europe are less favourable for testing the especial points brought to light in my own work.

This independence of the cosmic ray intensities of the positions of the sun, the Milky Way, or other celestial objects is the most amazing property of these rays, since it seems to show quite definitely that those portions of the universe—better, those directions in the celestial dome—in which matter is most abundant, such as the directions of the sun or the Milky Way, have no advantage over those directions in which matter is very scarce. I can see no possible escape from the conclusion that the conditions existing in those portions of the universe where matter is abundant, that is, in and immediately about the stars, are inimical to the formation of cosmic rays. This in itself bars out the likelihood of their being due to the annihilation of protons, provided such annihilation is to be called upon, in accordance with the demands of most modern astronomers, for maintaining the temperatures of the stars. In making this statement I am eliminating as scientifically unacceptable the hypothesis that in bygone ages these rays were created by processes no longer existing and have since been wandering like lost souls about a universe from which there is for them no possibility of escape. Further evidence on this point will be presently given.

If, then, the cosmic rays are forming *now*, there is no place of origin left except *outside the stars*, in the interstellar spaces, where both temperature and pressure are exceedingly low. This is not so unlikely a place of origin as it was a few years ago, before Bowen[7] at the Norman Bridge Laboratory had solved the seventy-year-old riddle of the nebulium lines and proved that the common elements oxygen, nitrogen, carbon, and sulphur, as well as hydrogen and helium, exist out there, giving rise to these nebulium radiations *in regions which may be light-years away from the exciting stars.*

(2) The second most significant cosmic ray fact is that which, after some less precise tests by Cameron and myself in 1926, was brought to light most unambiguously just a year ago when, by taking very careful and very exact readings with the same sensitive electroscope, first at Pasadena, lat. 34° N., then at Churchill, Manitoba, lat. 59° N., the nearest settlement on earth to the north magnetic pole, I proved that the incoming cosmic rays are not influenced at all by the earth's magnetic field, and drew from that fact the inevitable conclusion that when these rays enter the earth's atmosphere they have not previously traversed any amount of matter which is comparable with the thickness of that atmosphere, or else they would of necessity be mixed with secondary beta rays which would be directed into the earth most abundantly along the earth's magnetic lines and therefore enter it in the neighbourhood of the magnetic poles. These experiments furnish another independent and, I think, very beautiful proof that the rays must originate in interstellar space, for if they came from even the remotest exteriors of stars, they would have to be appreciably mixed with magnetically deflectable beta rays. The fact that they are not so mixed seems to me to

hit the annihilation theory a second fatal blow, for there is no sort of reason for assuming that annihilation takes place *only* in interstellar space. Such an assumption would destroy the whole purpose of the annihilation hypothesis, which up to the present has been to furnish the requisite energies to the stars.

Before I leave this point (No. 2), let me combine the experimental fact of uniformity of distribution (No. 1) with this other fact that the rays enter the atmosphere unmixed with deflectable beta rays. The uniformity of distribution could indeed be reconciled with the annihilation hypothesis if it could be assumed that, in looking out from the earth into the celestial dome, one were always looking through a quantity of matter equivalent to, say, a hundred metres of water, which is a thickness sufficient to absorb 99 per cent of all incoming cosmic rays. That one would actually encounter one thousandth part as much matter as this in going out to infinity through interstellar space seems to be contrary to all the other astronomical evidence. But let us forget this and see what the cosmic rays alone have to say about this point. If annihilation is going on in all matter independently of temperature, then so far as the cosmic rays coming to the earth's atmosphere are concerned, every element of the celestial dome would be like every other element, even if the sun were in one of these elements. This is the only way the annihilation hypothesis of the origin of cosmic rays can be reconciled with their uniformity of distribution. But in this case the whole of the cosmic ray beam entering the earth would be a beam in complete equilibrium with its whole train of secondaries, including the deflectable beta rays, and these latter would of necessity spiral about the earth's magnetic lines and thus enter the earth only near the earth's magnetic poles, a behaviour which clashes with fact No. 2. Since, then, no trace of such an effect is actually found, the cosmic rays alone deny the validity of this hypothesis and with it of this form of the annihilation hypothesis as to their origin. It seems to me, therefore, that as an explanation of facts about cosmic rays the annihilation hypothesis fails at every point at which one can test it. I shall comment upon still another of its failures in the next section.

(3) The third well-established and most significant fact of cosmic rays is that *they have a banded structure.* Cameron and I first brought this fact sharply to light in 1925,[8] but I do not think the evidence is yet clearly understood or its significance fully appreciated. The evidence goes back to the high balloon flight[9] with self-recording electroscopes which Bowen and I made in 1922, a flight in which we reached an altitude of 15½ km. and got 92 per cent of the distance to the top of the atmosphere as measured by the weight of the earth's atmosphere left beneath our instruments. *In other words, remembering that the atmosphere is the equivalent of* 10 *metres of water, we were within* 80 *centimetres of the top.* Now, 80 centimetres of water allows at least 3 per cent of rays as soft even as those of thorium C″ to pass through it. We made this high flight on purpose to determine whether the rate of increase of ionisation within a closed electroscope continued exponentially to the top of the atmosphere as Kolhörster's earlier balloon flight to a height of 9 km. had indicated was the case up to that altitude. Further, Cameron and I have since, with precision instruments, obtained quite as high ionisation readings up to 5 km. as those given by Kolhörster, thus checking sufficiently his exponential curve in the lower stretches of the atmosphere; but the 15½ km. balloon flight not only failed to do this, but it showed definitely and altogether unambiguously, since all possible sources of error would have increased, not decreased, our readings, that with increasing altitude the ionisation fails to maintain its rate of increase but drops back toward lower values, just as it should do if a band of about 25,000,000-volt pure photons enters the atmosphere and requires a considerable distance of penetration into it before it gets into equilibrium with its secondaries. This furnishes a third bit of independent evidence that the cosmic rays do enter the atmosphere as practically pure photons, and hence that they originate in interstellar space.

The high balloon flight shows much more than this. It proves conclusively that neither gamma rays of energy 2,500,000 volts, like those from thorium C″, nor rays of intermediate penetrating power up to that of the softest cosmic rays, which pass through about five times as great a thickness of water and have an energy of about 25,000,000 volts, enter the earth's atmosphere in amounts appreciable in comparison with that of this softest cosmic ray band; for any such abundant rays would have very rapidly discharged our electroscope when it got within 80 cm. of water of the top of the atmosphere. In other words, there is a definite and strong cosmic ray band of penetrating power about five times (energy ten times) that of the hardest gamma rays of thorium. The analysis of this band on its other side, that is, on its short wave-length side, into much lower intensity bands but of energies of the order of 100,000,000 volts and 180,000,000 volts respectively, has been made by Cameron and me,[10] though these results are less certain. *The existence, however, of a very strong cosmic ray band at about* 25,000,000 *volts, fairly* *sharply limited on both the long wave-length side and the short wave-length side, is altogether definitely established by our experiments.* This band carries of the order of 90 per cent of the total cosmic ray energy entering the atmosphere.

Now, the experimental fact of the existence of such a band is only interpretable, so far as I can see, by the assumption of some kind of an energy-emitting atomic transformation of definite energy-releasing value taking place continuously throughout interstellar space. The other suggestions which have been made to account for a band having such energy can, as it seems to me, be quite definitely eliminated. There are but two of them. First, some kind of a cosmical electrical field has been postulated of sufficient total potential difference to impart the necessary 25,000,000 volts to electrons falling through it. There is indeed known to be a symmetrical field surrounding the earth, *but its value is definitely known to be about one million volts and its direction is such as to drive electrons out, not in; in other words, it has one twenty-fifth the requisite strength and is of the wrong sign.* No potential difference of 25,000,000 volts, symmetrical with respect to the earth and positive at its surface, can possibly be assumed without, as I think, colliding head on with other well-established facts; and even if such a field existed, it would produce a more or less continuous spectrum, like the general X-ray spectrum, instead of a well-marked band. I cannot see any way of making this suggestion reproduce even remotely the experimental situation.

The second effort has been to find a way by which rays due to the annihilation of protons (which are at least thirty-five times too energetic) could be softened down to the observed values. The most interesting of these suggestions has been made by Dr. Zwicky, who seizes upon the nebular red shift recently discovered by Hubble to suggest that if at the creation, which he estimates from the maximum possible amount of matter in interstellar space would have been about 10^{13} years ago, annihilation rays began suddenly to be formed, and if these same rays are still hurtling about in a spherical universe and are subject to the red shift, these rays, with all that have been created since, would now constitute a spectrum having a definite limit to its frequency on the long wave-length side, but falling off very slowly in intensity on the short wave-length side, where the limit would be 25,000,000 volts. In my opinion, this is the only conceivable mechanism by which annihilation rays could become reduced in energy to that observed on the long wave-length side of the band which carries nine-tenths of the energy of the cosmic rays; but the shape of the spectrum on the other side is completely wrong, since it represents a very slowly falling intensity with increasing frequency, instead of a fairly sharp, well-marked band such as experiment reveals.

No other known mechanism can soften an original beam of photons of the gamma ray type. If such a beam is in the least inhomogeneous, our universal experience is that it is hardened, not softened, by passage through matter. If, on the other hand, the original beam is monochromatic, it is also at first apparently hardened in the process of getting into equilibrium with its secondaries, and when that condition has been attained it has regained its original absorption coefficient. If annihilation rays maintain the temperatures of the stars at all, the mechanism by which they do it is not that of a continuous degradation of wave-length until the wave-lengths corresponding to heat and light waves are reached. The process is rather that the penetrating power of the beam of photons is maintained *until all of these photons have been picked off by Compton encounters* and complete absorption of the beam has thus been brought about, the temperature of the matter traversed having been thus slowly raised by this straight attrition process. Our third fact, then, of a banded structure in the particular region in which the chief cosmic ray band is found, appears to me to be the last arrow that pierces the heart of the already twice fatally wounded annihilation hypothesis of their origin.

Also, I should like to present one more reason why the hypothesis of cosmic electrical fields as an agency for directly imparting energies of from 25,000,000 volts to, say, 400,000,000 volts to electrically charged particles cannot be admitted. It is not only that the most fantastic assumptions would have to be made to make such fields produce cosmic ray bands of the type observed, but also, more than that, to make fields of any such intensities symmetrical with respect to the earth and thus account for the uniformity of distribution of cosmic rays would involve, as it seems to me, something very like a return to the geocentric theory of the universe—a return scarcely acceptable to any scientific worker who has lived since A.D. 1500.

With cosmic electrical fields and the annihilation of protons both completely unacceptable, what is then left to furnish the energy, first, of the great cosmic ray band which carries 90 per cent of the energy of these rays? The answer seems to me to be as follows:—If the Einstein equation $E = mc^2$, and the actual facts of isotopes, as accurately worked out first by Aston, are taken as guides, then this answer is unambiguous. But first, how dependable is this Einstein relation? Note first that it is a purely thermodynamic equation, stating merely energy relations. In using it, therefore, we are completely independent of any assumption as to the nature of the cosmic rays. Whether they are photons or high-speed charged particles is, so far as it is concerned, quite immaterial. Again, as to its dependability, I think that most physicists would say that it is about as safe a guide as any theoretical equation which we now have in physics. It not only rests on excellent theoretical foundations, but also it has predicted quantitative relations which have stood the tests of all the careful experiments which we have as yet been able to apply to it. *It states with entire definiteness that there is no atomic transformation whatever that can furnish the necessary energy except an atom-building process.*

I have thus far reached, merely by a process of exclusion, the conclusion that the cosmic rays are the wireless signals of the building in interstellar space of some at least of the heavier elements out of the lighter. The evidence, however, is very much better than that. It is reasonably quantitative in the case of the main cosmic ray band. Here again theory and experiment support one another. For, if atom-building takes place at all, there is one such atom-building act that is more fundamental than all others, and that also must take place more frequently than all others, namely, the formation of helium out of hydrogen, because we have abundant evidence that all the elements are actually built out of hydrogen and helium, and that helium is built out of four atoms of hydrogen, so that the hydrogen-to-helium transformation should take place much more frequently than any other. The energy of this transformation is computed from Einstein's equation and Aston's measurements at 25,000,000 volts: just what I stated above to be the energy of the large cosmic ray band that carries the great bulk of the cosmic ray energy entering the atmosphere. But the way in which I arrived at that figure requires some explanation. Most simply stated, the method used was to compare directly in the waters of high altitude lakes the penetrating power of the cosmic rays there found with the penetrating power of the hardest known monochromatic gamma rays, namely, those of thorium C″, which have an energy of about 2,500,000 volt-electrons. *This I have done directly, the observed ratio being between* 6 *and* 12.

The comparison cannot be made directly with great precision, because the cosmic rays are not homogeneous, but when the inhomogeneities are sifted out into bands (and this does not need to be done with great precision, almost any reasonable kind of sifting being satisfactory, since the softest band carries so large a fraction of the total energy) the penetrating power of this softest band comes out very close to five times that of thorium C″. Further, at altitudes between 6 km. and 9 km., where the harder components should exert almost no influence, according to the observations of both Hess and Kolhörster in their manned balloon flights, the directly measured penetrating power of the cosmic rays was six times that of the hardest gamma rays. This checks most satisfactorily with our analysis of our curve. The best formula we now have (the Klein-Nishina) connecting penetrating power and energy then makes this energy come out ten times that of thorium C″, or about 25,000,000 volts. This Klein-Nishina formula has been directly proved by Bowen and myself, as well as by others, to fit the facts up to rays of the hardness of those of thorium C″ reasonably well, and the extrapolation from there up to the softest cosmic ray band is not likely to be very badly in error. Indeed this whole procedure may be looked upon merely as the extrapolation, to a not unreasonable distance, of an *experimental* curve, and thus as largely independent of the Klein-Nishina formula or indeed of any theory. At any rate the foregoing is, in my judgment, the only quantitative test of the energy of any portion of the cosmic ray spectrum that has any sort of significance. For to use the Klein-Nishina formula to compute the energies of the rays, not five times but 200 times as penetrating as those of thorium C″, as some who have sought to make the cosmic rays proton-annihilation rays have done, seems to me to be extraordinarily rash. If my extrapolation is not significant, theirs must represent that lack of significance raised to a very considerable power.

Let me not, however, overstress the precision of this quantitative comparison. *It is scarcely necessary to do so, since there is no other energy-releasing act of this order of magnitude that can produce this soft component of the cosmic rays.* There are, to be sure, other *atom-building* acts which might produce as soft or softer rays, and some of these may well be taking place, such, for example, as the formation of carbon out of helium, but a consideration of the *abundance* of the elements involved shows that such rays would in general be of negligible intensity. The fact that there are but some five *abundant* elements is here a powerful guide.

So far I have dealt only with the formation of helium out of hydrogen. Cameron and I have shown that our complete cosmic ray curve is consistent with the existence of three other bands corresponding to the three other abundant groups of elements which we have called the oxygen group, the silicon group, and the iron group, but the evidence was here necessarily qualitative in view of two recently demonstrated cosmic ray facts. The first is that referred to above, namely, the evidence that the rays come into the earth's atmosphere as practically pure photons. For this means that we may not assume that the harder rays have reached a condition of equilibrium with their secondaries at the points at which we measure them.

The second is that interesting new fact discovered by Bothe and Kolhorster[11] a couple of years ago: that the penetrating power of the secondary beta rays may apparently, with increasing energy, rise up to, or possibly surpass, the penetrating power of the original photons. This seems to me to furnish the most simple explanation of the fact brought to light by Regener, as well as by Cameron and myself in our work at great depths in water, namely, that there is a very small component of the cosmic rays of intensity of the order of 1/500 of that of the whole cosmic ray beam as it enters the atmosphere, which has a penetrating power thirty-five or forty times that of the main cosmic ray band of which we have been speaking. The hardest rays of appreciable intensity that should be formed by the atomic building process are those of iron, and their energy should be about seventeen times that of the helium rays. There are indeed more penetrating atom-building rays that might be formed, but the abundance of the elements corresponding to them is so small that these rays should be exceedingly feeble—probably too feeble to make the formation of these heavy elements out of hydrogen a good theory as to the origin of the hardest component of the cosmic rays.

There is, however, already some little evidence, which we hope soon to complete and extend, that the penetrating power of these very hard rays increases more rapidly than does their energy, and in the present state of our knowledge this is the best working hypothesis to account for this one point which might raise doubts about the completeness of the atom-building explanation of the cosmic rays. If, however, it might be assumed that proton-annihilation does not take place in the stars, but does take place, *with* atom-building, in interstellar space, then proton-building might perhaps be called upon to account for this 1/500th part of the cosmic rays which possess this great penetrating power. In other words, if one prefers to go no further than to seek an answer to the question, What processes are able to take place in Nature that are appropriate for supplying the energy actually found in the cosmic rays? then the answer is, atom-building taking place in interstellar space for supplying more than 99·5 per cent of the rays and proton, or nucleus, annihilation for supplying the remainder. If we assume them both, then the energy-conditions represented in Einstein's equation can easily be satisfied.

The reasons, however, for such proton-annihilation in interstellar space are not so cogent as are those for atom-building. These latter reasons, apart from the direct experimental evidence, may be stated thus. We know that all the atoms are actually built up out of hydrogen, and it is therefore natural to assume, even apart from direct experimental evidence, that somewhere or other the process is going on now. Secondly, Bowen has shown that the reason so-called forbidden spectroscopic lines appear in the nebulæ and not on earth is that, given a long enough time free from collisions, an atomic change will take place that cannot take place where atomic collisions are frequent. It is not a dissimilar hypothesis, and one concordant with modern wave mechanical thinking, too, that a cluster of four hydrogen atoms *free from collisions for a long enough time* will jump over a potential wall and find themselves together in the nucleus. The reason this does not take place in the atmospheres of the stars, or even on earth, is presumably that temperature and density, that is, energy and frequency of collisions, destroy the clusters or prevent altogether their formation. But at low enough temperatures, under the influence of ordinary molecular forces, these clusters *must* form; for what is liquefaction other than the process of formation of such larger molecular groups? It is such clustering, combined with freedom from energetic collisions, which, according to the hypothesis herein presented, provides the necessary condition for occasional atom-building. It might conceivably take place in the very remote regions of our atmosphere, but in that case it should also take place in the remote regions of the sun's atmosphere; and the cosmic rays should then be much stronger during the day than at night, a result contrary to fact. Atom-building *in interstellar space* is therefore a natural enough hypothesis. Proton annihilation, on the other hand, must take place, if at all, either within the nucleus or through the rushing of an enormously energetic electron into the nucleus. These acts ought to be either independent of temperature or else facilitated by it. The first cannot be true if cosmic rays are to be explained by annihilation, else the sun would be enormously influential. The second may be true, and annihilation therefore confined to the interiors of stars as has been generally assumed. It is therefore very unnatural, if not quite impossible, to assume annihilation to take place in interstellar space and *not* in the atmospheres of the suns. This hypothesis, therefore, I should not wish to make until every other avenue of escape from our difficulties has been closed. If the ideas presented herewith prove correct, they will obviously influence strongly not only present theories but also all future theories of the origin and destiny of the universe.

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[1] Richardson, NATURE, **73**, 607, **74**, 55, 1906.

[2] Kurz, *Phys. Zeit.*, **10**, 836; 1909: see also Millikan, NATURE, **126**, 14; 1930, for historical studies.

[3] Gockel, *Phys. Zeit*, **11**, 280; 1910: also **12**, 597; 1911.

[4] Millikan and Cameron, *Phys. Rev.*, **31**, 930; 1928.

[5] Millikan and Cameron, *Phys. Rev.*, **28**, 856; 1926

[6] Hoffmann, *Zeit. für Physik*, **69**, 703; 1931.

[7] Bowen, *Astroph. Jour.*, **67**, 1; 1928.

[8] Millikan and Cameron, *Phys. Rev.*, **28**, 851; 1926: see also *Phys. Rev.*, **37**, 244; 1931.

[9] Millikan and Bowen, *Carnegie Institution Year-book*, **21**, 385; 1922: also *Phys. Rev.*, **22**, 198; 1923, and **27**, 353; 1926.

[10] Millikan and Cameron, *Phys Rev.*, **37**, 235; 1931.

[11] Bothe and Kolhorster, *Zeit. fur Physik*, **56**, 751; 1929.

By Prof. E. A. Milne, F.R.S.

It has sometimes been asked whether the universe is evolving at all. Certainly its future evolution is a matter of speculation, and its past evolution a matter of inference. But that it is evolving at this present time is not a matter of speculation at all—it is a matter of observation. We actually see stars undergoing drastic changes—changes of organisation so fundamental that they can almost be described as mutations. I refer to those outbursts which we call 'novæ'.

From time to time in the heavens a faint star is seen to blaze up for a few hours or days, increasing in brightness perhaps some twenty-five thousand times, then irregularly fading and after a few years returning to its pre-outburst brightness. Such outbursts are by no means uncommon. The first quarter of the current century has witnessed five novæ visible to the naked eye. Many will remember Nova Aquilæ of 1918, which was visible even before dark; and Nova Cygni of 1920. These from their brightness were comparatively near-by stars—Nova Aquilæ, the more distant, was only some three hundred parsecs away. But many more have been observed in the most distant regions of space. Up to 1929 more than eighty novæ had been recorded in the great nebula of Andromeda, and were used by Hubble to determine its distance. Thus novæ are distributed throughout space. They are also distributed fairly frequently in time. Hubble has estimated that some thirty novæ occur each year in the Andromeda nebula. It has also been estimated that in our own galactic system there is at least one nova per year. Such estimates are conflicting, but, as many have pointed out, they imply that every star 'becomes a nova' at least once in its life-time. We thus have in each nova an evolutionary event characteristic of the stars as a whole. Let us examine the event more closely.

The spectrum of a nova shows that the outburst is accompanied by the emission of streams or jets of gas, in various directions, at the large velocity of some 1500 km. a second. There is little doubt that this gas is a portion of the atmosphere driven off by the greatly increased radiation pressure. Some years ago when I was engaged in discussing the sun's chromosphere, I found that the hotter stars would have difficulty in retaining certain elements such as calcium, since the pressure of the outflowing radiation, greedily absorbed by the atoms in their spectral lines, would be strong enough not only to balance gravity at the star's surface, but further to repel these atoms in a kind of upward rain. Later, I examined the probable limiting velocity that such accelerated atoms would attain, and I found that it was of the order observed for the gases expelled from novæ. Thus one of the characteristics of a nova outburst is that the huge increase in brightness blasts off, almost explosively, portions of the star's atmosphere, and that these clouds of gas travel outwards through space. We shall see the evolutionary significance of this later.

This driving off of atoms probably has its maximum effect when the star is at its brightest. What of the subsequent events as the star fades ? The atmospheric layers, or some of them, continue their journey outwards, but what of the mother star itself ? Let us re-examine such a star a few years after the outburst. We find that it has returned to the same undistinguished brightness as it possessed before the outburst—but with a difference. Its spectrum is now of what is called type *O* or Wolf-Rayet, indicating a very high surface temperature or surface brightness. From this we can make a most important deduction. If the *total* brightness of the star is the same as before the outburst, but the *surface* brightness—the brightness per square mile—is much greater than before, the total area of the star must be much smaller than before. If the area is smaller, so must be the radius and the volume. The reduction in radius as observed may be as much as 10 : 1 or even more. Thus after the outburst the star is found to have shrunk. We must resist the temptation to describe it as the shadow of its former self. It is smaller in dimensions but much brighter per square mile, and as bright as before in the aggregate. We have the paradoxical situation that the outer parts expand, forming an advancing outward-moving cloud, but the inner parts contract.

We can only see the shrunken star when the expanding clouds have moved out of the way. During the outburst itself the expanding atmospheric gases obscure our vision of what is happening. We can only conjecture what goes on behind the expanding screen. But there can be little doubt as to what is actually happening. The expulsion of the atmospheric clouds is a consequence of the brightening, but the shrinking of the rest of the star is not just an accompaniment of the brightening—it is the actual origin of the brightening. When the star contracts it must lose gravitational energy, which is set free as heat and light. Somehow it must get rid of this energy. If it got rid of it slowly there would be little visible effect. Actually we see the star, in its period of maximum brightness, getting rid of an enormous amount of energy very quickly indeed.

Since the rate of brightening is very rapid, we infer that the process of shrinkage is very rapid—in fact cataclysmic. The process of shrinkage is a veritable collapse. In a nova outburst the star is seen to be collapsing on itself ; and the suddenness of the collapse, and the resulting enormous amount of gravitational energy that must be got rid of in the short time available, conspire to produce the huge brightening of the star as observed. This sudden liberation of energy produces enormously increased radiation, which in turn expels the outer layers of gas. Such is the probable explanation of the origin of novæ, or 'new stars'.

These outer layers thus expelled constitute an exceedingly small proportion of the whole mass of the star. Thus the mass of the star, after the outburst, is practically the same as before, yet it occupies a much smaller volume. Hence its mean density must be much larger than before. The increase in density as observed varies from one-hundredfold to ten-thousandfold. The gases expelled from the star during the outburst are chips from the old block ; but the star itself does not remain an old block ; it becomes very much of a new block—a very dense block.

We can now link up this widely spread phenomenon with our general views on stellar evolution. A star may be supposed to fade, very slowly but quite definitely, as it ages. At some particular luminosity it collapses, giving rise to the appearance of a nova. This must be due to some structural weakness in the star, some insecurity in its foundations. It falls on itself like a house of cards. Samson in the Old Testament story lost his strength when he was shorn of his locks. The star also loses its strength when it is shorn of its locks. But the shearing of the stellar locks—the liberation of wisps of atmospheric gases—is a consequence, not the cause, of the internal weakening.

We know other stars which are very dense—the stars which are known as 'white dwarfs' and the nuclei of the planetary nebulæ. Planetary nebulæ are probably exceptionally large ex-novæ in which the expelled gases linger round the star as a permanently accompanying nebula. It is reasonable to assume that the white dwarfs have also undergone the process of collapse—that every white dwarf has been at one time a nova. Though few white dwarfs are known, all those with which we are acquainted are close to the sun, whence it is concluded that they are very common in Nature. This is in general agreement with the ideas I am describing, since if novæ are common the heavens must be littered with ex-novæ, and these remain in the form of white dwarfs. We must now endeavour to explain the origin of the weakening which causes the cataclysm. In my investigations of stellar structure I have encountered circumstances in which this weakening occurs. There is considerable discussion at the moment as to whether stars are built of perfect gas or not. It is true that the mathematician can construct in imagination configurations of perfect gas which in some ways resemble stars, but these are not the only configurations that he can construct. We are also acquainted with another phase which gaseous matter can assume—what is called the degenerate state, a state which gases take up when the density becomes disproportionately large compared with a certain function of the temperature. Our knowledge of this state is due to Fermi and Dirac, and it was shown by R. H. Fowler that this must be the state of a very dense star such as a white dwarf.

The mathematician's task in this connexion is to construct all the configurations in which a given mass of material can occur. Similar situations arise elsewhere in physics. For example, if the mathematician is dealing with a specimen of water in an enclosure, he will find configurations in which it may be entirely steam (in a super-cooled state) or partly in the form of steam and partly in the form of water. Some of his systems will be one-phase systems and some two-phase systems. Similarly, the astrophysicist can construct configurations, of the stellar order of magnitude, in some of which the material is entirely in the form of perfect gas, in others of which it is partly in the form of perfect gas and partly in the form of degenerate gas. There are probably other phases yet unknown to us, but we can at least construct the outer parts of possible configurations. When this is done, it is clear that the two-phase configurations, having very dense cores, have enormously less energy than the one-phase configurations, and consequently that the one-phase configurations, if disturbed, will undergo a transition to the two-phase configuration. The purely gaseous configuration is analogous to the super-cooled steam, which if suitably disturbed condenses partly into drops of water. Again, it is analogous to the excited state of a Bohr or Schrödinger atom which when disturbed executes a transition to a state of lower energy, giving up the difference as radiation. In each case the excess of energy is given up suddenly. Similarly, a gaseous stellar configuration if disturbed would collapse and give up energy rapidly as it passes to a configuration of lower energy. We infer that stellar gaseous configurations are in general unstable and cannot exist in Nature. The stars in Nature must have small dense cores—a sort of foundation stone.

As the luminosity of such a star decreases, the core will vary in size. The behaviour of the core is very complicated, and I have not yet been able to trace it in full detail. But it appears that at a certain critical value of the luminosity the core increases *suddenly* in radius, due to collapse of the gaseous envelope. This is a consequence of the very low opacity of degenerate matter.

Degenerate matter obstructs the passage of radiation far less strongly than gaseous matter, and so experiences a smaller radiation pressure; accordingly, at a certain luminosity, as soon as more degenerate matter is deposited on the core, radiation pressure weakens still further, further collapse occurs, more degenerate matter is deposited, and so on. The star has a canker at the core. Or, to put it another way, degeneracy is an internal disease which propagates itself with startling rapidity under favourable stellar conditions. The outward and visible symptom of the disease is the nova-phenomenon, and, as is not unknown in medicine, a high surface temperature is developed. The existence of a discontinuity in core-radius can be established mathematically, but I only provisionally identify this particular discontinuity with the observed discontinuity in Nature. We at least obtain a hint as to the character of one of the most important events in the evolutionary history of a star.

Collapse alone is not, however, the only possibility. If the collapsing star is in a state of rotation, the increased angular velocity consequent on collapse may cause the star to divide into two, in the manner described by Jeans. This may be the origin of the great frequency of occurrence of double stars in Nature. Something of this kind has been observed in the case of Nova Pictoris. The two fragments so produced may remain collapsed (and thus very dense), or, in certain circumstances, provided as they are with an internal source of energy, they may re-expand and re-form even giant stars. In the fable the mountains gave birth to a mouse. In the heavens the dwarf may give birth to giants.

To summarise, we see a twofold evolutionary process at work amongst the stars, both parts of the process occurring in this same phenomenon of the nova. On one hand we observe the stars to be collapsing and giving birth to planetary nebulæ, white dwarfs, and even double stars. On the other hand, we see nebulous clouds driven off to space, there to reinforce the already existing cosmic cloud. Reinforce? Possibly we have struck the real origin * of the cosmic cloud—possibly the cosmic cloud is the totality of the debris of the expelled atmospheres of novæ and other hot stars. The universe is simultaneously condensing into hard blocks and evaporating to form a tenuous nebula. I repeat, this is what we observe. Sir James Jeans has suggested that the universe began as a widely-extended nebula, which condensed into stars in virtue of gravitational instability. The picture I have attempted to draw is that of a concourse of stars, on one hand condensing into denser stars in virtue of instability under a waning light pressure, and on the other hand simultaneously expelling their atmospheres and generating a nebula.

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* This idea has been suggested also by Vorontsov-Velyaminov, *Observatory*, Aug. 1931.

By General the Right Hon. J. C. Smuts, P.C., C.H., F.R.S.

In a sense my presidential address dealt with some aspects of the evolution of the universe, but a good deal more could be said, if there were time, about the philosophical issues which are raised by this subject.

I do not agree with those who say that the recent advances in physics have no important value for philosophy. The most creative philosophical thinkers in the past have as a rule been saturated with the science of their time, which gave substance and body to their philosophy; and it is only to be expected that the recent revolutionary advances of physics are bound to have the most profound effect on our world-view and on our philosophical outlook. How, for example, could philosophy, which has for thousands of years speculated on the nature of time and space, be unaffected by the fruitful integration of the two which has been effected by the physicists in our time? Again, the concept of the quantum, with its peculiar behaviour, its holism, its indeterminacy, is bound to be far-reaching for philosophy no less than for physics. Of course, it is extremely difficult at this early stage, when we are at the beginnings of these changes and physical theory is still in a state of flux, to say what exactly will be the philosophical outcome of the new physics. But I have little doubt that the revolution in physics will yet be followed by a revolution in philosophy, and that in their joining of forces a new era will open up for both science and philosophy.

So far as philosophy is concerned, one is at present perhaps more impressed with the difficulties and perplexities, arising from the new concepts in science, than with its solid results. Thus one is inclined, from the point of view of relativity, to attach the greatest importance to the new space-time concept. If the old forces of Nature, like gravitation, and perhaps even electromagnetism, are (as Einstein teaches) nothing but curvatures of space-time, if matter itself is really only such a curvature, one feels inclined to look upon space-time as the basic structure of the world, and as no mere mathematical symbolism. Space-time becomes something like the old ether, a substratum or matrix from which all the physical differentiations have taken place. To such a view one is inevitably led by the relativity theory and its results. Yet the next moment, when one considers the behaviour of the ultimate physical units, especially the electron and the quantum, one meets with phenomena in flagrant contradiction with the idea of space-time, as if, for the electron and quantum, space and time really do not exist, as if space-time is a macroscopic result rather than an ultimate basic feature of the cosmos. If space-time is merely a statistical macroscopic result, there seems to be some flaw in the fundamental relativity treatment which makes it basic to everything in the world of existence. We seem to be making for a real clash between the relativity and the quantum concepts, unless we have to admit that both are still provisional, and that a wider, truer unification or reconciliation is still to come.

I could refer to other difficulties and perplexities arising from the new physics, but I pass on to another point which has perhaps a closer bearing on our topic for discussion. I wish to refer to the peculiar character of the ultimate physical units and their bearing on the evolution of the universe. Many physicists, including even a profound thinker like Sir Arthur Eddington, maintain the view that exact science, and physics in particular, is confined to the metrical aspects of the world and has nothing to say as to the nature of the universe. If this is really so, then how could Sir James Jeans say, in a recent book of his, that the universe as viewed by the new physics is more like a great thought than a great machine? This seems to go far beyond the metrical characters of the world. If physics were confined simply and solely to the metrical aspects of the world, then how can Sir Arthur Eddington himself find intimations of freewill in the law of indeterminacy? Truth is a whole, and the truth of physics will be found to link on and to be but part of that larger truth which is the nature and the character of the universe.

When we speak of the evolution of the cosmos we are faced with a series of questions in regard to the ultimate physical constituents of the world and their interplay, the routes they follow, the structures they form, and the resulting characters, size, mass, and properties of the universe as a whole. These are problems for physics. But we find that that evolution also comprises the emergence of life and mind, of the human soul and human personality, and a whole new world of values of all sorts. Truth, beauty, goodness, and love are as much structures of the evolutionary universe as the sun and the earth and the moon. But when we come to scrutinise the ultimate foundations of this vast superstructure, we naturally look for the characters which would in the long run render such enormous developments possible. This would be in particular the attitude of the philosopher, with his wider outlook over the realms of existence; and it is for him that from this point of view the new quantum physics has a peculiar fascination. For he finds that the physicists, working merely with their own tools and their own incomparable technique, and looking for no more than the metrical units which subtend this universe, have indeed, like the man who looked for asses and found a king, found much more than they have looked for. The units they have discovered will constitute not only a world of physics but, in the end and at far removes, also a world of life and spirit.

These units, particularly the electron and the quantum, have an almost metaphysical aspect: they are physics infected with thought; they are not in space-time, they behave as wholes, they are indeterminate in their behaviour, so that the law of chance rather than the ordinary causal law applies to them. Of course, it is possible that this ambiguous character is due to infection from the mind of the research worker, as if the mental instrument of research has affected the result. But it is far more likely that in this dual character of the physical units we reach an ultimate basic fact, that we transcend the mind-matter distinction and reach the bedrock where no such differentiation has yet arisen. Thus it comes that the ultimate units are not purely physical or material, but point to an undifferentiated primitive world matrix, which includes both the physical and the thought characters of the world.

When from these units we start our process of world building, we find at first what is apparently merely a physical universe. But gradually the suppressed vital and mental elements, inherent in the universe from the start, begin to emerge. Cosmic evolution is thus found to include organic evolution, and this again gives rise to the evolution of spirit, of social and spiritual values, which form our own human phase of this cosmic process.

The origin of life from matter, of mind and personality from both, has always seeemed an unresolvable mystery. The philosophy of emergence which has recently arisen, and purports to explain the creative rise in evolution, the coming of life and mind and spirit—this philosophy has appeared to be based on a miracle or a series of miracles. The quantum physics has come to the relief of this school, which surely teaches a significant truth. According to quantum doctrine, the roots of life and mind lie imbedded deep down in the ultimate structure of this universe, and they are not mere singular apparitions of an unaccountable character, arising accidentally in the later phases of evolution.

To me the significance of the new physics for philosophy seems to lie particularly in this linking of the deep-down beginnings with the most advanced achievements of the universe. The apparent huge gaps in evolution, requiring a miracle of leaps at more than one stage, are thus shown to be a gross exaggeration. We see the universe gradually pushing to the front certain features and characters which have been there all the time from the very beginning, although in most primitive and scarcely recognisable form.

One concluding remark. We cannot say that the universe has been built up from these units or any ultimate units in the course of its evolution. We can only say that these are the ultimate elements which we find on analysis. The universe may for ever have been a complex affair, a closely knit structure of some sort or other, as the law of entropy would seem to indicate. It may even have been one vast quantum, as the Abbé Lemaître suggests. But in the evolution of this mass there has been relative movement of parts or features; some have pushed more to the fore with time, and there is no doubt that life and mind are features that have thus emerged from the mass, with the increase of entropy.

By the Right Rev. E. W. Barnes, F.R.S., Bishop of Birmingham.

I will begin by briefly recapitulating the theory of the evolution of the universe in the form in which, as I understand, it at present exists.

In the beginning, a large unbounded finite three-dimensional universe with space of very small positive curvature was filled with highly diffused matter of very small density. The matter began to aggregate into masses of approximately equal size, spread fairly uniformly throughout the space; and the whole space began, at some epoch or another, to expand. The masses attracted neighbouring matter and somehow acquired velocities of rotation which increased as the matter in them condensed. Finally, incredibly vast bun-shaped aggregates, spinning too quickly for the stability of their outer edges, began to throw off drops, as it were. The drops congealed into suns, and ultimately the aggregates became the spiral nebulæ which now exist. Each of them, apart from possible central regions of diffuse matter, consists of thousands of millions of stars. Our sun is a star of no particular importance, belonging to a spiral nebula or group of nebulæ called the Galactic universe. That universe came into existence some five million million years ago.

Since they first existed, stars in the various universes have moved aimlessly under the influence of their initial velocities and mutual attractions. Periodically, but rarely, at intervals of tens or hundreds of millions of years, collisions between suns in the various universes have taken place and planetary systems have been born. So the earth came into existence some two or four thousand million years ago. Thus ours is quite possibly one of the youngest planetary systems in *our* universe. On the cooling earth primitive forms of life appeared at least a thousand million years ago; and gradually, by a slow evolution, more highly developed living organisms arose. Finally, about a million years ago sub-men emerged from a group of anthropoid apes.

If I personally am critical of this picture, I plead that we must not confuse speculative possibility with satisfactory demonstration. I am concerned that we do not give arguments to obscurantists, who claim that the scientific theories of one generation are usually repudiated by the next. So I would begin by emphasising that in the group of possibilities and probabilities just outlined there is much less certainty than, say, in the facts upon which Darwin rested his conclusions when the "Origin of Species" was published seventy-two years ago.

I need not refer to the prejudiced opposition by which Darwin was assailed. Of course, his triumph has been signally complete. But others before him had put forward theories of the evolution of terrestrial animals. What Darwin did was so to accumulate and arrange biological facts, that experts were convinced that evolution by the mechanism of natural selection had produced from primal organisms the vast range of living things upon the earth, including man himself. Since Darwin wrote, further investigation and discovery have confirmed his insight. Some of his subordinate opinions were erroneous ; but his main scheme stands intact because his facts were correct. All fresh geological and embryological investigation confirms the conclusions on which he rested. The scanty remains of primitive man that are discovered from time to time accord with expectation ; and such statistical investigation as those in R. A. Fisher's recent volume are a triumphant vindication of the potency of natural selection.

It is worth while recalling these facts when we consider the picture of the evolution of the universe which has emerged from recent work. I personally doubt whether the time has yet come for an astrophysicist of genius to write a book which shall in its own sphere rival the "Origin of Species". We can point to a few new facts and to considerably more new (and occasionally discordant) theories. Out of them there has emerged the present picture, immensely exciting, but by no means certain.

What of it can we regard as certain ? First of all, there is no reason to doubt the existence of island universes. Such form that vast, fairly regular distribution of spiral nebulæ through the depths of space which is revealed by photographs taken in the great telescopes. We can say with fair certainty that our own galactic universe is either a single spiral system or an aggregate of several such, each analogous to millions of others with which space is strewn.

Secondly, I would say that it is fairly certain that our space is finite, though unbounded. Infinite space is simply a scandal to human thought ; and, though we must not assume that the universe was made that man might understand it, the alternatives to finite space are incredible. We cannot accept the idea of island universes succeeding one another indefinitely as we pass in imagination through the depths of space. Such a distribution does not accord with a Euclidean-Newtonian gravitational scheme, for it would lead to infinite gravitational potentials. Neither can we with equanimity think of a vast finite group of universes forming a sort of island in empty space. Ultimately such a group ought, one would surmise, to aggregate into a single mass. But in Riemannian spherical space we can have a finite and uniform distribution of universes, inasmuch as such space is unbounded so that every point is related to the whole as is every other point. Finally, there is no fact of observation to set against the belief that space has a very small positive curvature.

Thirdly, I think we must accept as highly probable Jeans's hypothesis that in the stars matter is actually destroyed as protons and electrons unite to form radiation. To this conclusion, however, we are driven by failure to find any satisfactory alternative explanation of the vast output of energy by the stars. If, however, their lives were not to be measured by so long a period of time as millions of millions of years, the necessity for assuming the actual destruction of matter would not be so great.

Consider now some of the uncertainties and difficulties which belong to the present scheme. First of all, of course, there is the insoluble difficulty of infinite time. No man of science will postulate a supernatural intervention, a stirring of the uniformly distributed matter filling space with which in imagination the present scheme begins. Yet in default of such a beginning, we must imagine an infinite regress, a never-ending sequence of alternate periods of world-building and world-destruction, the rise and fall of universes without end. In comparison with such a past the future is perhaps less perplexing, though it is not very satisfying, because the second law of thermodynamics seems to necessitate an end when all energy will have so run down that nothing happens anywhere to break a deadly uniformity. Of course, we can escape from the difficulties caused by infinite time if we accept the opinion entertained by some philosophers that time is not real. With them we may hold that the notion of time is due to the nature of our perception. If we accept such an idea, we can assert that consciousness in its passage through the space-time continuum meets but does not cause events. It then follows, however, that all our fancied activities are an illusion. Against any such belief we must put what surely is our constant and invariable experience. We *have* a measure of freedom of will. Labour and struggle *are* real. We *can* get nearer truth and overcome evil as we strive for goodness. Thus I am forced to conclude that the time-process must be real. Yet, unless time is an illusion, or unless alternatively the cosmos had a beginning in time, any picture of the evolution of the universe must fail to satisfy.

Let us take it, however, that the primal mist that filled all space in the beginning aggregated into masses of roughly equal size in a finite universe and that these masses slowly began to condense and revolve. Whence came their rotation ? To this question I can find no satisfying answer. Let us ignore the difficulty. Out of condensation and rotation came the spiral nebulæ, the universes of thousands of millions of stars with which space is strewn. Obviously, with relatively few exceptions, the great nebulæ are built to a common pattern. They are results of rotation, and the picture of vast rotating lenticular masses throwing off stars, like drops at the edge of a fly-wheel, satisfies the imagination. But why are the arms of the spirals so short ? We should expect arms which curl repeatedly round the central nucleus. None such exist ; and yet there is apparently no ejection into space of early-born stars to account for the disappearance of the coils of stars that ought to be visible.

The different chains of reasoning by which Jeans has been led to assign a period of millions of millions of years for the age of our universe seem to me to demand respect. I doubt whether they are conclusive. But I wish that there were certain knowledge of the development and decay of typical stars. Theories abound. Some are magnificent in the ingenuity and in the intellectual power which have gone to their making. But the final theory of stellar evolution has not emerged. I confess, moreover, that I am by no means happy with regard to the expanding universe, and I doubt whether Doppler's principle is rightly applied to measure the velocities of recession of the great nebulæ. It is not improbable that the reddening of their light is due to other causes If the great nebulæ are moving away as fast as is suggested, we are lucky to be living at an epoch when we are able with our telescopes to see them at all. Moreover, the Friedman-Lemaître equations give contraction as an equally possible alternative to expansion. May it not be that a velocity of approach is masked by some other effect ? A universe that was continuously contracting would have a snug end. Steady and continued inflation, either of a currency or of a universe, is disquieting.

It is, however, when we come to the formation of planetary systems that I feel especially uneasy. The current theory is, as I have said, that the earth and its associated planets arose from the encounter of our sun with a wanderer which came so near as to disrupt it some few thousand million years ago. If the theory be true, planetary systems must be rare and therefore consciousness, as men know and possess it, is rare. In fact, the existence of consciousness, when it occurs, will be the by-product of an accident. We are then apparently forced to conclude that the universe was not created with the primary object of producing beings in whom mind should lead to spiritual excellence.

There is, of course, no reason why consciousness should be associated with animals such as ourselves who represent transformations of carbon compounds at temperatures between the boiling and freezing points of water. It might, for all we know to the contrary, be associated with changes in the ionisation of atoms or with the disintegration of their nuclei at temperatures of hundreds of millions of degrees. But of any such bases for the appearance of mind we have no knowledge. What we do know with certainty is that throughout the universe the raw material of which it is made is fairly uniform. The matter in distant stars is the same as that which exists in our own sun. We must then assume that there are planetary systems in distant island nebulæ, and that on some of them conditions resemble those which exist on our earth. So life, as we know it, must be distributed throughout the universe; but, if the collision theory of planetary origins is correct, the distribution is astonishingly sparse.

I do not, of course, suggest that there are human beings on other planets. The direction of the physical and physiological evolution of living things upon our earth would seem, if we can judge by the geological record, to have been somewhat erratic. Particular mutations coincided with particular conditions of environment to determine the direction of change at any instant. But, throughout the known geological process there has been large-scale progress, a possibly unsteady but quite definite development of mind. In the possibly very different living organisms of other planets there will have been a progressive development of mind. Our physical structure matters little in comparison with the kind of consciousness which it carries.

We can then, as it seems to me, assume the existence throughout the universe of conscious beings. If it be true that our earth and all planetary systems similar to our own originated in a chance collision of suns, life elsewhere must be as a rule unimaginably more developed than with ourselves. Also planets carrying living organisms must be incredibly rare. After a life history of five million million years our galactic universe will have but one sun in a hundred thousand with satellites which can carry life. Such extravagant world-building for such meagre results leaves one dubious as to whether the theory is correct. In defence of such doubts as are forced upon me I might point out that the origin of our moon, with its exceptional density and massiveness, has not been finally settled. The theory that it was broken from the earth when the latter was mainly liquid owing to a chance 'resonance' phenomenon Jeffreys, in a recent paper, deems untrue. Even present estimates of the age of the earth, in so far as they depend on the rate of disintegration of uranium, puzzle us because we do not know why there should have been any uranium in the earth at its birth. Thus I personally should not be surprised if new facts were forthcoming to give some other explanation of the existence of planetary systems. I suspect that such systems are much more numerous than is at present believed.

I need scarcely emphasise that the issue raised by the relative frequency of planetary systems is of great philosophical importance. From Judæa, through the Christian church, has come a belief in ethical theism which has been a strong and ennobling influence in European civilisation. To-day such belief rests upon the conviction that we can only explain the universe by assuming that it is due to creative thought and will, associated with purpose and plan. Such purpose appears most clearly on earth in the progressive development of mind, which has ended in the recognition of moral values by humanity; and the religious outlook of many of us is determined by our belief that God has thus created man for His service. But, if consciousness should be proved to be but a rare accident of a vast, otherwise aimless, universe, such belief in God would be encumbered by a new perplexity. I may add that the belief would not disappear, since we should still have to explain why man has been created with the conviction that he must be loyal to goodness and truth.

Such philosophico-religious speculation is, however, premature. We need more facts and, that we may obtain them, we need new instruments of greater power and precision. The interferometer, we may hope, points the way to instrumental triumphs in the future. If only an instrument could be invented which should enable us to determine whether stars, within, say, a hundred light-years' distance, have planetary systems attached to them! We should then know whether any of the few thousand stars near the sun have planets on which life may conceivably exist. If even one such system were found, the present theory of planetary origins would collapse. Failing any such invention of a super-telescope, there remains the possibility of wireless communication. As I have already indicated, I have no doubt that there are many other inhabited worlds, and that on some of them beings exist who are immeasurably beyond our mental level. We should be rash to deny that they can use radiation so penetrating as to convey messages to the earth. Probably such messages now come. When they are first made intelligible a new era in the history of humanity will begin. At the beginning of the era the opposition between those who welcome the new knowledge and those who deem it dangerously subversive will doubtless lead to a world war. But the survivors, when they extricate themselves from the economic consequences of the peace treaty, will begin what we may correctly term a strenuous correspondence course. I should like to be living then. We might get a true understanding of the evolution of the universe.

By Sir Oliver Lodge, F.R.S.

It is well known that a physical theory which ignores some of the elements of the problem is incomplete, and is therefore liable to break down when confronted with the facts. A physical theory cannot take the whole universe into account; but if it is to be complete enough to be satisfactory, and to make trustworthy predictions, it must take all relevant factors into account.

Sir James Jeans began his discourse by saying that in Section A we were concerned only with the physical universe—that is, with material bodies and the forces that act upon them. I suppose that is true. But the fact that it is true seems to make it impossible for this Section to enter upon a philosophical discussion of such a subject as the universe as a whole, and to decide its fate upon purely deterministic lines. For the universe certainly contains more than we deal with in this Section. We must remember that there are Sections D and K and I and J—that is, we must realise that the universe is not solely inorganic. Some of the matter is animated; and although it is still obedient to the laws of physics and chemistry, an animated body behaves in a spontaneous manner not predictable by those laws. When a thing behaves as if it were alive, physics loses interest in it and hands it over to another section; for it is incompetent to deal with motions attributable to spontaneity and free will. Wherever life has entered in, the predictions of physicists and astronomers and mathematicians are spoilt. Laplace's calculator might reckon the behaviour of every particle in the universe so long as it was not interfered with by life and mind.

I have looked sometimes at the ripples coming over the sand on a sea beach and leaving a deposit of foam. I have thought whether a mathematician, given sufficient data, could predict every ripple and every line of foam. Yes, he could, theoretically, provided there were no boats, nor any fish. The splash of a fish, the ripples of a boat, would put his calculations out. Given even a spark of free will, there are no data that can be supplied. It may be said that our sense of free will is an illusion. Well, that is a philosophical question that can be raised. But it cannot be settled in this Section. So I venture to think that before we can philosophise upon such a theme as the ultimate fate of the universe, we must be able to take everything into account, and philosophise with a very wide and comprehensive knowledge of reality.

Maxwell showed how the effect of mind could be introduced into the scheme of physics without contravening any of the laws of energy, except the purely statistical second law of thermodynamics. His 'demon', by dealing with the particles individually and selectively directing them, could interfere with and neutralise the consequences supposed to be deduced from that law. I claim as a physicist that too much attention has been paid to this second law of thermodynamics, and that the final and inevitable increase of entropy to a maximum is a bugbear, an idol, to which philosophers need not bow the knee.

It is doubtless instructive to learn from high and competent authorities what the unadulterated or rather unvivified laws of physics applied to the universe will lead to. We are faced with a steady running down or degradation of energy to a predetermined end: without hope of novelty introduced at any stage of the process, all settled and dull, events just going through the hollow form of taking place. But it is all on the assumption that there is nothing or no one to wind it up or to guide it to some nobler end. Guidance has only recently intruded itself into the scheme of physics; but already there are guiding waves which determine the path of a particle of matter. What the significance of those guiding waves may be, whether they have any connexion with the observed phenomena we know as life and mind, is at present an unanswered question.

To philosophise from a restricted point of view is interesting enough, but it is not conclusive. It does not fully account for the state of the world to-day, nor can it be depended on to formulate its course to-morrow.

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deposits; major divisions of the Palæozoic; geomorphogenic processes in arid regions; fossil man and contemporary faunas; and orogenesis. It is also hoped to make provision for the presentation of papers not falling under any of these headings. The responses received, together with those from the first circular, will form the basis of the mailing list for the next circular. This will be issued in 1932 and will contain registration forms. The present circular may be obtained from the General Secretary, Sixteenth International Geological Congress, Washington, D.C., to whom all inquiries should be addressed.

SIR SIDNEY HARMER, lately Director of the Natural History Departments of the British Museum, has been elected a foreign member of the Royal Swedish Academy of Science.

AT the ordinary meeting of the Institution of Electrical Engineers to be held on Nov. 5, an oil painting of the late Dr. S. Z. de Ferranti, an honorary member and a past president of the Institution, will be presented to the Institution by Mr. H. Marryat. The portrait is by Mr. David Jagger, R.A.

THE following have been elected officers of the Philosophical Society of the University of Durham: president, Prof. R. A. Sampson; vice-presidents, Sir Westcott Abell, Prof. G. R. Goldsbrough, Prof. T. H. Havelock, Prof. P. J. Heawood, Sir William Marris, Prof. J. Irvine Masson; honorary general secretary, Mr. W. M. Madgin; honorary treasurer, Mr. J. W. Bullerwell; editor, Prof. G. W. Todd; and honorary librarian, Dr. F. Bradshaw.

ON Oct. 13, the first public lecture under the Estlin Carpenter Educational Trust was given at Oxford by Sir Peter Chalmers Mitchell, on the subject of "Life and Matter". The chances, he pointed out, are enormously against the existence of requisite conditions for life elsewhere than in very minute parts of the universe. In support of the view that life is not a distinct principle apart from physical and chemical conditions, Sir Peter laid stress on the facts now known concerning the properties of crystals, of colloids, and of 'Bütschli's foams'. Speaking of the production of organic substances in the laboratory, he instanced the formation of starch and sugar from formaldehyde under the influence of ultra-violet rays. Much advance has been made in this direction since the first artificial production of urea.

AN autumn expedition to Churchill, on Hudson Bay, for the purpose of photographing the aurora borealis is announced by the press bureau of the Canadian National Railways. Churchill has been chosen because it is in the direct line between the auroral and the magnetic poles and on the path of the maximum light frequency of auroral waves. The expedition, which is now at work, will remain for about six weeks, and hopes not only to photograph the aurora but also to measure its height. In order to record the complete range of colour in the aurora, special cameras have been designed.

THE Ministry of Health desires to continue the investigations, commenced in 1926, into the characteristics of acute disease of the nervous system (occurring in the form of meningitis, encephalitis, or polio-encephalitis) following in the wake of vaccination or of acute infections, such as measles, chickenpox, influenza, and the like. It is therefore requested that medical practitioners who may be called in to attend cases of this nature will immediately forward information to The Senior Medical Officer, Med. i., Ministry of Health, Whitehall, London, S.W.1. Attention is also directed to the fact that an antivaccinal serum has been prepared by the Lister Institute, doses of which can be supplied by the Ministry on application, for the treatment of post-vaccinal encephalitis.

THE twenty-second annual exhibition of electrical, optical, and other physical apparatus is to be held by the Physical Society and the Optical Society on Jan. 5–7, 1932, at the Imperial College of Science and Technology, South Kensington. The Trade Section will comprise the exhibits of manufacturing firms. The Research and Experimental Section will be arranged in two groups: (*a*) exhibits illustrating the results of recent physical research; (*b*) lecture experiments in physics. The Exhibition Committee invites offers, from research laboratories and institutions and from individual research workers, of exhibits suitable for inclusion in either of the above groups. Offers of exhibits, giving particulars of space and other facilities required, should be communicated immediately, and in any case not later than Nov. 9, to the Secretary, Exhibition Committee, 1 Lowther Gardens, Exhibition Road, London, S.W.7. The Section for Apprentices and Learners has for its object the encouragement of craftsmanship and draughtsmanship in the scientific instrument trades. Apprentices and learners may exhibit, in competition, specimens of their work, providing they are in the regular employ of a firm which is exhibiting at the next annual exhibition, or has exhibited once during the past three years. Printed particulars of this Section will be sent on application to the Secretary.

A SHORT list (S.S. No. 2) of second-hand scientific journals, transactions of learned societies, and books relating to science has reached us from Messrs. Oppenheim and Co. (Rare Books), Ltd., 317A Fulham Road, S.W.10.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A graduate assistant master for mathematics, science, etc., in the Devonport High School—The Secretary for Education, Rowe Street, Plymouth (Oct. 31). An engineering assistant in the water department of the City of Sheffield—The General Manager and Engineer, Town Hall, Sheffield (Oct. 31). A graduate assistant in the mathematics department of the Coventry Municipal Technical College—The Director of Education, Council House, Coventry (Nov. 12). A science master at Sir Thomas Rich's School, Gloucester—The Headmaster, School House, Gloucester. A senior mathematical master in the Newport, Isle of Wight, Secondary School—The Director of Education, County Hall, Newport, I.W.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Age of the Oldoway Bone Beds, Tanganyika Territory.

As readers of Nature are aware, there has been a certain amount of controversy over the Oldoway skeleton found by one of us (Prof. Hans Reck) at Oldoway, in Tanganyika Territory, in 1913.

In order to clear up this question if possible, and to try to find some data by means of which the Oldoway bone beds could be definitely correlated with those in Kenya Colony, it was decided that the East African Archæological Expedition should spend a part of the 1931–32 season at Oldoway, and Prof. Reck (of Berlin) and Mr. Hopwood, of the British Museum (Natural History), were invited to be members of the expedition during that part of the season's programme.

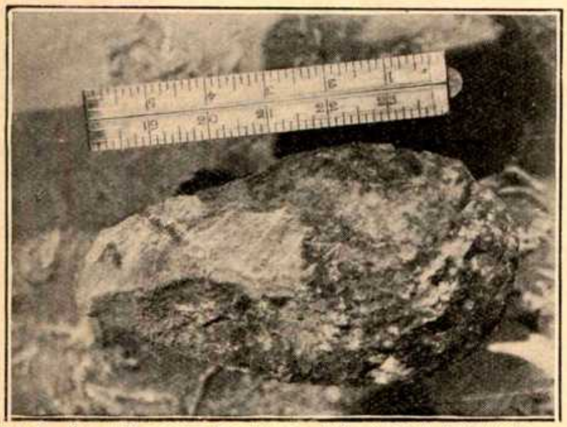


Fig. 1.—One of the coups de poing found *in situ* in Bed B at Oldoway.

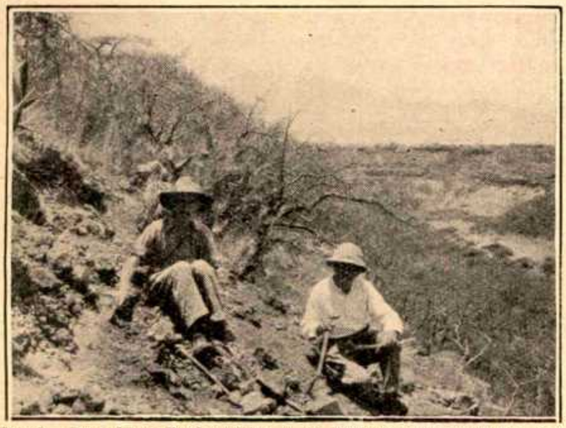


Fig. 2.—Prof. Hans Reck and Mr. A. T. Hopwood sitting on the exact spot where Prof. Reck dug out his Oldoway man in 1913.

After a very careful examination of all the evidence on the spot, and the collection of certain new data, we have come to the following conclusions:

1. There is no possible doubt that the human skeleton found in 1913 came from Bed No. 2, and not from a pocket of Bed No. 4, as was suggested by one of us (Leakey) in "The Stone Age Cultures of Kenya".

2. Beds Nos. 3 and 4, which overlie Bed No. 2 conformably, have both yielded unrolled coups de poing *in situ*, and these tools are absolutely typical of the late Kenya Chellean and of the Kenya Acheulean from the upper part of the Kamasian series at Kariandusi River, as described in "The Stone Age Cultures of Kenya" by Leakey. Bed No. 2 has so far yielded two flakes with definite bulbs of percussion.

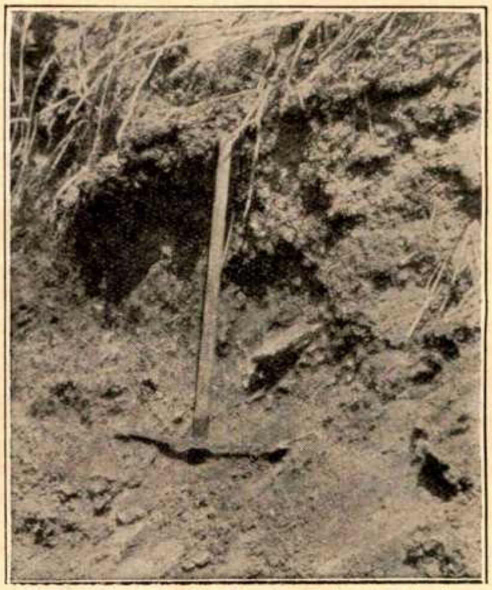


Fig. 3.—The same coup de poing as Fig. 1 but *in situ*.

3. Although in Kenya the deposits of Kamasian age have yielded as yet no identifiable fossils, it thus seems to us clear that the Oldoway bone beds are the equivalent of the Upper Kamasian, and this correlation is borne out by the fact that the Oldoway beds, like the typical Kamasian series in Kenya, are older than the period of volcanic activity and rift faulting, which was responsible in Kenya for the Gilgil and Kikuyu Escarpments and the volcanic mountains, such as Longonot, Suswa, etc., and in Tanganyika Territory for the Ngorongoro volcanic highlands and the escarpment which cuts them to the east.

4. The fact that the Oldoway bone beds prove to be of Upper Kamasian age and not Gamblian is absolutely in harmony with the palæontological evidence, since the Oldoway beds contain a fauna in which more than 50 per cent of the animals are extinct genera and species.

5. From all the available evidence, it thus seems to us that the Oldoway skeleton represents a type of *Homo sapiens* living during the Upper Kamasian period, from which up to the present the only lithic cultures known are the late Kenya Chellean and the Kenya Acheulean.

L. S. B. Leakey.
Arthur T. Hopwood.
Hans Reck.
East African Archæological Expedition,
P.O. Box 658, Nairobi, Oct. 5.

The Mercury Band Spectrum in Fluorescence.

Much has been written on the various band-series and isolated bands in the spectrum of mercury, and their relation to the atomic excited states: but it cannot be said that the subject has been satisfactorily cleared up.

I wish here to record an observation which will help to decide between the various alternatives which have found favour. Mercury vapour saturated at a pressure of 5 mm. was excited to fluorescence by a cooled mercury vacuum arc, the light of the latter being filtered by a dilute solution of thiophene in alcohol, which completely cuts off wave-lengths of 2460 or less. Under these conditions the fluorescence is excited exclusively by the core of the atomic resonance line. I have called such fluorescence the 'core effect'. The spectrogram shows the first three members of a series of bands originally found in absorption by R. W. Wood. These are at 2345, 2338, and 2334. Being of much shorter wave-length than any line from the thiophene-filtered source, the bands appear on a clear background free from false light. I do not know of any equally striking case of the violation of Stokes's law.

As regards interpretation, I limit myself at present to remarking that the experiment suggests a relation of Wood's bands to a ^3P and not to the ^1P state of the molecule. It would be easy to say a good deal more: but there has perhaps been a tendency to over-facile theorising on this subject, and further discussion is reserved.

RAYLEIGH.

Terling Place, Chelmsford,
Oct. 12.

Constitution of Thallium and Uranium.

THE preparation by Dr. v. Grosse of suitable volatile compounds of thallium and uranium has enabled me to obtain their mass-spectra. The lines of thallium were obtained by means of its triethyl compound. As was expected, it consists of two isotopes, 203, 205. The latter predominates to an amount in good agreement with the chemical atomic weight (204·39).

Results with uranium hexafluoride indicate that uranium is probably simple to at least 2 or 3 per cent. Its line 238 was photographed in satisfactory strength, followed by a series, 257 UF, 276 UF_2 . . . etc. The last line visible in this series, 333, corresponding to UF_5, is the heaviest mass definitely recorded on a mass-spectrum. It has not yet been possible to determine the packing fraction of U 238.

F. W. ASTON.

Cavendish Laboratory,
Cambridge,
Oct. 8.

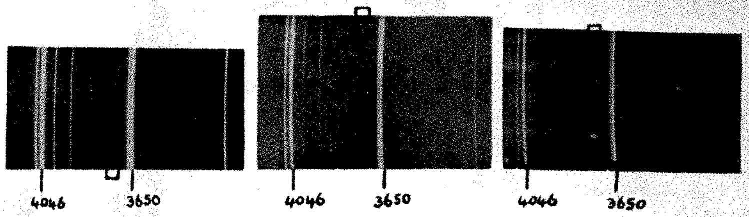
Raman Lines due to Co-ordination Bond.

FOLLOWING J. J. Thomson, Kossel, and others, it can be shown that a large number of observed facts about co-ordination compounds can be explained on the assumption that these groups are held by purely electrostatic forces to the central atom. Grimm has been able to calculate the heat of association per molecule of NH_3 surrounding the cation of a simple salt, from a knowledge of the heat of formation of the ammines and the lattice energy of the simple salt. He has shown that for a monovalent cation with an octet shell the heat of association is 14 calories per gram molecule, 28 calories for a divalent ion, and so on. Also, the maximum co-ordination number of an atom can be shown to depend on the relative size of the latter to those of the co-ordination groups.

Other properties of such compounds, namely, the diamagnetism of certain complex radicles with a paramagnetic central atom, the change of valency of the radicle when one of the co-ordinated group is replaced by another, for example, by the replacement of a NH_3 group by Cl, find an easy interpretation on the theory proposed by Sidgwick. According to this theory, the co-ordinated groups are bound to the central atom by homopolar bonds, in which both the electrons are supplied by the former. It has been pointed out by one of us [1] that from magnetic evidence alone it can be shown that even in the case of co-ordination compounds of the iron group of elements there is not always a sharing of electrons as contemplated in Sidgwick's theory. According to our point of view, a true co-ordination bond occurs when the spin moment of one of the uncoupled electrons in the third shell of the central atom is neutralised by the spin moment of one of the two electrons supplied by the co-ordination group. This leads either to a complete neutralisation of the magnetic moment of the central atom or to a large reduction in its value.

From this point of view it is interesting to compare the magnetic moments of $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_6]Cl_2$ with that of the simple salt $CoCl_2$. The first one is diamagnetic, and in it the NH_3 groups are replaceable by Cl with a lowering of the valency of the radicle, while the second compound has a magnetic moment almost the same as that of the simple salt, namely, 25 Weiss's magnetons, while that calculated according to Sidgwick's theory is 8·6.

Thus we see that the first one is a true co-ordination compound and the second is an associated compound. According to the view proposed here, since a co-ordination bond is a weak valency bond between the central atom and one of the co-ordinated group, the presence of such a bond ought to manifest itself in the Raman spectra. We have photographed the spectra of the radiation scattered by solutions of these two hexammine compounds, and have found definite evidence of the presence of modified lines in the case of the cobaltic compound, but not in the case of the other (Fig. 1). The mercury lines used by us were:



Mercury arc. $[Co(NH_3)_6]Cl_2$. $[Co(NH_3)_6]Cl_3$.

FIG. 1.

	λ.	ν.	Intensity.
A	3650·2 A.	27,388 cm.$^{-1}$	10
B	3654·8	27,354	6
C	3663·2	27,291	10

In some cases, by using a filter of Wood's glass (transmission 390-320 mμ), we have cut off all the other strong lines of mercury except those given above. With the cobaltic solution we obtained the following modified lines:

	λ.	ν.	Δν.	Origin.	Δν.	Origin.
a	3715·8 A.	26,905 cm.$^{-1}$	483	*A* − *a*	575	*A* − *b*
b	3728·5	26,813	478	*c* − *b*	562	*C* − *c*
c	3740·2	26,729				

It is supposed that the modified lines are due to the two strong mercury lines denoted by *A* and *C*, and the middle one represents two lines not resolved. That the absence of modified lines in the radiation scattered by the cobaltous compound is not due to the difference in the absorbing powers of the two solutions in this region is supported by the fact that while $[Co(NH_3)_6]Cl_2$ has an absorption band only at 519 mμ, $[Co(NH_3)_6]Cl_3$ has two, one at 515 mμ and another at 349 mμ. Similar modified lines also appear with a solution of $[Co(NH_3)_5Cl]Cl_2$.

D. M. BOSE.
S. DATTA.

University College of Science,
Calcutta, Aug. 15.

[1] Bose, *Zeit. für Phys.*, vol. 65, 677; 1930.

Melting Points of Nitrobenzene and of Benzene.

IN recent issues of NATURE, Messrs. Wolfke and Mazur have recorded discontinuities in the temperature coefficients of the density and of the dielectric constant of nitrobenzene; and they specify the melting point of their purified material as 5·5°.[1] It appears that this is taken by them to be the true melting point of nitrobenzene of really high purity.

Eight years ago, Roberts and Bury[2] reviewed the very various melting points—ranging from 3° to 9°—which are recorded for this substance; and by purifying commercial nitrobenzene they obtained constant fractions which melted 0·175° higher (by a Beckmann thermometer) than did purified dry benzene. Accordingly, accepting for the melting point of the latter compound the value 5·493° given by T. W. Richards, Carver, and Schumb,[3] they stated the melting point of nitrobenzene as 5·668° ± 0·010°. They also noted and measured the marked depression of melting point caused by traces of moisture, atmospheric or other. These figures, 5·493° for benzene and 5·67° for nitrobenzene, are quoted in the International Critical Tables as suitable datum-marks in precise thermometry.

It will be seen that the figure given by Roberts and Bury is nearly 0·2° above that of Mazur and Wolfke; this is not easy to explain, unless the latter's material were, after all, not as pure as the former authors', or unless the American figures for the melting point of benzene were too high.

Recently I needed some really pure nitrobenzene, and made it by the following method. Benzene, bought from Messrs. The British Drug Houses as "Extra pure, for molecular weight determination", and melting near 5·5°, was fractionally frozen between 5·58° and 5·38° in a slow current of pure dry hydrogen, in such a way that it took eleven hours to freeze out 210 gm.—two-thirds of the original—as a clear icy tube. This solid melted steadily at 5·58°, and the same figure was obtained a month later when phosphorus pentoxide was added to a 40 c.c. sample.

Of this purified benzene, 2 gram-molecules were mononitrated by hand for five hours at 45° (finally 60°) with a slight excess of a pure mixed acid of molar fractions H_2SO_4 (0·33), HNO_3 (0·18), H_2O (0·49), which acid I had found, in other work, not to dinitrate nitrobenzene. The product (98·5 per cent yield) was washed, dried, and distilled from phosphorus pentoxide below 64° (1·0–1·5 mm.) in an all-glass apparatus; the middle fraction was then put through exactly the same process of fractional freezing (5·80°–5·50°) as that described for the benzene. The solid fraction (four-fifths) melted at 5·84°, and this was repeated with a sample containing phosphorus pentoxide a month later. The liquid fraction, after being redistilled *in vacuo*, melted steadily at 5·83°. Exposure to air, or in rubber-stoppered vessels, lowered the melting point by about 0·1°. The thermometers were standardised by the National Physical Laboratory immediately after the end of these tests, and the temperatures given are true to the nearest 0·05°.

It thus appears that: (1) The melting point of benzene suggested by T. W. Richards as 5·493° is about 0·1° too low and should not be taken as a fixed point in precise thermometry. The value 5·58° agrees with the result obtained by Sydney Young. (2) The melting point of dry nitrobenzene is close to 5·85°. Judged by this, as also by the original standard of Roberts and Bury's materials, the melting point given by Mazur and Wolfke is decidedly low. I should not regard either my benzene or my nitrobenzene as being of the highest attainable purity; but the constancy of their arrest-temperatures for an hour or more, during the transition from liquid to solid block, indicates that the impurity, if any, was in each case extremely small.

IRVINE MASSON.

Durham, Oct. 2.

[1] Wolfke and Mazur, NATURE, **127**, 741; 1931. Mazur, *ibid.*, 893, 993. Wolfke and Mazur, *ibid.*, **128**, 548; 1931.

[2] Roberts and Bury, *J. Chem. Soc.*, **123**, 2037; 1923.

[3] Richards, Carver, and Schumb, *Jour. Amer. Soc.*, **41**, 2019; 1919.

Spectrum of Glow-worm.

It is well known that the luminous organs of insects like the fire-fly represent one of the most efficient sources of light, in that almost all the energy is concentrated in a narrow band in that part of the spectrum to which the human eye is most sensitive. In the case of the fire-fly, the spectrum photographed by Mr. Ives[1] shows that this band extends from 5230 to 6550 A.

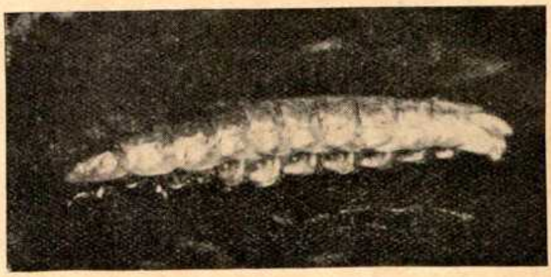


FIG. 1.

We had recently an opportunity of photographing the spectrum of a glow-worm which belongs probably to one of the species of Lampyridæ. Figs. 1 and 2 illustrate the worm in two positions and magnified about one and a half times. The portion indicated by an arrow in Fig. 2 shows one of the two luminous organs of the worm. The spectrum of the light emitted was photographed on an Ilford panchromatic plate with a night-sky spectrograph. An exposure of about fifteen minutes was found sufficient when a fairly narrow slit was used. The spectrum consisted of a single band extending from 5290 to 5860 A., that is, only half as broad as the

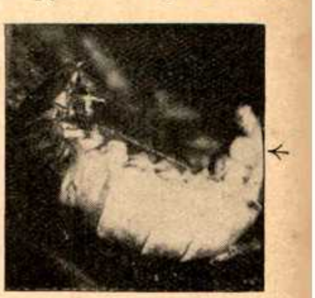


FIG. 2.

band in the spectrum of the fire-fly. Fig. 3 is an enlarged reproduction of the spectrum.

The glow-worm was not seen to emit any light by day even when observed in a dark room. Even at night the emission is not continuous. The worm can apparently do this at will. Slight irritation or shaking seems to make it well disposed to glow very brilliantly.

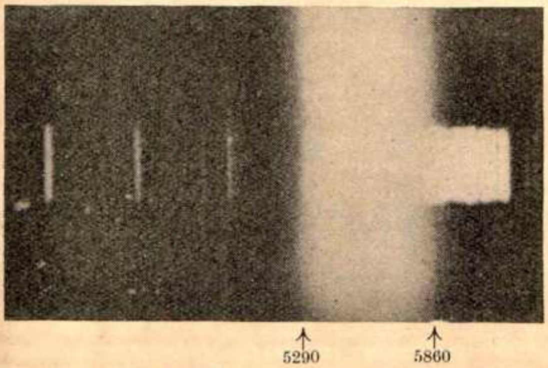


FIG. 3.—Spectrum of light from a glow-worm with a comparison spectrum (neon).

L. A. RAMDAS.
L. P. VENKITESHWARAN.

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[1] H. E. Ives, "The Fire-fly as an Illuminant", *Journal of the Franklin Institute*, vol. 194, p. 213; 1922.

The Viscosity of Liquids.

IN NATURE for April 12, 1930, Prof. E. N. da C. Andrade states his theory of the viscosity of liquids as based upon "a temporary union of molecules in contiguous layers". This theory has been proposed in order to account for the temperature variation of the coefficient of viscosity in liquids, which is opposite in sign to that of gases. The nature of viscosity must be importantly different in a liquid and a gas.

It is the purpose of this brief letter to direct attention to the agreement of the theory of Prof. Andrade with the conception of the nature of the liquid state which arises from X-ray diffraction studies of various liquids. It is common for physicists to regard a liquid from the point of view of the nature of a gas, although in practically every kind of physical measurement except fluidity the liquid is more like the crystalline than the gaseous state, and even this exception is more apparent than real. The X-ray experiments have shown that there is coherent diffraction in liquids analogous to that in a crystal. Instead of sharply defined periodicities of structure in liquids there are found bands of periodicities. There is molecular arrangement caused by the molecular fields which cannot be accounted for by the existence of that portion of the field which has the effect of a shape or volume. This somewhat orderly arrangement of molecules is unstable; the distance of molecular separation is a matter of probability. At any instant there are spots throughout the liquid where the molecules have a more orderly arrangement which fades off into one of much less regularity. These spots or groups are not merely instantaneous, for periodicity occurs frequently in more than one direction—indeed, sometimes it is detectable in three, but there is also a constant change occurring in the constituents of a periodic region. This structure of a liquid is not crystalline. A word is needed, and I have suggested 'cybotaxis' as indicative of space arrangement.

Now the theory of Prof. Andrade postulates a duration of the 'temporary union' of molecules which does not exceed the very brief time for the molecules to acquire a common velocity of translation. Obviously the cybotactic condition is not described precisely in this manner, but the theory of Andrade may be said to represent one aspect, and may therefore be said to be to this extent in harmony with the cybotactic conception of liquid structure.

According to my own view, in these well-ordered spots or groups the slippage of one layer past the other is hindered by the molecular fields, and hence the larger or more perfect these groups the greater the viscosity of the liquid. This view is borne out by an examination of 22 octyl alcohols. Here a definite correlation has been found between the perfection of the orderly arrangement and the viscosity. The results are shortly to be published. It is clear that the effect of rising temperature would be to reduce the extent of a well-ordered group, and hence to decrease the viscosity.

It would seem therefore that X-ray diffraction experiments indicate strongly that Andrade's theory is in the correct direction, though not yet developed in accordance with my interpretation of the periodicities clearly evidenced by X-rays.

G. W. STEWART.

University of Iowa,
Iowa City, Iowa.

Nature of Viruses.

READING General Smuts's presidential address to the British Association and listening to a sectional discussion on the nature of viruses, I have been wondering whether the following will satisfy those who find great difficulty in believing that things so small as the agent of foot-and-mouth disease or the bacteriophage can be live organisms. General Smuts says that the world is constructed on a biological plan, that it is made up of events, and that matter, life, and mind are three grades of the same thing. In common thought, inorganic phenomena are quantitatively related to the matter with which they are associated. Mind, on the other hand, has no perceptible quantitative relations. Life would be generally considered to be quantitatively related either (by the mechanist) to living matter or (by the organicist) to living organisms. But need this always be so? Cannot life sometimes or partly be more like mind, so that the events of life are quantitatively out of proportion to the perceptible matter involved?

A. E. BOYCOTT.

Radlett, Oct. 4.

Spin of Light Quanta.

[BY RADIOGRAM.]

THE possession by photons of intrinsic angular momentum is further strikingly confirmed by investigations of light scattering in liquids. The spin theory indicates diminution of rotational scattering to half the value given by classical considerations. Spectroscopic measurements of the depolarisation of scattered light, using broad and fine slits, furnish a convenient test. Observations by Venkateswaran with carbon disulphide and benzene liquids quantitatively confirm the predicted results.

C. V. RAMAN.
S. BHAGAVANTAM.

210 Bowbazar Street,
Calcutta, Oct. 12.

Research Items.

Were-Tigers in India.—In *Man* for October, Mr. L. A. Cammiade points out that in an article appearing recently in the *Illustrated London News*, and describing the killing of a man-eating tiger which had been responsible for the deaths of more than thirty people, there are indications that, all unknown to the hunter, Mr. L. Handley, the tiger he was hunting was, in the opinion of the jungle people, the Gonds, a man who by magical means had assumed that form for nefarious ends. Thus, although the Gonds are normally quite unafraid of tigers, they deserted Mr. Handley when he was approaching the place in the jungle where the body of a woman was being devoured. They would not follow the blood trail except in a crowd and with the beating of drums and letting off of fireworks. This would have frustrated his object had the tiger been an ordinary beast; but is intelligible as against witchcraft. In one case the body was placed in a tree after recovery; but this is a practice of the Koi and Konda Reddis, neighbouring jungle tribes, in similar cases. For some unknown reason the body must not rest on the ground. Mr. Handley would not be aware of the Gonds' belief, as to voice their suspicion above a whisper, even among themselves, might be followed by murder. Mr. Cammiade also points out that the deities "who have to be propitiated after the killing of the tiger", according to Mr. Handley's account, judging from their appearance, are not tiger deities but more probably the images of notable ancestors to whom an offering of thanksgiving was made for delivery from the were-tiger. Tiger deities would have to be propitiated, and consent obtained before any action was taken; while it is customary to ask the ancestors for protection on a journey through the jungle and for success in disposing of merchandise at its end.

Oceanic Bird Wanderers to Ceylon.—Under this title W. E. Wait describes twenty species of birds which appear casually in the neighbourhood of Ceylon (*Spolia Zeylanica*, vol. 16, p. 181, Aug. 1931). They comprise three species of terns, three frigate-birds, one booby, tropic bird, shearwater, and stormy-petrel, all of which may be said to frequent the tropical waters of the Indian Ocean; two gulls which are casual wanderers; and rare stragglers, including a shearwater and booby from the temperate South Indian Ocean, two skuas and a petrel from the Antarctic, and a petrel, a stormy-petrel, and probably a skua from the Northern Pacific Ocean. It seems likely that the location of Ceylon at the focus of many important steamer routes may have some bearing upon the appearance of these wandering birds, since it is known that many oceanic birds follow ships for long distances at sea.

A Supposed Primitive Gill-less Nudibranch.—A new family (Okadaiidæ) has been created by Kikutaro Baba for a gill-less holohepatic nudibranch, *Okadaia elegans*, described by him a year ago (*Annot. Zool. Japon.*, vol. 13, p. 63; 1931.) The new description deals in detail with the internal organisation of the sole species of the genus, which has been found at several localities on the Japanese coast. Until now, the only known gill-less dorid, of the tribe Holohepatica, has been *Doridoxa*, and while the main characters of *Okadaia* show that it belongs to the Holohepatica, there are others which recall in some degree the Cladohepatic series. The most striking structural characteristic described is the absence of a heart, for the sections revealed no trace of a proper pulsatory centre or the heart and pericardium comparable with those in other nudibranchs. Sir Charles Eliot was of opinion that the absence of gills had little effect on the rest of the organisation; this unique case of the correlated disappearance of branchiæ and the proper circulatory centre is regarded by the author as "the most primitive or retrogressive form" (surely not the same thing!) amongst the dorids.

Nature of Golgi Substance.—In Papers from the Tortugas Laboratory of the Carnegie Institution of Washington, vol. 27, is an interesting publication by D. H. Tennant, M. S. Gardiner, and D. E. Smith, on a cytological and biochemical study of the ovaries of the sea urchin, *Echinometra lucunter*. A new method is introduced into the study of cell inclusions by examining them both as structures and as substances. The tissues were subjected to the usual fixing and staining techniques, and at the same time the tissues were analysed and separated into their component substances. These substances were then subjected to the same fixation and staining techniques as the tissues themselves. As a result, the authors come to the conclusion that neither Golgi bodies nor chondriosomes are constant structural elements in the cellular architecture, but that both are the chemical products of physiological processes. It would seem that fatty acids of the oleic series meet the requirements of a Golgi substance in their reaction with osmium tetroxide. In the same report, observations are given on the formation of the egg in *Echinometra lucunter*, by R. A. Miller and H. B. Smith.

Rust Diseases of Cereal Crops.—A very useful summary of the present state of our knowledge of the commoner rust diseases of cereals is contained in the presidential address by Sir R. H. Biffen to the British Mycological Society (*Trans. Brit. Mycol. Soc.*, vol. 16, pt. 1, pp. 19-37). The strains and biologic forms of *Puccinia graminis* and other rusts are discussed in concise, though masterly fashion, and the recent work by Stakman and his colleagues on the crossing of forms is reviewed. Methods of control are dealt with at great length and include a historical as well as a modern presentation. Many factors which affect the incidence of epidemics are described, and the value of the removal of the ascidial hosts of such species as have them is discussed. The most valuable part, however, is the collection of recent results of work on the breeding of wheat resistant to the rust. The academic mycologist and the applied biologist will both find matter of interest in this account.

Geological Map of Finland.—Nearly twenty years have elapsed since the publication of the last edition of a general map of the ancient rocks of Finland. A new edition was prepared in 1925 for inclusion in the "Atlas of Finland", and this, with a few minor changes, is now published with *Bull.* 91 of the Commission géologique de Finlande. The Bulletin is a beautifully illustrated general account of the Pre-Quaternary rocks by Prof. J. J. Sederholm. The Pre-Cambrian rocks formerly known as Jatulian, Kalevian, and Ladogian are provisionally united under the common name *Karelian*. The levelled-down mountain chains which originated when these formations were folded are called *Karelides*. Their geotectonic study has already shown that they possess a structure analogous to that of the Alps. Mountain chains of a still more remote period are found from middle Sweden through southern Finland and these are designated *Sveco-Fennides*. It is shown that during the Pre-Cambrian, periods of erosion and quiet sedimentation were several times interrupted by epochs of orogenic folding and intrusion of granite, and it is thought probable that in these early ages, as since, mountain-building has been restricted to narrow belts of the earth's crust.

Absorption Spectra of Complex Salts.—A paper by Dr. R. Samuel in a recent issue of the *Zeitschrift fur Physik* (vol. 70, No. 1) contains much new information on the absorption spectra of complex salts of iron, cobalt, nickel, palladium, and platinum. The measurements have been made both in the visible region and well into the ultra-violet (2300 A.), the progress towards shorter wave-lengths being due to an improvement in technique, involving the use of the continuous spectrum of hydrogen as a light source. Graphs are given showing the variation of absorption coefficient with wave-length for twenty-one substances. The chief interest in these experiments is in their possible bearing on the structure of the complex radicles. Dr. Samuel records a number of apparent regularities, such as the existence of three similarly situated bands in the spectra of the diamagnetic cyanides and the appearance of a fourth band at greater wave-length with paramagnetic cyanides. His work, although extensive, is, however, definitely of a preliminary nature. The physics department of the Muslim University of Aligarh, of which Dr. Samuel is the head, is being reorganised and equipped to provide facilities for research in molecular physics, and he is continuing his work there.

Explosions in Closed Cylinders.—There is a pronounced increase in the speed of propagation of flame in a gas mixture in a tube open at both ends when a number of restricting brass rings are arranged within the tube. This effect, observed by Chapman and Wheeler in 1926, has been shown by Kirkby and Wheeler, in the *Journal of the Chemical Society* for September, to apply also to a closed tube. In explanation of the general effect of restrictions, it has been shown that during the early stages of an explosion in a tube the unburnt mixture ahead of the flame front moves as a current and the speed of the flame depends on the speed of the current. When the restricting rings are close enough together, the tongue of flame issuing from the first ring passes through the second and initiates combustion of the gas beyond while the portion between the two rings is still burning. The combustion of a comparatively large volume of gas is thus almost instantaneous. The effect occurs also in closed tubes, the sudden expansion resulting from the almost simultaneous combustion of the gas in each compartment producing a shock wave.

Rhenium Compounds.—The preparation of rhenium tetrachloride, and the rhenichlorides of potassium and silver, is described by Briscoe, Robinson, and Stoddart in the September number of the *Journal of the Chemical Society*. Precipitates of insoluble rhenichlorides were also obtained with mercurous and thallous salts. The primary product of treating the metal in chlorine is the tetrachloride, $ReCl_4$, which has not previously been observed. No evidence of the existence of the reported hexa- and hepta-chlorides was obtained, although the black crystalline tetrachloride was always accompanied by traces of a brown, well-crystallised substance, melting sharply at about 21°, obtained in quantities insufficient for analysis. No evidence of the formation of a lower chloride was obtained when rhenium was treated in dry hydrogen chloride up to 900°, the metal being unattacked. Potassium rhenichloride, K_2ReCl_6, was obtained in green crystals by heating a mixture of rhenium and potassium chloride in chlorine and crystallising from cold water. The silver salt, Ag_2ReCl_6, was obtained as an orange precipitate on adding a slight excess of silver nitrate to an aqueous solution of potassium rhenichloride. It is not obviously crystalline. Preliminary experiments on the behaviour of metallic rhenium when heated with bromine and iodine confirmed the observations of Noddack: the products are regarded as tetrahalides.

Astronomical Topics.

Meteoric Hypothesis for the Origin of the Solar System.—The Abbé Moreux contributes articles on cosmogony to *Scientia* for September and October. Instead of invoking the approach of another star to the sun, he supposes the sun to have traversed a region of space full of dust or meteoric matter, such as are indicated by the dark 'Horse's Head' in Orion and a number of similar dark patches. The orbits of such particles about the sun would in general be hyperbolic, but he suggests that by collisions and other mutual interference a considerable part of the matter might be captured by the sun. He traces its subsequent behaviour in some detail, and attempts an explanation of Bode's law of planetary distances. He notes that the planes of the giant planets are alternately on opposite sides of the invariable plane of the system; he draws an argument from this in support of his system. But the planes are in a state of constant change, and it would seem that proof is required that the relation now existing is permanent before any cosmogonic argument can be drawn from it. In his discussion of Neptune's system he assumes that Neptune's rotation is retrograde, like the motion of the satellite. The observations of J. H. Moore and D. H. Menzel at the Lick Observatory in 1928 showed that the rotation is direct. In such a difficult subject as cosmogony, it is well that all possible suggestions should be examined. It is unlikely that any one of the suggested systems is completely true.

Repetition of the Michelson-Morley Experiment.—Six years ago, Prof. D. C. Miller announced the results of a series of experiments that he made on Mt. Wilson; these seemed to indicate a variation of some 9 km./sec. in the course of the year, which he ascribed to a drift of the solar system in a direction nearly normal to the ecliptic. In the "Encyclopædia Britannica" (14th edition, vol. 15, p. 418) are described three series of experiments, by Kennedy and Illingworth, by Piccard and Stahel, and by Michelson, Pease, and Pearson, all made between 1927 and 1929, and all giving a zero effect like the original experiment.

The *Scientific American* for October gives details of a later series of experiments carried out by Prof. G. Joos, of the University of Jena, using apparatus constructed by the Zeiss works. The path of the light in the apparatus is brought up to 70 feet by repeated reflections. The results are recorded photographically and they are stated to preclude any ether drift exceeding one mile per second, so that it may be assumed to be zero. The large cross of the apparatus is constructed of quartz, for the double reason of its low coefficient of expansion and its freedom from magnetic effects. The cross is suspended by 700 springs of piano-wire, so as to support every part equally and prevent torsion. There is thus a great majority of experiments that indicate a zero effect of ether drift.

Africa in Transition.*

DURING the last fifty years, Africa has passed from the age of the pioneer and of geographical exploration, and has become a mosaic of more or less organised territories, controlled by European Powers. But although Africa has made such an advance that Nairobi, where forty years ago no vestige of human life was to be seen, is now a modern city with hotels and cinemas, in the less accessible parts, off the rail and main roads, tribes still exist as we knew them long ago: men and women nude, the only instrument of agriculture a pointed stick, and money in the form of coin still unknown. What has been the effect of the impact of the twentieth century on these relics of the stone age? This is the field of the new exploration of Africa, the field in which we need the assistance of the practical and constructive anthropologist.

As contact with modern civilisation must have a profoundly disruptive effect on the social organisation of a primitive society, and this effect is a continuing process, it is, therefore, essential for the anthropologist, administrator, and educator, in endeavouring to build foundations capable of bearing a permanent superstructure, to remember that they are dealing with a people in a period of social and intellectual transition. In other words, scientific research, in so far as it is concerned with practical work, must be directed to the African of the future rather than the African of the past or even as he is to-day, though an apprehension of both is essential for an understanding of the tendencies of the future.

Great changes have been brought about by the introduction of law and order and the suppression of slave-raiding. The concentration of the use of force into the hands of a central authority has *pro tanto* undermined the power and authority of the chief, and deprived the youth of Africa of its normal occupation of fighting and military service; while the suppression of war and slave-raiding has broken down the isolation of communities, so that the individual is able to offer his services as a wage labourer hundreds of miles away from his home. He has become acquainted with the conditions of life in an urban native quarter, and has acquired the command of money. This has also assisted in the spread of disease.

These are the inevitable effects of the white man's rule. When we come to the methods of applying that rule, there are two principles, generally known as assimilation and association.

The theory of assimilation would assign age-long tradition, customs, and beliefs to the scrap heap and substitute for them the modern forms of democracy, making the African a black European or black American. This system has been adopted by France in West Africa, but a growing body of opinion in France doubts the wisdom of this policy. An analogous system, though stopping short of miscegenation and conscription, known as 'direct rule', has been adopted widely in British dependencies. It is the system of which the results are now to be seen in India.

The alternative system of association works by devolution to native communities of the management of their own affairs, subject to the supreme authority of the governor and the law of the land. It recognises native institutions as the basis on which to build, and aims at their progressive improvement and adaptation to the changing conditions of Africa. Which of the two systems shall Africa in transition follow? The answer brooks no delay. Great Britain must choose between the two systems, and on that choice the future of Africa depends. One thing is certain, that with the spread of education the African will not remain inarticulate.

Contact with the white man brings the African face to face at once with the fundamental conflict of conceptions between the communal outlook, upon which his life and actions have been framed, and the individualism taught by his dealing with the white man. His employer tells him his wages depend upon his individual exertions; the missionary tells him to obey the laws of God if he would save his own soul, and that tribal expiation will avail him nothing. These are new conceptions; for his dominant characteristics are identification with his clan and belief in the presence and potency of the ancestral spirits of the tribe. Missionaries of long African experience believe that it is possible to engraft pagan rites on Christianity as they were in the early Church, while the Standing Advisory Committee of the Colonial Office has declared that what is good in the old sanctions and beliefs should be strengthened and retained. It is a problem that cannot be ignored. The new policy, too, in secular education will have a profound effect on the future of Africa.

The economic development of the resources of Africa is having an effect on African life, which is receiving intensive study by the International Institute of African Languages and Cultures. The access of wealth which has followed the opening up of Africa by road and rail, making possible the export of additional material produced by the extension and improvement of methods in agriculture, has greatly raised the standard of life.

It lies with us to see that the conclusions of science are rightly applied, and that the transition of the African from a lower to a higher standard of life and civilisation may be guided by a well-considered policy and scientific study, not only of the African as he used to be, but as he is to-day, and more especially of the tendencies which will operate to change him still more to-morrow.

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* Substance of a lecture by Lord Lugard, delivered on Sept. 24 at a joint meeting of Sections E (Geography) and H (Anthropology) of the British Association.

Control of Finance.

AT the recent meeting of the British Association, Mr. P. Barratt Whale read a paper to Section F (Economic Science and Statistics) on the Macmillan Committee's Report on Finance and Industry. This Report, he said, is as important to-day as when first printed, despite the crisis that has since occurred. The country no doubt will come through this crisis, and once more it will be necessary to operate the gold standard system, though it is desirable that this should be done on lines more satisfactory than in the immediate past. In the future, therefore, the Macmillan Report will be looked to for guidance.

The keynote of that Report is that currencies should be managed from the point of view of stabilisation of prices, and this is in accordance with the general trend of modern ideas in monetary science. It is, however, in marked contrast with the views which prevailed during the nineteenth century, when it was generally held that the gold value of the currency should remain unchanged. Now the main aim is to secure that the currency represents a definite standard of value in terms of its purchasing power, so that the price level can be stabilised. Stabilisation, however, may mean one of two things, and it will therefore be necessary to decide on the particular kind of stabilisation which is most desirable. Either the level of commodity prices as measured by the wholesale index number can be stabilised, or allowances can be made for changes in productive conditions which may imply variations in general prices not needed to be corrected by a process of stabilisation.

The first type of arrangement aims at complete stability in commodity prices, while the second would allow some variation in prices, so far as that variation should be attributed to general changes in productive conditions. Mr. Whale considers that the Macmillan Committee was justified in shirking a choice between these two methods, but a choice will have to be made and it is important for economists to determine what kind of stabilisation is most desirable. Currency systems will require to be managed by the central banks with much greater freedom than hitherto.

Restrictions which have existed in the past have proved harmful, since they have generally operated to lock up gold. It is not enough for the central banks to control the domestic situation only, as against the influences of the other banks in the country ; the gold standard also implies that the currencies of the different countries should move together and have a closely related balance. There should thus be common aims and a common policy for all the central banks of the world. The Report took the view that the existing unequal distribution of the world's gold supply is not a cause but rather the result of causes—namely, the definite intention of France and the United States to accumulate gold. But there is another view which the Committee did not put forward, and that is that the accumulations of gold might not have been deliberately acquired by these countries but might have flowed as a result of the balance of international payments.

On this view the fundamental cause was the unbalanced state of indebtedness. The remedy, if this be the cause, is that France and the United States should either lend more abroad or should import more goods. Mr. Whale considers that the Committee has failed to give sufficient emphasis to the importance of price adjustments in balancing indebtedness. Both France and the United States have refused to allow a rise in their internal price levels, but if this had been permitted it would have facilitated imports into these countries from the rest of the world.

The Macmillan Report represents a combination of the ideas of the currency school with those of the banking school. The latter insists on the need for elasticity in currency arrangements, while the former emphasises the necessity of strict regulation of currency. Control, however, should be exercised by the central banks, so as to secure stability in the price level. The Report is on the right lines, but it is clear that in many respects the ideas of the Committee require to be worked out in detail, and some of its fundamental assumptions might be challenged.

The Unit of Atomic Weight.

DISCUSSING the unit of atomic weight before Section A (Physics) at the meeting of the British Association in London on Sept. 28, Dr. F. W. Aston contrasted the point of view of the physicist and the chemist. The painstaking research in recent years to determine whether the atomic weights of complex elements vary with their origin and to effect the separation of isotopes has proved conclusively that for practical purposes variation in Nature is negligible, and has justified the decision of the Committee of the International Union of Chemistry to retain the old relative meaning of the words ‘element’ and ‘atomic weight’. There is little reason to alter the present unit of atomic weight, $O=16$, which has figured so long in chemical literature.

The physicist, on the other hand, is interested in the actual weights of the atoms, and it is only in the last twenty years that any comparison of the actual weights of the individual atoms has been possible. The original parabola method of Sir J. J. Thomson was followed by the first mass-spectrograph, in 1919, with a resolving power of 1 in 130 and an accuracy of about 0·1 per cent. With few exceptions, atomic weights deduced from mass-spectra agreed well with those generally accepted. The second mass-spectrograph, built in 1925, with a resolving power of 1 in 500 and an accuracy attaining 0·01 per cent, permitted the calculation of the percentage deviation of weight of an atom from a whole number on the scale of $O^{16}=16$. During the last three years a valuable check on chemical calculations has been provided in a photometric method of calculating the relative abundance of isotopes from the intensity of their lines on mass spectra, which has been used to determine the mean atomic weights of complex elements.

After discussing Giauque and Johnston's announcement that observations on oxygen band spectra indicate the presence of O^{17} and O^{18}, requiring alternatives to oxygen as our standard, Dr. Aston stated that he is in favour of retaining the present chemical scale unaltered. For most practical operations the chemist only requires a list of numbers, accepted internationally and guaranteed to within 0·1 per cent of the true atomic weights. For the fundamental requirements of physics the neutral atom of oxygen 16 appears to be the best standard, being the most convenient for work with band spectra and mass spectra. The 0·01 to 0·02 per cent difference in the two scales is not serious, and the meaning underlying the chemical scale differs so completely from that underlying the physical that confusion can easily be avoided by speaking of ‘the atomic weight of chlorine’ on one hand and ‘the weight of the atom of chlorine 35’ on the other.

The Greenland Cod.

IN the recently published report of the North-western Area Committee of the International Council for the Exploration of the Sea,[1] much interesting and valuable information is brought together on the natural history and biology of the Greenland cod (*Gadus callarias*). This fish appears every year in Greenland waters, but its numbers are subject to most violent and sudden fluctuations.

About the year 1820, the date of the earliest available records, cod were present in enormous numbers in the Julianehaab district, and even so far north as Disco Bay. Thereafter they disappeared from all but certain fiords and sounds in the vicinity of Sarfânguak and Fiskenaesset in the south-west for roughly a quarter of a century. During the period 1845–49 they were back again in large numbers, but by the end of 1850 scarcely a fish remained. During the second half of the nineteenth century and the first two decades of the present century, cod continued to be scarce in Greenland waters. More recently, however, they have once more reappeared in enormous numbers, and in the year 1929 were again numerous so far north as Disco Bay.

Besides this recent enormous increase in the stock of cod, other changes also have taken place. Previously, in their lean years, the cod approached the coast only in the summer and autumn months, whereas now they come inshore and enter the fiords as early as March or April.

This great change in habit and increase in the stock of cod in recent years is not the only indication of fundamental changes in the animal life of the waters of south-west Greenland. Shoals of coalfish (*Gadus virens*) have also frequently been seen with the cod in various districts since 1924. The herring, too, a fish practically unknown around Greenland in normal times, has recently appeared in large numbers; and even haddock, not previously recorded from its waters, have been taken.

The climate and other natural conditions at south-west Greenland have also been quite out of the ordinary. The winters have been unusually mild, and the western ice has had a much more restricted distribution than formerly. The causes underlying the changes in the animal life of the area must probably be sought in the abnormal conditions in their environment, but sufficient data are not yet available for linking up cause and effect. There is of course every reason to expect a swing-back to normal conditions at any time; but if this reversion does not take place too rapidly, there is every prospect of a good cod fishery continuing off south-west Greenland at any rate until 1936. G. A. S.

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[1] "Rapports et Procès-Verbaux des Réunions," vol 72, April, 1931

The Fortin Barometer.

WHILE a barometer of the Fortin pattern is generally regarded as a better laboratory instrument than one of the Kew pattern, many observers prefer the latter, owing to the difficulty found in setting the mercury accurately to the pointer in the cistern of the Fortin barometer. If the illumination is good and the mercury clean, this setting provides no difficulty; but barometers are often of necessity set up in positions of poor illumination and the mercury surface becomes dull after a few years of use, so that accurate setting of the mercury to the pointer is rendered difficult.

Messrs. C. F. Casella and Co., Ltd., of Regent House, Fitzroy Square, London, W.1, have recently brought out a new pattern of Fortin barometer designed to overcome these difficulties. The object aimed at appears to have been achieved in a most satisfactory manner. The usual glass cistern is replaced by a cast-iron one, having a horizontal extension at one side, in which a stainless steel pointer is rigidly fixed. In the front of the extension is a small telescope directed down at an angle towards the pointer, and on the back a plane glass window. Behind the window a white illuminated surface is provided. With clean mercury the view through the telescope shows a clear-cut impression, on a magnified scale, of the pointer facing its image, and the two can be brought into contact by using the adjusting screw, which raises the level of the mercury in the cistern of the barometer, with great confidence and precision. In order that the mercury surface may not become contaminated, all air entering or leaving the cistern has to pass through a small filter, which is said to be effective even in the atmosphere of a chemical laboratory. This does not end the novel features of the instrument, as the horizontal chamber terminates in a glass window held in position by a screwed ring. If the mercury surface is lowered and this ring with the window removed, the inside of the cistern can be cleaned and, if desired, the mercury pumped out of the cistern and fresh mercury inserted.

Owing to the pointer being at some distance from the vertical axis of the barometer, it is of special importance that the instrument should be set up truly vertical. The makers point out that verticality is easily ensured by rotating the barometer in its mounting and noting that the pointer remains in contact with the mercury surface in all positions. The design undoubtedly marks an important step forward in the construction of Fortin barometers.

University and Educational Intelligence.

CAMBRIDGE.—The following have been elected to fellowships at Trinity College: Prof. G. H. Hardy, Sadleirian professor of pure mathematics in the University (professorial fellowship); Mr. L. C. Young; and Mr. H. S. M. Coxeter.

Mr. A. H. Chapman (St. Catharine's) has been appointed official secretary to the Department of Engineering.

The Regent House has passed a grace to the effect that the title of Professor Emeritus be conferred on Sir R. H. Biffen upon his retirement from the professorship of agricultural botany.

The electors to the Frank Smart studentship in botany give notice that the studentship is now vacant. Any graduate of the University is eligible, provided that not more than fourteen complete terms have elapsed after his first term of residence. Women are also eligible. The successful candidate must devote himself to research in botany under the direction of the professor of botany. The value of the studentship is £200 per annum. Applications must reach Prof. A. C. Seward, at the Botany School, on or before Oct. 24.

FOR the forthcoming general parliamentary election, the Universities of Cambridge, Oxford, and Belfast, and the Scottish Universities, are returning unopposed members, as follows: Cambridge, Sir John Withers and Mr. G. H. A. Wilson; Oxford, the Right Hon. Lord Hugh Cecil and Sir Charles Oman; Belfast, Col. T. Sinclair; Scottish Universities, Mr. John Buchan, Dr. D. M. Cowan, and Mr. A. Noel Skelton. On the other hand, the Universities of London and Wales and the Combined English Universities are to have a poll. The following are the candidates for election: London (1 member), Sir E. Graham-Little and Major A. G. Church; Wales (1 member), Mr. E. Evans and Mr. S. Lewis; Combined English Universities (2 members), Miss E. Rathbone, Sir R. Craddock, Mr. H. G. Williams, Sir William Jowitt, and Mr. H. Nicolson.

FROM the United States Office of Education we have received two bulletins of more than ordinary interest. The first, "National Ministries of Education" (pp. 158, price 25 cents), is a description, supported by statistical tables and a bibliography, of the status, functions, and activities of the ministries of education in fifty-five of the seventy-three main political divisions of the world: the remaining eighteen, including Germany, the U.S.S.R., the United States, India, Brazil, Australia, and Canada, are excluded because their ministries of education, where they have any, are less than national in their legal and functional characteristics. Under the heading " General Characteristics " are dissertations on the internal organisation of the ministry in Italy, Belgium, Persia, and Uruguay, and organisations advisory to the ministry in Hungary, Belgium, Spain, England, New Zealand, and Bulgaria. In a chapter on the relations of the ministry to secondary education, the systems in force in Spain, Portugal, and Rumania are described as typical of the twenty-five Latin language countries studied, those of Yugoslavia, Denmark, and Hungary for the Germanic type, and those of the Irish Free State, New Zealand, and England and Wales for the English language countries. Special chapters are devoted to the Board of Education of England and Wales and the ministries of France, Belgium, and Mexico. The other bulletin, on " Accredited Higher Institutions ", is a compilation of the lists of institutions of college grade accredited or approved or classified by recognised State or voluntary agencies, including national professional organisations, with descriptions of standard criteria used.

Birthdays and Research Centres.

Oct. 26, 1874.—Prof. T. M. Lowry, C.B.E., F.R.S., professor of physical chemistry in the University of Cambridge.

I am interested in problems of valency, especially in the compounds of nitrogen, phosphorus, sulphur, and tellurium, and in the study of molecular structure by physical methods. Optical and spectroscopic methods have been used extensively for this purpose; but researches on photochemistry, the diffraction of electrons, the scattering of molecular rays, electrode potentials, electrolytic conductivity, and lubrication are also in progress in the Laboratory of Physical Chemistry at Cambridge. In polarimetry, the study of optical rotatory power has been extended to vapours, and measurements are now being made of the form of the dispersion curves in the region of absorption within which the Cotton phenomenon is observed.

Oct. 27, 1856.—Prof. E. W. Hobson, F.R.S., formerly Sadleirian professor of pure mathematics in the University of Cambridge.

It is very improbable that, at my age, I shall be able to take up investigation of any new subject. I hope, however, to be able to fill up some gaps in subjects such as the theory of integral equations, and possibly in the calculus of variations; subjects at which I have worked in past years.

Oct. 27, 1894.—Prof. Lennard-Jones, Melville Wills professor of theoretical physics in the University of Bristol.

The theoretical researches in the Wills Physical Laboratory, Bristol, centre round problems of cohesion and molecular structure. The main investigations, in which we are now engaged, aim at (1) a detailed knowledge of the electronic structure of certain atoms and molecules, (2) a calculation of the cohesive forces between atoms in a molecule, (3) a correlation of certain properties of gases and solids with the electronic structure of the atoms and molecules of which they are composed.

Societies and Academies.

London.

Society of Public Analysts, Oct. 7—**J. Cecil Maby**: The identification of wood and wood charcoal fragments. The economic and forensic importance of distinguishing between different woods by their microscopical structure is discussed, and the value of the method in archæological investigations is illustrated by various examples, such as the identification of the nature of the wood in the piles of lake dwellings, and of the charcoal from ancient furnaces.—**T. Callan** and **N. Strafford**: The examination of dyed leathers in cases of alleged dermatitis. The possibility of applying to dyed leather the tests used by Cox for the detection of diamines and allied bodies in fur has been investigated. The tannins in leather may interfere with many of these tests, but four of them will enable definite conclusions to be drawn, provided that control tests are applied to portions of the extract from the leather, after the addition of very small amounts of a meta- and para-diamine respectively.—**W. L. Davies**: The determination of chlorides in dairy products and biological material. The advantages of a wet (nitric acid) method are described, and suggestions for obtaining a sharper end-point in the titration of the excess of silver nitrate are made.

Physical Society, Oct. 16.—**G. A. Wedgwood**: Young's modulus for steel in two directions in a bar. Experiments showed that the elastic constant E of the various steels from which the hollow cylinders used were made is the same in two directions at right angles, one direction being along the axis of the original bar and the other across a diameter.—**N. W. McLachlan**: On the effective mass of flexible discs and conical diaphragms used for sound reproduction. The effective mass of a circular aluminum disc vibrating in air is zero at the centre-stationary and centre-moving modes. At a centre-stationary mode the effective mass attains a positive maximum before the zero value and a negative maximum thereafter. From the shape of the curves for a disc it is possible to interpret those obtained for conical diaphragms. In the latter case the curves depend upon the apical angle of the cone.—**A. T. McKay**: Further study of diffusion for the infinite plane sheet. A method is developed whereby the diffusivity and surface constants can be evaluated from experimental data. In order to facilitate the practical application of the methods propounded to this and similar diffusion problems, tables have been specially calculated giving the first four roots of each of the four equations $\left.\begin{matrix}\tan\\ \cot\end{matrix}\right\}x = \pm x\,.\left.\begin{matrix}\tan\\ \cot\end{matrix}\right\}\lambda$.

Paris.

Academy of Sciences, Sept. 7.—**André Blondel**: New graphical solutions of calculations for electric cables transmitting at high voltage.—**E. Bataillon** and **Tchou Su**: The three types of mitosis characteristic of the first development in the egg of *Bombyx*, fertilised or parthenogenetic.—**R. Tremblot**: The application of (optical) interference to some problems of flow at high velocities. By means of the apparatus described in an earlier communication the author has measured the distribution of the densities in a Laval tuyère in order to decide between the conclusions of Prandtl, Steichen, and Stodola (rigorously adiabatic flow) and those of Müller (at constant heat). The curves obtained agree with the first hypothesis within one per cent.—**Jean Peltier**: The search for want of symmetry and faults in ferromagnetic test pieces. In the differential arrangement described and figured, any want of homogeneity in the test pieces is shown by the production of a note in a loud speaker.—**Maurice Billy** and **Félix Trombe**: The preparation of pure cerium. In various experiments the crucible holding the fused salt was carbon, porcelain, fused quartz, and fluorspar porcelain (Damiens). The best results were obtained with an apparatus consisting of a carbon crucible as anode, at the bottom of which was a quartz or fluorspar crucible. The cathode was a molybdenum cylinder. The metal contained 0·08 per cent of silicon, and no other impurity could be detected.—**P. Fallot**: The palæozoic massif of Talambot (Spanish Riff).—**Michel Polonovski** and **René Hazard**: Some physiological effects of chlorotropane. The esterification of tropanol by hydrochloric acid increases the toxic power of this alcohol: it reinforces the paralysing action of the latter on the cardiac vagus, and gives to the action of the molecule on the intestine a resemblance to that produced by nicotine.—**P. Cappe de Baillon**: The experimental bipartition of the odd pieces of the exoskeleton in *Tenebrio molitor*.—**René Wurmser** and **Louis Rapkine**: A method of quantitative micro-injection.

Geneva.

Society of Physics and Natural History, June 18.—**Paul Rossier**: (1) An astrophysical formula. A classical relation between the absolute magnitude, the radius, and the temperature of a star necessitates a term based on a simplifying hypothesis concerning the spectral sensibility of the eye. Replacing this by a much more probable supposition, the author gives this term a closer approximation.—(2) The calculation of the apparent diameter of a star. The author replaces an old relation between the apparent magnitude, the apparent diameter, and the temperature of a star, an equation holding for an integral receptor only, by a new formula including the magnitude furnished by any receiver whatever. Although the numerical constants are furnished by the sun, the application to giant stars, the diameters of which have been measured with the interferometer, gives results agreeing with observation.—**W. H. Schopfer**: The study of the influence of yeast extracts and concentrates of B vitamins on the sexuality of a fungus. Concentrated extracts of yeast were added to a rigorously synthetic fungal medium. A clear action has been observed on the development and on the sexuality of the fungus utilised.—**A. Amstutz**: The petrographic character of Banks Island in Melanesia. The author has defined the petrographic character of Banks Islands, which form one of the numerous archipelagos scattered in the Pacific and are attached politically to the Franco-English condominium of the New Hebrides. These islands are essentially volcanic in origin and are constituted of augite labradorites.—**E. Joukowsky**: A levigator with a motionless liquid medium. The author describes an apparatus designed for the study of fine sediments. This allows the classification of the sediments into a considerable number of grades, according to the differences in the velocity of fall in water. The ultra-fine elements which remain in suspension are obtained without loss.—**A. Schidlof**: The application of wave mechanics to nuclear physics. With reference to a recent work of M. Terroux on the energy of the β-rays emitted by radium E, the author remarks that, contrary to the conclusions drawn by M. Terroux, the results of his experiments furnish a striking confirmation of the quantum theory of radioactivity.—**Georges Tiercy**: The systematic use of the rotation of the transit instrument. The idea of turning the transit instrument for all stars has been sometimes attributed to the German astronomer Schnauder (1891). The author shows that Plantamour, director of the Geneva Observatory, had applied this idea so far back as 1868; the credit of using this innovation systematically in the simplest possible manner appears to belong to the Padua Observatory (1878). Hence Schnauder was anticipated.

July 2.—**A. Borloz**: Liquation phenomena in a coinage bronze. The author has taken several samples from different points of an ingot of coinage bronze. The analyses show nearly perfect homogeneity, except for the upper portion, the jet, where there is some liquation, as shown by a concentration in the copper and a reduction in the proportion of tin.—**A. L. Perier**: Contribution to the study of the maxillofacial correlations. Is the alveolo-palatal sagittal development related to the upper facial height? Observations on two cranial series, Bushmen and Alpine, give a negative answer. In fact, the alveolo-palatal region is modelled by the dental arch, the potential of growth of which is quite independent of the other facial diameters.—**E. Galopin**: The use of the polarising microscope in the determination of organic substances. Organic substances generally, possessing very high double refraction, can only be studied optically in very minute crystals of the order of 0·01 mm. The author has recognised that special operations are necessary for the production of such crystals; he (with Marc Cramer) has studied the special media for microscopical preparation. The measurement of the double refraction is made by a Berek compensator with convergent light on plates fixed parallel to the principal sections of the mineral studied.—**J. J. Pittard**: The bitumen of the Urgonian limestone and the molasse of Pyrimont (Ain). The author shows by numerous analyses that the proportion of volatile products of the bitumen is much higher in the Urgonian limestone (69 per cent) than in the molassic grits superposed (55 per cent). This suggests impregnation *per ascensum*, the hydrocarbons coming from deep layers and showing increasing oxidation towards the top.

Rome.

Royal National Academy of the Lincei, April 12.—**A. Lo Surdo**: Thermionic valves with fall of potential across the grid. A thermionic valve is described in which the grid consists of a conductor of suitable form for passing a current through it. By adjusting the intensity and sense of this current the non-uniformity of behaviour of the various parts of the filament grid space may be diminished or enhanced. In this way it seems possible to increase markedly the amplifying power of thermionic valves.—**Q. Majorana**: Certain new facts ascertainable by means of ordinary photoelectric cells. Further observations on the negative electrification of the photoelectric metal of an ordinary photoelectric cell when red light impinges thereon are described.—**M. La Rosa**: New proof of the influence of motion of the source on the velocity of light; ballistic explanation of Miss Leavitt's law (2).—**A. Del Chiaro**: Homogeneous functions.—**F. Tricomi**: Further observations on the distribution of the baricentres of the plane sections of a body.—**G. Palozzi**: A characteristic property of Darboux's tangents.—**Giacinta Andruetto**: The intrinsic equations of elastic equilibrium. Using the methods of absolute differential calculus, Tonolo has established the intrinsic equations of anisotropic or isotropic elastic bodies, including the case when the elastic body is immersed in a space of constant curvature. All these equations may be derived by rapid calculations by applying modern vectorial methods to the known vectorial equations for the equilibrium of elastic media.—**R. Calapso**: Surfaces of the third degree (of Cayley's type) united to the point of a given surface.—**R. Caccioppoli**: The united elements of functional transformations: an observation on the problems of limiting values.—**R. Serini**: The integrals of the equations of propagation in one dimension.—**G. M. Pugno**: Contribution to the treatment of doubly hyperstatic elastic systems.—**B. Novàkovà**: Microphotometric measurements of the line H_α at the centre and at the edge of the sun.—**R. Zoja**: The distribution of the tensions in a solid with rectilinear axis and with rectangular transverse section of variable height.—**C. Antoniani**: The behaviour in an electric field of colloidal humic-mineral complexes. A colloidal complex, extracted from soil by means of 10 per cent sodium hydroxide solution and afterwards purified to remove clayey constituents, and containing 82·75 per cent of organic matter and small proportions of inorganic matter, was found to be electronegative and to have its isoelectric point at *p*H 7·4. When the complex was flocculated at the isoelectric point and brought back to the disperse state by addition of sodium hydroxide, it exhibited anodic migration under the influence of an electric field. As the concentration of the hydroxyl ions is increased, the velocity of this migration increases to a maximum and then gradually decreases to zero, cathodic migration ultimately ensuing.—**G. Roberti**: Hydrogenation of the nitrogen compounds contained in primary tar. At 350° C., under a pressure of 100 atmospheres, and in presence of cobalt sulphide as catalyst, the bases of primary tar give rise to hydrocarbons, the nitrogen being liberated as ammonia. Aniline yields cyclohexane, cyclohexene, and small amounts of hydrogenated diphenyls. Pyridine gives pentane, amylene, hexane, hexene, heptane, etc., whilst quinoline is converted into propylcyclohexane, propylcyclohexene, and other hydrocarbons.—**M. Airoldi**: Fossil Corallinaceæ from the Canaries (2). *Porolithon inaspectum* n. sp. and other forms are described.—**G. Cannicci**: Bacterial flora of certain fish. Bacteriological examination of cod, pilchards, and mullet caught in the Gulf of Naples shows that the cœlom contains only bacteria; the gills contain mostly motile bacteria, with moulds and chromogenic micro-organisms in some cases. The pilchard is the richest in *B. proteus* and the cod in fusiform bacteria which liquefy gelatine. *B. vulgare* Hauser, which is able to degrade proteins with formation of toxic products, occurs most abundantly in the gills during the summer, and *B. proteus* is found only in small number during the autumn and winter.—**Amelia Tonon**: Structure of mulberry buds and their development (2).—**R. Perotti**: The struggle of cereals against *stretta*. Incorporation of finely divided wood or bone charcoal with the layer of soil pervaded by the root systems of chlorophytes of various families, including the Gramìnaceæ, results in diminished dispersion of water from the soil, the food reserves of which are utilised more efficiently.

Official Publications Received.

British.

Proceedings of the Royal Society of Edinburgh, Session 1930–1931. Vol. 51, Part 2, No. 17: The Ionizing Efficiency of Electronic Impacts in Air. By Dr. John Thomson. Pp. 127-141. 1*s.* 3*d.* Vol. 51, Part 2, No. 18. Relation between the Composition of Retortable Carbonaceous Minerals and their Yield of Crude Oil. By Prof. Henry Briggs. Pp. 142-149. 9*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 1, No. 3: The Life-History and Cytology of *Didymium nigripes* Fr. By Dr. Elsie J. Cadman. Pp. 93-142+5 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 8*s.*

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1374 (E. 46—I.C.E. 789): Oxidation Characteristics of Fuel Vapours with regard to Engine Detonation. By Dr. E. Mardles. Pp. 27+14 plates. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

The Royal Technical College, Glasgow. Calendar for the One Hundred and Thirty-eighth Session, 1931–1932. Pp. 448+xxx. (Glasgow.)

Transactions of the Leicester Literary and Philosophical Society, together with the Council's Report and the Reports of the Sections, 1930–31. Vol. 32. Pp. 78+9 plates. (Leicester.)

University of Manchester: Faculty of Technology. Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1931-32. Pp. 360. (Manchester.)

British Museum (Natural History). Picture Post-Cards. Set F39: British Orchids, Series No. 7. 5 cards in colour. 1*s.* Set F40. British Orchids, Series No. 8. 5 cards in colour. 1*s.* Set F41: British Orchids, Series No. 9. 5 cards in colour. 1*s.* Set F42: British Flowering Plants. Series No. 13. 5 cards in colour. 1*s.* Set F43: British Flowering Plants, Series No. 14. 5 cards in colour. 1*s.* (London: British Museum (Natural History).)

Journal of the Indian Institute of Science. Vol. 14A, Part 3: i. Cantharidin from *Mylabris pustulata* Fb., India, by B. H. Iyer and P. C. Guha; ii. The Fatty Acids from Oil of Cantharis (*Mylabris pustulata* Fb., India), by B. H. Iyer and P. Ramaswami Ayyar. Pp. 31-45. 1 rupee. Vol 14A, Part 4: i. Amylase from Rice; ii. Dialysis of some Cereal Amylases. By Vinayak Narayan Patwardhan and Dattatreya Vishnu Karmarkar. Pp 47-57. 12 annas. (Bangalore.)

Department of Agriculture, Straits Settlements and Federated Malay States. General Series, No. 5: Report and Proceedings of the Second Inter-Departmental Agricultural Conference held at Kuala Lumpur, Federated Malay States, 27th October to 1st November 1930. Pp x+79. 1 dollar. Scientific Series, No. 6: Stem-Rot of the Oil Palm in Malaya. By A. Thompson. Pp. iii+23+7 plates. 50 cents. Scientific Series, No. 7: Two Citrus Fruit Borers, by H. T. Pagden; The "Green Scale" of Coffee *Coccus* (*Lecanium*) *viridis* Green, by N. C. E. Miller. Pp. 29. 50 cents. (Kuala Lumpur.)

Hydrographic Publication H.D. 302: Report on the Tides, Currents and Tidal Streams in the Southern Part of Torres Strait. Prepared under the direction of Rear-Admiral H. P. Douglas. Pp. 16. (London: H.M. Stationary Office; J. D. Potter.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell Vol. 69, No 417, September. Pp. 1045-1188+xxvi. (London: E and F. N. Spon, Ltd.) 10*s.* 6*d.*

India: Meteorological Department. Scientific Notes, Vol. 3, No. 26: Some Statistical Relations of Temperature and Pressure in the Upper Atmosphere over Agra (1926-29) and Batavia (1910-15). By S. Gopal Rao. Pp 83-88. 4 annas; 5*d.* Scientific Notes, Vol 3, No. 28: Horizontal Gradients of Pressure and Temperature in the Upper Atmosphere over India calculated from Pilot Balloon Winds. By A. Narayanan. Pp 115-120. 6 annas; 8*d.* (Calcutta: Government of India Central Publication Branch.)

Foreign.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 20, No. 3, July. Pp. 323-488. (Tokyo and Sendai: Maruzen Co., Ltd.)

Proceedings of the United States National Museum. Vol. 79, Art 16: Descriptions of a New Genus and Eight New Species of Ichneumon-Flies, with Taxonomic Notes. By C. F. Muesebeck. (No. 2882.) Pp. 16. (Washington, D.C.: Government Printing Office.)

Conseil International de Recherches: Union Geodésique et Géophysique Internationale: Section d'Hydrologie Scientifique. Bulletin N. 16: Note e comunicazioni della Sezione nazionale italiana. Pp. 55. Bulletin N. 17: Notes et communications. Pp. 44+14 planches. Bulletin N 18: Réunion plénière de la Section (Stockholm, Août 1930). Pp. 32. (Venezia.)

Bulletin of the American Museum of Natural History. Vol. 61, Art 8: Notes on Amphibians from Fukien, Hainan and other Parts of China. By Clifford H. Pope. Pp 397-611+plates 13-22. (New York City.)

U S. Department of Agriculture Circular No. 176: Observations on the Satin Moth and its Natural Enemies in Central Europe. By R. C. Brown. Pp. 20. (Washington, D C: Government Printing Office.) 5 cents.

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 7, No. 2, August, R.P. Nos. 339-347. (Washington, D.C.: Government Printing Office.)

Publications of the Allegheny Observatory of the University of Pittsburgh. Vol. 8, No 3: Wave Lengths in the Spectra of the Vacuum Copper Arc. By Kelvin Burns and Prof. Francis M. Walters, Jr. Pp 37-38 Vol. 8, No. 4: Wave Lengths in the Spectra of the Vacuum Iron Arc. By Kelvin Burns and Prof. Francis M. Walters, Jr. Pp. 39-64. (Pittsburgh.)

U.S. Department of Commerce: Bureau of Standards. Research Paper No. 327: Special Refractories for use at High Temperature. By Wm. H. Swanger and Frank R. Caldwell. Pp. 1131-1143 (Washington, D.C.: Government Printing Office.) 10 cents.

Smithsonian Miscellaneous Collections. Vol. 85, No. 4: Mexican Mosses collected by Brother Arsène Brouard, III. By I. Thériot. (Publication 3122.) Pp. 44. (Washington, D.C.: Smithsonian Institution.)

Proceedings of the United States National Museum. Vol 79, Art. 18: Notes on and Descriptions of some American Moths. By Carl Heinrich. (No. 2879.) Pp. 16+7 plates. (Washington, D C.: Government Printing Office.)

Transactions of the San Diego Society of Natural History. Vol. 6, No. 25: Age of the Orbitoid-Bearing Eocene Limestone and Turritella Variata Zone of the Western Santa Ynez Range, California. By W. P. Woodring. Pp 373-387. Vol. 6, No 26: A New Subspecies of Peromyscus from the Gulf Coast of Lower California, Mexico. By Laurence M. Huey. Pp. 389-390. (San Diego, Calif.)

Instituts scientifiques du Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 13, Livraison 2, Août. Pp. 169-292. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

Svenska Hydrografisk-Biologiska Kommissionens Fyrskeppsundersokning år 1930. Pp. 46. (Göteborg: Elanders Boktryckeri A.-B.)

Airgraphics. By Alexander McAdie. Pp. iii+37+7 plates. (Cambridge, Mass.: Blue Hill Observatory.)

Diary of Societies.

FRIDAY, October 23.

Royal Society of Medicine (Disease in Children Section), at 5.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Nature and Extent of the Changes which have Affected the Jaws of English People in Recent Centuries.

Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6—Dr. W. Trantom: The Barium Industry.

Institution of Mechanical Engineers, at 6.—Lt.-Col. E. Kitson Clark: Presidential Address.

Society of Chemical Industry (Newcastle-upon-Tyne Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Dr J. T. Dunn: Chairman's Inaugural Address.

Junior Institution of Engineers, at 7.30.—I. Fagelston: Some Instruments used in connexion with Power Plant.

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.—Prof. Major Greenwood: The General Register Office (Presidential Address).

Royal Aeronautical Society (at Merchant Taylors' School).—C. R. Fairey: Lecture.

MONDAY, October 26.

Royal Society of Edinburgh, at 4.30.—Statutory Meeting.

Royal College of Surgeons of England, at 5.—C. P. G. Wakeley: Demonstration of Specimens of Primary Bone Tumours.

Institution of Mechanical Engineers (Graduates' Section, London), at 6.45.—W. W. S. Robertson: The Manufacture of Wire.

Institution of Electrical Engineers (Informal Meeting), at 7.—Discussion: Is the Engineer given his Due Share in Management?

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—A. G. Shearer: Chairman's Address.

Institution of Automobile Engineers (Glasgow Centre) (at 39 Elmbank Crescent, Glasgow), at 7.30.—W. A. Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

Society of Chemical Industry (Edinburgh and East of Scotland Section) (jointly with Institute of Chemistry—Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30—W. R. Guy: Housing the Industrial Chemist.

Royal Society of Medicine (Odontology Section), at 8.—E. B. Dowsett: Operative Procedure for Cysts of the Jaws.—J. G. Turner: (*a*) Backward Movement of Lower First Molars; (*b*) Difficulties of Extracting Retained and Unerupted Teeth.

TUESDAY, October 27.

Electrical Association for Women (at Lighting Service Bureau, 15 Savoy Street), at 3.—Mrs. Pender Chalmers: By Air to Baghdad, Babylon, and Ur (Lecture).

London Natural History Society (at London School of Hygiene and Tropical Medicine) (Annual General Meetings of Sections).—Archæology, at 6; Botany, at 6.30; Entomology, at 7; Plant Galls, at 7 30; Ramblers, at 7 45; Ornithology, at 8.15.

Institution of Electrical Engineers (East Midland Sub-Centre) (at College of Technology, Leicester), at 6 45.—Dr. A. B. Everest: The Use of Nickel in the Electrical Industry.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—R. G. Ward: Chairman's Address.

Royal Photographic Society, at 7.—Dr. E. Goldberg: Photoelectric Cells (Traill-Taylor Memorial Lecture).

Quekett Microscopical Club, at 7.—Gossip Meeting.

Institution of Automobile Engineers (Leeds Centre) (at Hotel Metropole, Leeds), at 7.15.—W. A Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

WEDNESDAY, October 28.

British Astronomical Association (at Sion College), at 5.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—L. O. Burrill and E. W. Fraser-Smith: Addresses.

Institution of Automobile Engineers (Manchester Centre) (at Engineers' Club, Manchester), at 7.30.—W. A. Tookey: The Internal Combustion Engine and its Performances (Presidential Address).

British Psychological Society (Medical and Industrial Sections) (at Medical Society of London), at 8 30.—Papers on Accidents by Prof. Major Greenwood, Eric Farmer, and Dr. G. Groddeck.

Institution of Chemical Engineers (Graduates' and Students' Section).—C. A. R. Stead: Crushing and Grinding with special reference to Ball Mills.

THURSDAY, October 29.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—Capt. A. G. Lamplugh: Accidents in Civil Aviation.

British Association of Chemists (Notts and Derby Section) (at Technical College, Derby), at 7.—F. Scholefield: Vat Dyestuffs—their Application and Properties.

North-East Coast Institution of Engineers and Shipbuilders (Tees-Side Branch—Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—F. S. Fletcher: Chairman's Address.

Institution of Electrical Engineers (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Lt.-Col. H. E. O'Brien: Chairman's Address.

FRIDAY, October 30.

Royal Astronomical Society (Geophysical Discussion), at 4.30.—Isostasy. Speakers: Sir G. P. Lenox-Conyngham (who will communicate a paper by Dr. De Graaf Hunter), Prof. A. M. Davies, Dr. Harold Jeffreys, H L P. Jolly, Prof. O. T. Jones. Chairman: Admiral H. P. Douglas.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Anatomy of the Pyloric Sphincter in Cases of Hypertrophic Enlargement.

North-East Coast Institution of Engineers and Shipbuilders (in Mining Institute, Newcastle-upon-Type), at 6.—Mrs. E. M. Smith-Keary: The Effect of Immersion on Propellers.

Institution of Electrical Engineers (London Students' Section), at 6.15.—G. J. Shaw and G. A. M. Hyde: The Business of Electrical Apparatus Manufacture.

Institution of Chemical Engineers (at Institution of Civil Engineers), at 6 30.—Dr. E. F. Armstrong: Hydrogenation (Lecture)

Illuminating Engineering Society (at Royal Society of Arts), at 6.30.—P. Good and others: Discussion on Some Impressions of the I.I.C. Floodlighting.

Institution of Mechanical Engineers (East Midland Branch) (at University College, Nottingham), at 6.30.—Prof. C. H. Bulleid: The Importance of Metallurgy to the Engineer.

Institution of Mechanical Engineers (Informal Meeting), at 7.—R. Borlase Matthews and others: Discussion on Engineering in Agriculture.

Iron and Steel Institute (jointly with West of Scotland Iron and Steel Institute) (at Royal Technical College, Glasgow), at 7.15.—J. H. Andrew, W. R. Maddocks, D. Howat, and E. A. Fowler: The Equilibrium of Certain Non-Metallic Systems.—B Matuschka: The Solidification and Crystallisation of Steel Ingots: the Influence of the Casting Temperature and the Undercooling Capacity of the Steel.

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.—J. N. Waite: Combustion and Boiler-house Efficiency.

Society of Chemical Industry (South Wales Section) (at Technical College, Cardiff), at 7.30.—R. D. Owen: Chemistry of Dairy Products.

Junior Institution of Engineers, at 7.30.—S. J. Clifton: Automatic Combustion Control.

Royal Aeronautical Society (at Eton College).—The Master of Sempill: Lecture.

PUBLIC LECTURES.

SATURDAY, October 24.

Royal Institute of British Architects, at 3.—A. S. G. Butler: Tendencies in Modern Buildings.

Horniman Museum (Forest Hill), at 3.30.—F. A. Rudd: The Legacy of Antiquity.

MONDAY, October 26.

University College, at 5 30.—Prof. G. M. Trevelyan: The Call and Claims of Natural Beauty (Rickman Godlee Lecture).—K. de B. Codrington. Indian Sculpture.

University of Leeds, at 8.—Prof. B. A. McSwiney: Our Daily Diet.

TUESDAY, October 27.

University of Bristol, at 5.—Dr. A. L. Flemming: The Partnership between Anæsthesia and Surgery (Long Fox Lecture).

London School of Economics, at 5.—Prof. E. Cammaerts: The Development of Belgian Culture.

University College Hospital Medical School, at 5.15.—Prof. C. R. Harington: The Chemistry and Functions of the Thyroid Gland. (Succeeding Lecture on Nov. 3.)

King's College, London, at 5.30—Sir Bernard Pares: Russian History to 1861: Break-up at Kiev: Migrations; the Tartars.

University College, at 6.30.—S. J F. Philpott: Fluctuations in Human Output. (Succeeding Lectures on Nov. 3 and 10.)

WEDNESDAY, October 28.

Royal Institute of Public Health, at 4.—Prof. F. J. Browne: The Health of the Expectant Mother.

THURSDAY, October 29.

University College, at 2.30.—Miss Margaret A. Murray: Egyptian Sculpture.

Science Museum, South Kensington (in connexion with the Exhibition of Modern Technical and Artistic Glasses), at 4.45.—Dr. W. M. Hampton: Recent Progress in Optical Glass.

B.M A., at 5.15.—Dr. F. J. McCann: The Prevention of Cancer (Chadwick Lecture).

King's College, London, at 5.30.—Dr. Eveline Martin: West Africa of To-day: Northern Nigeria; the Moslem Walled Towns of Kano, Zaria, and Katsina; Camels, Traders, and Travellers.

SATURDAY, October 31.

Royal Institute of British Architects, at 3—H. B. Creswell: The Uses of an Architect.

Horniman Museum (Forest Hill), at 3.30.—J. E. S. Dallas: A Naturalist in Western Cornwall.

ANNUAL MEETING.

October 31 to November 2.

International Society of Medical Hydrology (at American Hotel, Amsterdam).—Discussions on the Influence of Chill in the Causation of Disease, opened by Profs. Schade and van Loghem, and on Factors in Marine Treatment, opened by Prof. Moll and Dr. Haberlin.

CONFERENCE.

November 16 to 21.

International Conference on Bituminous Coal (at Carnegie Institute of Technology, Pittsburgh, U.S.A.)—Subjects for discussion:—Coal as Locomotive and Steamship Fuel, Coal in the Electric and Gas Industries; Competition of Coal with other Fuels in Heating Buildings; Coal in the Metallurgical Industries, Coal and its By-products in the Chemical Industries, Problems of Coking; Origin and Classification of Coals; Cleaning and Preparation; Mechanism of Combustion, Pulverised Coal; Relationships of Coal, Oil, and Natural Gas; Coal versus Water Power; Hydrogenation and Liquefaction of Coal; Fertilisers from Coal; Economics of Low Temperature Carbonisation; Storage and Weathering of Coal; Smoke Abatement; Stream Pollution.

No. ....
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NATURE

SATURDAY, OCTOBER 31, 1931.

CONTENTS.

PAGE
The International Institute of Agriculture . . . 737
Our Mathematical Ancestry. By Prof. H. W. Turnbull 739
Physical Anthropology of the American Indian. By Prof. W. E. Le Gros Clark 740
Organic Chemistry. By E. F. A. 742
Short Reviews 743
On the Nature of Mind. By Dr. C. S. Myers, C.B.E., F.R.S. 744
Ultrasonics: Some Properties of Inaudible Sound. By Prof. F. Lloyd Hopwood 748
Obituary:
  Dr. Thos. A. Edison 751
  Dr. C. A. Keane. By A. H. 752
  Prof. Fritz Foerster 752
News and Views 753
Letters to the Editor:
  Crystalline Vitamin D.—F. A. Askew, Miss H. M. Bruce, Dr. R. K. Callow, J. St. L. Philpot, and T. A. Webster 758
  A New Type of Magnetic Birefringence.—Sir C. V. Raman, F.R.S., and S. W. Chinchalkar 758
  Multiple Ionisation and Secondary X-ray Absorption Edges.—A. Sandström 759
  Isotope Effect in the Band Spectrum of Lithium Hydride.—Prof. Gisaburo Nakamura . . 759
  Symbiotic Algæ of Corals.—Capt. A. K. Totton; Dr. C. M. Yonge 760
  The Comma Butterfly in England.—Dr. F. Sherwill Dawe; N. D. Riley 760
  Change of the Dielectric Constant of Carbon Disulphide with Temperature.—Dr. J. Mazur 761
  Cosmic Evolution and Earthly Needs.—Prof. Henry E. Armstrong, F.R.S. 761
  Chemical Nature of the Tigroid.—Prof. A. Szent-Györgyi 761
Research Items 762
Astronomical Topics 764
Modern Glasses at the Science Museum . . . 765
Foot-and-Mouth Disease Research. By Prof. J. M. Beattie 765
Cotton Growing in Egypt. By Dr. F. P. Slater . 766
The Study of Forest Entomology in India . . . 767
Palæolithic Flint Implements 767
Development of Weather Forecasting . . . 768
University and Educational Intelligence . . . 768
Birthdays and Research Centres 768
Societies and Academies 770
Official Publications Received 770
Diary of Societies 771
Recent Scientific and Technical Books . . Supp. v

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The International Institute of Agriculture.

NOTWITHSTANDING the position of science in the life of the nation, little or nothing has been done by the administration of Great Britain to give 'a square deal' to the scientific and technical officers employed in the service of the State. Frequent references to the disabilities under which the specialist officers labour have been made in these columns; and whenever suitable opportunity occurs we shall continue to associate their cause with that of efficient administration. Readers of this journal will recall the recent discussion of the report of the Royal Commission on the Civil Service, when a number of proposals for reform were advocated (NATURE, Aug. 8 and 15, 1931).

Two things are needed to hasten these reforms. In the first place, an informed public opinion must be created which will insist that all important questions of the day involving scientific considerations are discussed with the full assistance of experts, who, moreover, must have free access to the supreme authority represented by the Minister. In this way the specialist officers will take their proper share in the formation of policy. In the second place, every blunder in administration which might have been avoided by the proper utilisation of scientific knowledge should receive the widest publicity.

A striking example of the maladministration of a scientific question has recently been brought to light by the publication of a detailed account of the founding, organisation, and administration of the International Institute of Agriculture at Rome.* This is the work of Dr. Asher Hobson, who for some years resided at Rome as the representative of the United States on the Permanent Committee of the Institute.

The inception of the International Institute is associated with something approaching romance. In 1884, a successful Californian merchant, the late Mr. David Lubin, bought a farm. To his intense surprise, the business ability which made him a successful merchant failed him entirely in the work of crop production. He became perplexed and at once set on foot an inquiry into the causes of his failure. This led to the study, among other things, of such subjects as railway freights, tariffs, and statistics of the area, yield, prices, and stocks of products like wheat. Eventually the idea took shape in his mind of an international organisation which would provide the farmer with all the essential information as to the world production of agricultural staples. Instead of being a blind producer and seller of some raw product like wheat, he would be in possession of the main factors of the great producing and distributing industry of which he is a unit.

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* The International Institute of Agriculture (An Historical and Critical Analysis of its Organisation, Activities and Policies of Administration). By Asher Hobson. Pp. vii+356. (Berkeley, Calif.: University of California Press, 1931.)

Lubin then proceeded as a private individual to Europe to place this idea before its governments and rulers. He was fortunate in obtaining the interest and support of the King of Italy. An international meeting was called at Rome to discuss the question, and in 1905 a Convention, establishing an International Institute of Agriculture, was agreed to by the nations. One of the main objects of the new undertaking, as stated in the Convention of 1905, was to " collect, study and publish as promptly as possible, statistical, technical or economic information concerning farming, both vegetable and animal products, the commerce in agricultural products, and the prices prevailing in the various markets, and to communicate to parties interested, also as promptly as possible, all the information just referred to ".

The various chapters of Dr. Hobson's book make melancholy reading. After the inspiring account of the personality of Lubin, it is sad to trace the gradual decline of the Institute as the inevitable consequence of unsound principles of organisation and of administration. Although a scientific institution, the man of science has from the very beginning not only been denied opportunities in direction but also has been relegated to a subordinate position. The direction of the Institute has failed to take note of the fact that the universities of the world for many years past have provided numerous examples of the successful administration of scientific work, and have never failed to attract and to retain talent of the first order.

Instead of following the well-tried methods of the great republics of learning, those responsible for the conduct of the International Institute of Agriculture have attempted other methods of getting things done. The members of the *corps diplomatique* and the retired Civil servants who have been in charge of the movement have, with the valour of ignorance, applied the conventional methods of departmentalism both to the organisation and governance of a scientific institute. The result has been a tragic failure, in spite of the recent efforts of the representatives of the United States and Great Britain on the Permanent Committee in obtaining funds for the development of the work and in urging reform. One after another the scientific men, who at the beginning were attracted to the movement, have resigned in despair. Instead of specialising in statistical work, and so making an honoured name for itself in international effort, the resources of the Institute from the very beginning have been thinly spread over a vast number of projects, none of which has been effectively handled.

The library of the Institute has been neglected, in spite of a generous provision for staff and equipment supplied by well-wishers in America. The publications can only be described as deplorable. Perhaps, however, the worst feature of all is the attempt in recent years to make programmes take the place of research. The most glaring example of this is the creation of the International Scientific Agricultural Council, consisting of 23 separate Commissions, with more than 600 members. The actual result so far accomplished has consisted in the holding of one meeting—in November 1927—and the issue of a vast programme covering the whole of agriculture, the conclusions alone of which occupy no less than 75 printed pages. It bears no relation whatsoever to the actual resources and work of the Institute.

In the last chapter of his book, Dr. Hobson deals with the future and with the reforms which must be adopted if the Institute is to fulfil its proper functions and become an important and effective body in the world's agriculture. This matter is dealt with in the following words:

> " The Institute represents many peculiarities but perhaps none is so peculiar as the fact of its being a scientific organisation without a scientific staff. . . . It is safe to assert that the Institute will never be able to satisfy expectations until the Permanent Committee faces the task of recruiting a highly trained technical staff, thereby enabling the bureaus to turn out information of a reliable and usable variety. This task has always been relegated to the background on the basis of lack of funds, but it is suggested that the present salary budget distributed over fewer and carefully selected individuals, would go a long way in accomplishing the desired result. The fact that funds are limited makes it more urgent that unproductive employees be eliminated. To attempt to conduct a scientific institute without scientific and technical leadership is akin to the maintenance of a hospital without doctors, surgeons or nurses."

The present complex system of government consisting of a Permanent Committee and of an Assembly should be simplified. A scientific man, of the necessary standing, assisted by a properly trained staff, should be appointed for the future conduct of the Institute. If this were done, the prospects of future development would be much more promising than they are at present.

Our Mathematical Ancestry.

A Manual of Greek Mathematics. By Sir Thomas L. Heath. Pp. xvi + 552. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 15*s.* net.

It is scarcely necessary to introduce the reader to an author so well known and so distinguished for his writings upon Greek mathematics. Among those who are fortunate enough to have learnt something of the wonder and liveliness of ancient geometry, a new book by Sir Thomas L. Heath is always hailed with delight. On the other hand, there are doubtless many who may be tempted to think that, amid the distractions and interests of present-day science, it is a vain thing to spend time in reading up history of such a distant past. There is presumably enough to engage the attention of the most active mind in acquiring a working knowledge of current methods in mathematics or mathematical sciences. This is, of course, a mistaken idea: from the point of view of gaining proficiency in technique alone, there is much value in cultivating mathematical style, just as the young artist is encouraged to study the work of the early masters: and no boy plays worse cricket from watching Hobbs bat. Greek arithmetic, Greek algebra, and Greek geometry were all wrought by men of genius, who were working in a material of not too intricate a texture, so that an intelligent reader, with only the rudiments of mathematics, can follow their arguments without a long apprenticeship. It is therefore a boon to have a book which gives unstintedly an account of these early centuries, and enables a student to read for himself of the doings and discoveries of Euclid and Archimedes.

As the author remarks in the preface, the book is not written for experts, but for the student and the general reader who has not altogether forgotten his school mathematics. The treatment is straightforward and complete, giving a very judicious choice of interesting or important material, without the inevitable tedium of long preliminary proofs covering special cases. In the background is the sanction of a lifelong study of the documents: and the reader feels that he has been put in living touch with the men who fashioned mathematics. Here, for example, is the work of Euclid, no longer diluted, improved, or misunderstood, as the case may be, but given as it actually was. Whatever may be the defects of the " Elements " as a school textbook in geometry, the present reviewer is grateful that in his boyhood Euclid was still taught at school. How came it about that a Greek, of the name of Euclid, wrote a textbook which in an almost literal translation was used in our schools and colleges as the one recognised basis of instruction in elementary geometry until some thirty years ago? The author addresses himself to answer this interesting question.

The present manual, which gathers into one volume the substance of earlier works by the same author, begins with an account of the origins of western mathematics in Babylonia and Egypt: it ends with the relatively undistinguished minor characters, of the sixth century of our era, who succeeded Diophantus, renowned for his algebra, the last great representative of the Second Alexandrian School. In recounting this impressive story of so many ages, the author has given himself a free hand, and has appeared in the rôle not so much of the cautious historian (which scarcely needs saying), but as that of the teacher or expositor who adds the suggestive touch that makes the picture live.

The book has its passages of special interest for the expert, as it embodies several notable and recent discoveries. The romantic discovery in 1906 of the "Method" of Archimedes in a Constantinople palimpsest has thrown light upon a perplexing problem: How did the Greeks find out their results? In the finished pages of Euclid or Archimedes, just as in the published results of Gauss, there is little to show the beginning of the quest—the guesses, conjectures, and tentative arguments which gave way to the final proof. But not until the "Method" was found by Heiberg was any light thrown upon the problem. In the present " Manual " we have considerable details of this newly found document. As Sir Thomas has remarked in his earlier " History ", it incidentally establishes Democritus as a pioneer in the integral calculus, for he was the first to state correctly the formula for the volume of a cone. Archimedes confesses that he discovered the analogous formula for the area of a parabolic segment by weighing it, theoretically or practically. At any rate, the theoretical proof might have come out of a current textbook on statics, illustrating the theory of moments and centroids with both elegance and precision.

Another passage of interest concerns Egypt and Babylonia. Recent exhaustive investigations of the Rhind Papyrus (by Prof. T. E. Peet in 1923 and Mr. Arnold B. Chace in 1929) have made the facts far more accessible than they were at the time when the " History " was written. Something of the yet unpublished Moscow Papyrus of the Twelfth Dynasty has also been included, and all this has greatly increased the prestige of Egyptian mathematics.

While it is still true that nothing comparable to a general proof has yet been found among all the Egyptian writings, more and more *ad hoc* formulæ are continually being brought to light; and some of these are very remarkable, such as the arithmetical instances which strictly illustrate the formula $V=\frac{1}{3}h(a^2+ab+b^2)$ for the volume of a truncated pyramid with parallel square faces whose sides are a and b: or again the still more remarkable formula

$$S=\{2d-\tfrac{1}{9}\,.\,2d-\tfrac{1}{9}\,(2d-\tfrac{1}{9}\,.\,2d)\}\,.\,d$$

for the surface of a hemisphere whose diameter is d (Moscow: Problem 10). If this is worked out, $S=2\,.\,\frac{256}{81}\,.\,r^2$ so that it gives 256/81 as the value of π, a very good approximation.

Even more wonderful is the state of mathematical science in Babylon, as it now appears in the light of the most recent discoveries. We are led to infer from the inscriptions that the Babylonian surveyor of 2000 B.C. had little indeed to learn from the modern practical textbook on quadratic equations. Not only was a sexagesimal number notation in vogue—involving a multiplication table up to 59 × 59 and the position-value system—but also a formula for the solution of quadratic equations was employed. For example, if

$$\xi^2-\frac{2d\alpha}{\alpha^2+\beta^2}\,\xi=\frac{A-d^2}{\alpha^2+\beta^2},$$

then

$$\xi=\frac{1}{\alpha^2+\beta^2}\,[d\alpha+\sqrt{\{d^2\alpha^2+(\alpha^2+\beta^2)(A-d^2)\}}].$$

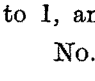
An inscription actually gives the detailed evaluation of this formula, with $A=1000$, $d=10$, $\alpha=40$, $\beta=60$. Examples of parametric bilinear equations in two unknowns, leading to a quadratic in one unknown, are also solved.

A few of the many passages of interest in the account of the Greeks may also be mentioned. On p 27 appears a diagram of an abacus—no ordinary abacus, but something of a riddle. Its likeness to the full musical stave, with eleven lines, five for treble, five for bass, and one for middle C, may be a coincidence, but there it is.

The beautiful proof of the identity

$$1^3+2^3+\ .\ .\ .\ +n^3=\{\tfrac{1}{2}n(n+1)\}^2$$

by Nicomachus is duly given. The series is equal to $1+(3+5)+(7+9+11)+\ .\ .\ .$, but this neat result is certainly not told in all the ordinary textbooks, on algebra, where surely it should have place. Border one small square with three equal squares and again with five, making $1+(3+5)=3^2$: a gnomon has been added to 1, and this gnomon is the cube of 2. Nicomachus proves the identity by adding the general gnomon after n terms, and by so doing he provides a genuine example of mathematical induction.



The author has sacrificed nothing (and has made the pages much easier reading) by exhibiting results in our familiar algebraic notation, as in the above Babylonish examples. Each formula is justified by the context.

The book is well printed and does credit to the publishers, who have performed their work most attractively. Considering its scope and contents, the book is reasonably priced, and is likely to be widely read.

H. W. TURNBULL.

Physical Anthropology of the American Indian.

The Indians of Pecos Pueblo: a Study of their Skeletal Remains. By Earnest Albert Hooton. Appendix on the Dentition by Habib J. Rihan; Appendix on the Pelves by Edward Reynolds. Statistical and Laboratory Assistants: Ruth Otis Sawtell, Ethel Clark Yates, Pearl B. Hurwitz. (Papers of the Southwestern Expedition, No. 4.) (Published for the Department of Archæology, Phillips Academy, Andover, Mass.) Pp. xxvii + 391 + 112 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1930.) 56*s.* net.

IT is not always sufficiently realised to what extent a study of the early history of man in the New World may throw light on the early history of man in the Old World. No doubt this arises from the fact that many anthropologists are content with the assumption that all the aboriginal inhabitants of America were from first to last Mongoloids. But " the theory of the originally and perpetually Mongoloid character of the American population is difficult to accept in view of the decidedly non-Mongoloid character of the stratigraphically early types ". This opinion, quoted from the last paragraph of Dr. Hooton's elaborate and carefully prepared monograph, indicates one of the central problems which are presented as a result of his ten years' study of the skeletal remains of the Indians of Pecos.

The ruins of the Indian pueblo of Pecos lie on an easily defensible site in the valley of the Pecos river in central New Mexico. The village was visited by the first Spanish expedition which penetrated south-west in 1540. In 1620 the population is reported to have been about two thousand. The historical period of the village lasted until 1838, when the remaining twenty inhabitants of Pecos migrated. On the basis of stratigraphy and pottery sequence, it was possible to recognise six periods in the life of the settlement of Pecos since its foundation about A.D. 800. Of these, four periods belong to the prehistoric phase, that is, prior to the date at which the natives came into contact with Europeans. The excavations of the ruins have clearly been carried out with the utmost scientific precision and only skeletal material of undoubted provenance and in good preservation has been included in the series upon which Dr. Hooton has based his study. We are impressed, therefore, with the suitability of the Pecos material for a study of the physical nature of the American Indian population before it became in any way affected by post-Columbian migrations.

Dr. Hooton's treatment of his unique osteological collection is eminently scientific. He is aware of the limitations of physical anthropology so far as skeletal material is concerned, and he is careful to distinguish clearly between legitimate deductions from ascertained facts and speculative considerations. In estimating the age and sex of the material, he has had the assistance of Prof. Wingate Todd. It is instructive to note that in the sexing of 264 complete skeletons, these two authorities (both of whom are to be regarded as experts in their subject) disagreed in 15 per cent of cases. To those less experienced anthropologists who are not aware of the difficulties of sexing a skeleton, even when the pelvis is intact, this result will appear surprising. Another interesting fact is that the inhabitants of Pecos seem not to have varied their stature over a period of a thousand years, in spite of the fact that since the Spanish intrusion there was a gradual extinction of the population through war, disease, and probably famine and malnutrition.

Most of the present volume is devoted to the craniology of the Pecos Indians, a study which was complicated by the fact that only 40 crania out of a collection of 615 showed no trace of artificial deformation. Dr. Hooton was able to distinguish a number of morphological cranial types, which he distinguishes as "Basket Makers", "Pseudo-Negroids", "Pseudo-Australoids", "Plains Indians", "Long-faced Europeans", "Pseudo-Alpines", etc., but at the same time he finds no evidence that any "new race" appeared during the history of Pecos. The question remains as to how far these cranial types represent valid morphological types and not the artificially selected extremes of a homogeneous but very variable group. The author believes that the former interpretation is correct, and his statistical evidence certainly seems to confirm this conclusion. He further illustrates his types by a series of photographs made by the superimposition of images of a number of skulls of the same type on the same negative. We think this method of composite photography to be not very sound. An examination of the composite photographs makes it clear that the impression produced on inspection is not that of an 'average' skull. In the contour outline of the skull as a whole, for example, the photograph, by its method of production, tends to lay much more stress on the smaller contours and more restricted outlines of the group. We should have been happier to have seen average contours constructed on the basis of actual measurements, as has been done so successfully by Parsons and others in Great Britain.

It is in the discussion of the affinities of these morphological types that Dr. Hooton especially attracts our interest. The Basket Maker type is very similar to the Basket Maker crania of Arizona, and also bears a strong resemblance to crania of the so-called Mediterranean race. Indeed, "in indices the South-western American crania are so similar to the crania of Egyptians as to be well-nigh identical". The author thinks, however, that we cannot go beyond the inference that "the Basket Maker and Ancient Egyptian groups represent divergent off-shoots of a common primitive race which may have sent colonies in many different directions during the neolithic period". The Pseudo-Negroid type is found to differ less from the African negroes than from other morphological types in the Pecos population. This leads to the conclusion that the earlier dolichocephalic invaders of America carried with them an infusion of negroid blood which had been derived from the tropical parts of the Old World. If this conclusion is not legitimate, then it is only possible to infer that craniological variability in a homogeneous population is much greater than most anthropologists would care to admit, and that, in fact, it is a very risky business to attempt the racial diagnosis of a skull when dealing with isolated specimens.

The Pseudo-Australoid type is admittedly a misnomer and the type is found to stand very close to the Ainu, though there are significant differences. The Long-faced Europeans and the Pseudo-Alpines were likewise provisional names given to types which on subsequent analysis were found, in this case, to be related to Mongoloid types, the former showing an affinity to Eskimos in general proportions and the latter resembling crania of Tibetans, Burmese, etc.

As has been already indicated, Dr. Hooton's treatment of this material is exhaustive, and we sympathise with him when he says at last, "After traversing all of this weary waste of tables and statistical comparisons of measurements, indices, and anatomical details, I feel justified in permitting myself the luxury of expounding my present views on the anthropology and prehistory of the American Indian". Briefly, Dr. Hooton believes that his evidence indicates a migration by way of the Bering Straits into the New World, soon after the retreat of the last glaciation, of a mixed group of dolichocephals containing a Mediterranean element, a Negroid element, and a more primitive element represented in part by the Ainus of Japan. At a later period, the Mongoloid invasion of the New World took place and the invaders either supplanted or interbred with their predecessors.

This is an attractive theory and one of fundamental importance to students of Old World prehistory, for its acceptance must inevitably affect current ideas regarding the distribution of non-Mongoloid races in Asia during late Palæolithic and early Neolithic times. Further, Dr. Hooton's conclusions provide an additional and rather interesting basis of argument for those ethnologists who maintain that there was abundant contact between the Old and New Worlds in pre-Columbian epochs. This point of view, however, is not touched upon by Dr. Hooton, somewhat to our disappointment.

We heartily congratulate Dr. Hooton on the production of this monograph on the physical anthropology of the American Indian. If, as he himself says, the study of this subject is still in its infancy, the result of his work of ten years has done much to bring it towards maturity.

W. E. Le Gros Clark.

Organic Chemistry.

An Introduction to Organic Chemistry. By Prof. John Read. Pp. viii + 365. (London: G. Bell and Sons, Ltd., 1931.) 6*s.* 6*d.*

We confess this book makes a strong appeal to us: it approaches our ideal of how organic chemistry should be taught to that difficult person, the student—whose primary interest lies in other fields in which, if he only knew, he will make real progress only with difficulty unless his understanding of what to-day is comprised in organic chemistry is substantial.

Prof. Read is happy at the outset in his extract from that famous book of Mrs. Marcet on which we are told Faraday was nurtured. Organic chemistry is not a mass of dry facts or confined to analytical minutiæ; it is the livest of all sciences, full of unexpected and exciting happenings, and yet withal the game is played according to a set of rules based on molecular structure; rules which, elaborated in early days by Frankland, by van 't Hoff and Le Bel, by Kekulé, still prevail to-day; rules which have permitted us to glimpse at the inner structure of the sugars with Emil Fischer, of chlorophyll with Willstätter and porphyrins with Hans Fischer, of the alkaloids with Perkin, of the anthocyanin colours of plants with Robinson. Mrs. Marcet well said that "Nature also has her laboratory, which is the Universe". It is a happy inspiration of the author to develop aliphatic chemistry round the fats, the carbohydrates, and the proteins and to proceed to the closed chain aromatic, alicyclic, and heterocyclic compounds, treating them on the broadest lines. Actually the book contains the subject matter of a series of thirty lectures and it is interspaced with lecture experiments. A number of questions appear at the end of each chapter. There are several simple illustrations, a number of clear tables, and an ample index appropriately introduced by an extract from "Caroline's Conversations". We have special praise for the formulæ, which are not unnecessarily elaborate, whilst judicious use is made of heavy type.

We are not too satisfied with the author's repeated use of the term 'nucleus' for the carbon skeleton of a number of compounds. It is true that this is habitually used by chemists to distinguish the aromatic part of benzenoid from the side chains, so that he has some justification for the extension of the term, but to us the word nucleus does not imply a chain of carbons and we prefer the more usual words skeleton, grouping, or unit; this, however, is a very minor criticism of a successful attempt to make clear to the student how characteristic and how common certain arrangements of carbon atoms are.

It is surprising how much information has been included in so small a compass as the result of leaving out the old and, to the student, uninteresting details of preparation and reactions; space is even found to embody much information in relation to the utilisation of the compounds in practice and industry. Prof. Read has certainly succeeded in catching the spirit of the subject, and we shall be disappointed if students do not find his book inspiring.

E. F. A.

Short Reviews.

The Vitamins. By Prof. H. C. Sherman and S. L. Smith. (American Chemical Society Monograph Series, No. 6.) Second edition. Pp. 575. (New York: The Chemical Catalog Co., Inc., 1931.) 6 dollars.

MORE than nine years have elapsed since the previous edition of this American Chemical Society Monograph was reviewed in NATURE (vol. 110, p. 6, July 1, 1922). This second edition contains 349 pages of text and about 3000 bibliographic references; the corresponding figures for the first edition were 234 and 1000.

During the intervening period, 'fat-soluble A' has been split into vitamin A proper and the antirachitic vitamin D: the latter has been prepared photo-synthetically and obtained crystalline, though not pure, in two laboratories independently; vitamin E, essential for rats and some other animals to prevent resorption of the fœtus by the pregnant female and degeneration of the spermatogenic tissue in the male, has been discovered and styled the anti-sterility vitamin; vitamin B has been split certainly into two, probably into four and possibly into five or more different factors; of these, B_2 has been generally credited with the prevention of pellagra; vitamin B_1, the actual anti-neuritic factor, preventive of beri-beri, has been obtained crystalline in four different laboratories. Besides this, an enormous mass of investigation, proportionately indicated by the increase in bibliographical references noted above, has been conducted into the physiology of the vitamins.

The subject has come to be a recognised part of biochemistry, with its own technique and its own specialised schools, often associated with the names of distinguished individual scientific workers. It has been recognised, indeed, by the Nobel trustees, since at least three of the workers in this field have been honoured by their award.

This book is the only one in the English language —and, we believe, in any language, with one possible exception—covering the subject as a whole. It is not a popular exposition, but a technical monograph in the strictest sense, and of the highest order of excellence. It is indispensable to all concerned in any way with nutritional problems and to all biochemists, and should also be so to the majority of physiologists and to many medical men.

A. L. B.

Measures of Double Stars. By Prof. Francis P. Leavenworth. With which are included the Measures by William O. Beal. (Publications of the Astronomical Observatory, University of Minnesota, Vol. 1.) Pp. viii + 111. (Minneapolis: University of Minnesota Press, 1930.) 5 dollars.

THIS volume is published as a memorial to Prof. F. P. Leavenworth, who died in 1928. It contains the annual means of his observations of 1185 double stars, made between 1886 and 1927. They were made chiefly with the 10½-inch refractor of the University of Minnesota, but some were made at Yerkes, Haverford College, Leander McCormick, and Goodsell Observatories. Many stars that show motion have been followed regularly; thus Castor (*AB*) was observed forty-five times during an interval of thirty-nine years; the distant companion *C* was also observed five times; there are forty-six observations of Sirius, and seven of Antares, which shows no appreciable change of distance or angle in forty years.

The volume contains a brief sketch of Prof. Leavenworth's life and astronomical work; an appendix gives a full list of his papers; another appendix gives measures of 289 double stars by Prof. W. O. Beal, who was instructor in astronomy at the University of Minnesota from 1913 until 1926, and assistant professor from 1926 until 1930.

A. C. D. C.

A Laboratory Manual of Electrochemistry. By Prof. Dr. Erich Müller. Translated from the fourth edition by Dr. H. J. T. Ellingham. (Twentieth-Century Chemistry Series.) Pp. xiv + 363. (London: George Routledge and Sons, Ltd., 1931.) 15*s.* net.

THE present manual deals with practical electrochemistry in more detail than laboratory works on physical chemistry, and is more suited to a special course on the subject than to the ordinary course in physical chemistry, where there is not usually sufficient time available for so many experiments on electrochemistry. It includes inorganic and organic electrochemical preparations and potentiometric titrations as well as an excellent series of experiments on the fundamental laws. Brief but very clear accounts of the theories are given, and the book will be useful in the study of theoretical electrochemistry as well as in the laboratory. The translation is good and the printing well done, although the paper is too thick for a laboratory manual and the book will not stay open on the bench. The book should be in every university and technical college laboratory for reference.

The Story of Surnames. By William Dodgson Bowman. Pp. vii + 280. (London: George Routledge and Sons, Ltd., 1931.) 7*s.* 6*d.* net.

MR. BOWMAN's popular account of the methods and material for the study of surnames will serve a useful purpose in making known a fascinating and instructive subject of investigation to a wider public. It is indeed surprising that the literature on the subject is relatively so small. Few investigations which can be so readily followed throw more light on the habits and mentality of our ancestors than the surnames they used and the reasons for which they gave them to individuals. Mr. Bowman's work is fully in accordance with accredited methods; nor does he fail to warn us by precept and by examples, which follow scientific method, of the dangers of the over-hasty conclusion which is nothing more or less than guesswork. The chapter on fourteenth century London is an excellent example of the intimate detail relating to the organisation and life of an urban population that this class of evidence can be made to yield.

On the Nature of Mind.*

By Dr. C. S. Myers, C.B.E., F.R.S.

PSYCHOLOGY was given the status of an independent Section, with the approval of the Sections of Physiology and Education, at the Cardiff meeting of the British Association in 1920. The new Section met for the first time in 1921 under the presidency of Prof. Lloyd Morgan. Thus the present centenary meeting marks also the completion of ten years' existence of our Section. I can vividly recall the doubts which were expressed, not so much in words, as in general attitude, by the Committee of Recommendations of this Association when in 1920 it was asked to consider the formation of a separate Section of Psychology. Such hesitation was probably based on several grounds, not wholly on any one of them. But some of these grounds have lost much of their force to-day, because of the pronounced change that has since taken place in the attitudes and beliefs which were in vogue among physicists of that time. No physicists would then have dared, as now, to cast doubt on the sole sway of determinism in the physical world. None of them would then have suggested, as now, the impossibility of predicting what any *individual* atom (or still smaller *individual* entity) will do next. None would have questioned, as now, the universal truth of the second law of thermodynamics or of the principle of conservation of energy. None would have ventured, as now, to suppose that electrons change in the very act of becoming known to us, and that therefore the mental factor is ultimately inseparable from physical investigations. None would then have dared, as now, to conjecture that particles of matter correspond in their properties to certain *group* waves of the ether, the *constituent* waves of which, travelling at an enormous speed, 'guide' and 'direct' the group waves without any energy of their own.

Psychology has been similarly bereft of reality by the operations of mathematicians, present and past. The earliest example of this was the derivation by Fechner of the 'law' which now bears his name, that the intensity of a sensation is proportional to the logarithm of the magnitude of its stimulus. This statement was deduced by purely mathematical procedure from Weber's law that just appreciable differences between sensations depend on a constant ratio between the magnitudes of their respective stimuli. Weber's law, however, was based on direct observation and experiment; whereas Fechner's 'law' was the outcome of purely mathematical calculations which not only neglected a constant appeal to the 'reality' of experience, but also ran actually counter to it—neglectful, for example, of the 'facts' (i) that Weber's law holds for only moderate magnitudes of stimuli; (ii) that from the point of view of conscious experience it implies a *single experience* of difference, not a *difference between two* separate experiences; and that (iii) from the same point of view we are quite unwarranted in adding together or subtracting from one another two intensities of sensation or two sensation differences as such.

Elsewhere in his treatment of psychological data, as in his treatment of physical data, the mathematician has arrived at results that can directly be neither verified nor rejected by conscious experience. The establishment of 'general mental factors', involved in and influencing the performance of various mental tests and other processes, affords us another example. By mathematical operations on experimental data we can, it is claimed, deduce the existence of such general factors. But from the strictly psychological point of view the nature of these factors cannot be interpreted; for we are unable to appeal to direct experience to ascertain what these factors are. At best their significance in terms of actual experience can only be conjectured by abstraction and imagination; or it is expressible only in terms of general behaviour. At worst, as in the case of g (the so-called 'general intelligence'), we are quite ignorant of their psychical nature. We cannot hope for direct psychological evidence as to the precise mental nature of such mathematically deduced 'factors'.

Psychology and Behaviour.

The escape from such difficulty on the physical side—so as to avoid dethronement of the literally divine claims which some mathematicians have made for the fundamental truth of their own science—is to regard the universe as constituting a vast nexus of ultra-physical and mathematical necessities and probabilities, only some of which can become physical through the further operation of the human mind. We might, perhaps, adopt a corresponding attitude towards some of the subjectively unverifiable conclusions arising from the applications of mathematics to psychological data.

In psychology an additional difficulty confronts us. We have to recognise that the data with which the 'mathematical psychologist' operates are not measurements of the fundamental subject matter of psychology—conscious mental processes. (Nor can they probably be measurements of unconscious processes, so long as the latter are regarded as mental in character.) For mental processes are not directly measurable: we can *grade* a series of conscious experiences according to their degree or amount, say of hue, brightness, loudness, pitch, temperature, extent, duration, clearness, pleasantness, etc.: we can say that one member of such a series has more or less of any one such character or quality than another member, or that the difference between two members of a series in respect to any one of these characters or qualities is greater or less than, or equal to, the difference between two other members. But the psychologist can only *measure* the amount of any conscious experience indirectly—either by reference to behaviour, that is, to the organism's *physical* response or expression, or by reference to the *physical* character of the relevant stimuli, in terms of objective standards of number, space, and time which are immediately independent of actual subjective experience.

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* From the presidential address to Section J (Psychology) of the British Association, delivered in London on Sept. 28.

Let us remember, then, that when we are attempting to measure any mental ability or character or quality by means of a test, or series of tests, we are not directly measuring that mental ability or character or quality, but only the corresponding stimulus or the outward response or expression by which that mental ability or character or quality is manifested. We are, no doubt, justified in assuming a broad correlation between the speed, accuracy, amount, etc., of the response or expression of a mental ability or character or quality and the degree in which that mental ability or character or quality is present. Even this broad assumption, however, is sometimes unjustifiable, as in the case where too much of a given mental ability or character or quality may lead to a deterioration, and no longer to an improvement, in the corresponding performance. But we are certainly never justified in assuming that we can measure accurately any mental process by measuring its objective response —that, for example, twice the amount of the response necessarily means twice the quantity of the mental process of which the response is the expression. All that we are measuring is *behaviour* —that is to say, something largely on the efferent side, something largely physical and indescribable in terms of pure immediate experience, involving a complex of factors many of which, indeed, may be remote from those which we commonly believe we are measuring; whereas what we ultimately aim at dealing with in psychology is *experience* —the meeting point of the afferent and efferent sides.

In fact, then, the 'behaviourists' are quite right when they insist that scientific measurement is applicable only to the behaviour of the organism. Where they are quite wrong is in their assumption that conscious processes must necessarily be ousted from scientific psychology, because measurement is excluded; the truth being that, even where measurement is excluded, the possibilities of systematic observation and experiment still remain. Natural science has surely a function wider than that of merely reducing its subject matter to units of space and time. Highly valuable and deserving of the utmost encouragement as is the measurement of behaviouristic data, however helpful be the light they may ultimately throw on mental processes and their general characters, however wider be mental processes than the range of mere conscious experience, the scientific study of the mind by direct observation and experiment is never to be discountenanced or discarded.

SELF-ACTIVITY.

Just as experimental physics patiently pursues its researches into Nature, heedless of such mathematical conclusions as are not amenable to verification by experiment, so experimental psychology must realise that its progress is not primarily dependent on, however much assistance it may receive from, the work of those who fail to recognise that the fundamental subject matter of psychology is conscious experience, not conduct. Now conscious experience can only be enjoyed by the active self, namely, the 'individual' (that is, undivided) mental activity of the entire living organism. It is the fundamental function of such self-activity—by recourse to past experiences, by receiving present experiences, by foreseeing future experiences and by creating new experiences—to select from alternative responses and from alternative environments those which are most advantageous to the ever-evolving and developing organism; to secure the most suitable movements and environments and thus to help in the evolution of the organism are the prime objects of consciousness. Where, as in plants, mobility and plasticity are at a minimum, self-activity and consciousness are inappreciable. Self-activity is to be regarded as the highest, unitary integration of the directive mental (conscious and unconscious) activity of the organism.

DERIVATION OF PRESENTATIONS (OR CONTENTS) FROM FEELINGS.

Self-activity and its inherent consciousness may presumably be traced back to a stage where self and not-self are but just distinguishable. At this remote stage in animal evolution there can scarcely have been more than a differentiation of self-activity into 'acts' of the self and 'modifications' of the self. These modifications of the self became early differentiated into (*a*) those which are due to internal happenings within the organism, and (*b*) those which are due to more variable external happenings in its environment, and later into (*a*) those which we come to recognise as 'affects' *of* the self and 'feeling tones', and (*b*) those which come to be regarded as 'presentations' *to* the self or as 'contents' of the self's consciousness. Sensations, perceptions, memories, and thoughts—all that we finally come to recognise as conscious *presentations* to the self—have been differentiated (onto- and phylo-genetically) from modifications of the self: instead of being *feelings* of the self, they have become *contents* of consciousness.

We end by 'projecting' certain of these original feelings. The external 'objects' of our perception have been separated from or carved out of originally vague external 'situations', of which we or our remote ancestors were first conscious merely as diffuse modifications or feelings of the self. So, too, any colour or sound comes to be regarded no longer as a self-feeling but as a something projected and existing outside us. The degree to which such projicience and presentation is carried out varies with different sensations: colours clearly have a projected, apparently independent, existence; sounds, smells, tastes, hardness, and temperature are only imperfectly projected; the painful prick of a pin and our sensations of movement, though not projected, are nevertheless regarded as 'presentations' to the self; whereas our experiences of visceral sensations are scarcely even presented:

they seem almost as clearly modifications of the self as are our emotions and other affects.

ORIGIN OF ACTS AND CONTENTS.

This difference between the acts and the contents of consciousness — between the conscious *acts* of apprehending, recalling, deciding, inferring and *what* is consciously apprehended, recalled, decided, inferred—is a most important one. It is exemplified in the two kinds of memory which are distinguishable. On one hand, we may recall the *separate acts* of the self, say, in the course of solving a problem or of acquiring some specific skill; these are individually unique and only individually revocable. On the other hand, we may recall the *generalised contents* of our consciousness, that is, of presentations we have received by a repetition of such acts, for example, in learning a prose passage or series of skilled movements.

I would suggest that the distinction between conscious acts and contents has come about with the gradual differentiation of higher and lower levels of mental activity—and in the following manner. There is no awareness of self-activity when we sense a colour or a temperature, or when we perceive a familiar object, or when an idea 'occurs' to us. Our sensations, our perceptions, and many of our thoughts and ideas are, I suggest, the unconscious 'acts' of relatively lower mental levels. But when these lower-level 'acts' are accompanied and received by the self-activity of the highest levels, they become *ipso facto* 'presentations' to the self. A loud noise to which we are impelled to attend or an idea which 'occurs to the mind' is not a conscious presentation (or content of consciousness) until the self receives it.

I suggest that such differentiation of higher and lower levels has never occurred to the same extent in the case of our kinæsthetic and, especially, cœnæsthetic sensations and in the case of our feelings (which depend on a more primitive, thalamic, activity): we fail, therefore, to objectify them immediately as presentations, and they continue to be received in their primordial undifferentiated state.

UNCONSCIOUS DIRECTION AND PURPOSE

The self is the highest controlling and directing power. The orders which it consciously gives and the efforts which it consciously makes may, once started, continue to be carried on unconsciously, that is, without the conscious participation of the self. Thus we may consciously but vainly try to recall some past experience or to solve some difficult problem; and after giving up the effort, this directive activity may still persist unconsciously until suddenly the forgotten object, or the abandoned solution, suddenly flashes full-born and unbidden into the self's consciousness. So, too, we may go to sleep determined to wake up at a given hour, or we may accept, in the hypnotic state, a decision to carry out some prescribed act on the lapse of a prescribed period of time after emerging from that state; and at the ordained moment the sleeper wakes, or an uncontrollable impulse is felt to perform the suggested act.

Not only is purposive activity not limited to th duration of conscious activity but also it need no originate there. The inspirations of genius an the intuitive judgments and decisions which, crud though they may be before submission to the self' judgment, arise apparently from the 'depths' o the mind with impulsive force and compelling conviction afford striking examples of this fact. Th well-known improvements in learning which continue after we have ceased to practise, so that i has been said of us that we learn to skate in summe and to swim in winter, are further examples of suc activity—whether or not we choose to ascribe suc improvement to the gradual disappearance of adverse initial inhibitions or to the direct strengthening ('consolidation') of acquired integrations (o associations).

Further, the self is continually being played upo both by the impulsive and by the perseveratin forces of lower mental systems. They struggle, no less than the self, for their own existence and fo their own lower 'self-ish' ends. Where they ar modified by inhibition (or repression), it is only t ensure general harmony and general compatibility Inhibition is not to be viewed as a mere act o passive drainage of energy from one mental constellation to another, but as an active repressiv force against which the inhibited constellation eve tends to rebel in its endeavour to gain somehow o another liberty of action, in some lower degre purposeful and directive.

CEREBRAL LOCALISATION OF CONSCIOUSNESS.

While consciousness always implies self-activit and while the self is to be regarded as the expressio of the highest level of mental activity, we mus guard against the notion that such high-leve activity implies a narrowly limited zone of menta processes. On the contrary, it implies a wid sphere of activity rather than a punctate, pineal gland-like soul. It follows, therefore, that w cannot hope to localise any act or any content o consciousness in one small region of nervous substance. Afferent-efferent localisations of functio undoubtedly occur—regions where the incomin impulses become deflected to outgoing processes our knowledge of the physiology and structure o the spinal cord clearly points to this. Sensori motor localisations may, in a sense, be said to exis similarly in the brain. The occipital region of th cerebral cortex, for example, is concerned wit vision. But because vision ceases when the *are* *striata* in this region of the cortex is injured, we ar not justified in saying that this area is the *seat* o centre of our visual consciousness. All that we ar warranted in concluding is that it is *essential* for ou visual consciousness, that without it vision is impossible—a very different statement.

Once again, let me repeat, consciousness implie self-activity. There are no separate loci for different kinds or modes or qualities of consciousness The nervous system and the system of self-activit work as a widespread unity. Different regions o the brain are more particularly concerned in *givin* *rise* to certain kinds of consciousness. The thala mus, for example, is especially concerned with the emotional consciousness; but we are not justified in calling it the *seat* or centre of such consciousness.

We are, in fact, neither warranted in supposing that there are definite seats or centres of sensation or emotion, nor justified in supposing that our manifold percepts, images, or ideas each have their seat in different narrowly localised centres of the brain. A similar truth holds for the association (or integration) of such experiences. We can *mentally* picture an integration of two 'patterns' of conscious activity occurring when two experiences *a* and *b* follow one another repeatedly, so that when *a* is later given, *b* (or rather the whole *a–b*) recurs; but *neurologically* we can form no simple corresponding picture of two collections of nerve cells being associated together. We have no evidence to support such cerebral localisation of association areas; indeed such experimental evidence as we have is against it.

Even if there were no evidence pointing in one direction or the other, how could such localisation of memories and habits possibly occur? Consider the babe that is learning to associate its mother with the satisfaction of its hourly wants. Its mother is never twice the same—now in one dress or facial expression, now in another; and the visual image of the mother received by the retina is never twice the same—for example, sometimes the mother is very near, sometimes farther off; sometimes the image falls on one part of the retina, sometimes on another. How can we imagine, then, any definite collection of retinal or cortical nerve cells responsible for developing the image of 'mother'? What develops is surely rather a 'meaning'—a generalisation of images, 'standing for' something, that is, for the assuaging of certain needs, for the execution of a wide range of adjustments of the infant.

Relationships and meanings are therefore the all-important mental acquirements. The acquisition of such relationships is shown, for example, in the many experiments conducted on a large variety of species, high and low in the animal scale, where by long practice the organism is trained to enter *B*, the brighter of two alternative compartments, *A* and *B*, in order to reach its food. When later, in place of *A* and *B*, *B* and *C* are substituted, *C* being now brighter than *B*, does the animal go to *B* to which it had previously been trained to go? Generally, no. It enters the *C* compartment. That is to say, it has learnt to enter not a *particular* compartment, but the *brighter* of any two compartments. It has not learnt to select a 'particular' object. It has learnt a 'relation'. Surely evidence of this kind is contrary to any atomistic localisation of individual mental functions in separate cerebral areas.

RELATION BETWEEN DIRECTIVE AND MECHANICAL ACTIVITY.

The fundamental purpose of consciousness is to enable the self to preserve the organism by guidance and direction—by the formation and satisfaction of ends and values. As in the evolution of living species something far more is involved than the mere blind running down-hill of a wound-up mechanism, so in the mental and bodily life of each organism the physical conceptions of 'entropy' and of mechanical energy are inadequate. On the physical side we can form no conception of the mode of working, throughout life and mind, of anything resembling Clerk Maxwell's directive 'demon'. Physiologically, that is to say, physically, the brain-worker should need food with a far lower caloric value than he actually takes and requires for the successful maintenance of his purely mental activities. But, in fact, mental work appears to make far greater demands on metabolism than it should according to purely physical considerations of the expenditure of mechanical energy.

At present we can form no conception of the nature of the undoubted connexion between chemical metabolism and direction in the living organism —between senility of body and senility of mind, between the rise and decay of procreativeness and the rise and decay of the creativeness of genius. At present we can form no bridge between mechanical and creative, directive activity. We can only say that both activities are essential to a conception of the evolution and working of life and mind. Mental activity involves a quintessence of the non-mechanical, directive activity of life; and consciousness is but that activity raised to its highest power. Even lower-level mental and neural systems, even the activities of the lowest living organisms, are characterised by unconscious creation, direction, guidance, and purpose in varying degrees. But conscious creation and direction, the consciousness of *acts*, is limited to the highest-level psycho-neural activity—the self.

I have suggested above that, when the physiological activities of the lower-level systems meet with the highest-level activities, they may become manifest as conscious *presentations*; these highest-level activities are, I believe, to be regarded as arising from the supreme organisation and distillation of the directive activities of the living organism. The acts at this highest mental level constitute the purposeful, directive, creative, and contemplative self, and are the recipients of presentations from lower cortical, and also of feelings from lower, primordial, thalamic activity.

The psychologist's principle of the *conservation of self*, which corresponds to the biologist's inevitable principle of the *struggle for existence*, is the fundamental function of this conscious activity. It is as real and important as the physicist's principle of *conservation of energy*. We must leave to the future the task of bridging the present impassable gulf which yawns between these two principles. Meanwhile let us always remember that blind mechanism in the material world is a truth not more fundamental than the reign of guidance, creation, and purpose in the world of life and mind, and, it may well be, throughout the universe; indeed, our very notions of these two principles, governing perhaps both the living and lifeless world, appear to be the outcome of, even if they do not wholly depend upon, the experiencing, reasoning, and imagining self.

Ultrasonics: Some Properties of Inaudible Sound.*

By Prof. F. LLOYD HOPWOOD.

THE intensity or loudness of a sound depends upon the extent or amplitude of the vibration set up, and its pitch upon the frequency or number of vibrations per second. Disturbances of the same type as sound waves may be inaudible either because the intensity (loudness) is insufficient or because the ear is deaf to those particular frequencies: the normal range of hearing of a human being extends approximately from 20 to 20,000 vibrations per second.

'Sounds' of higher frequency than 20,000 are called supersonic or ultrasonic. They can be generated in a variety of simple ways, as, for example, by rubbing a resined rag along a steel wire or by tapping the end of a short rod of material with a suitable hammer; thus, a steel rod 10 cm. long, clamped at its middle point and tapped at one end, will emit an inaudible 'note' of 26,000 vibrations per second, and when two steel balls 1 in. in diameter collide, they vibrate after impact at the rate of more than 100,000 vibrations per second.

Such ultrasonic emission is discontinuous, of feeble intensity, and is accompanied by parasitic audible sounds. The most convenient generator of sustained vibrations is the valve-oscillator. The vibrator itself is a disc of natural quartz crystal cut with its plane faces parallel to its optic axis and at right angles to an electric or binary axis. Such a disc was shown by MM. Pierre and Jacques Curie to possess the remarkable property that when it is compressed its faces become oppositely electrified, and that its electric charges become reversed in sign if the disc is subjected to extension instead of compression. Periodic reversal of stresses is immediately followed by periodic reversal of electrification. Prof. Pierre Curie also showed that natural quartz, in common with certain other crystals, possesses the converse property, namely, that if the opposite faces of a suitably cut disc are electrified, the crystal contracts in one direction and expands in another.

This latter property was utilised by Prof. Langevin of Paris to produce high-frequency sound vibrations by applying alternating electric potentials to electrodes in contact with a quartz plate. The plate vibrates with its maximum amplitude when the frequency of the electrical alternations coincides with a natural frequency of mechanical vibration of the quartz; in other words, when resonance is obtained.

For our experiments we use a quartz crystal cut in the form of a circular disc more than 7 centimetres in diameter and nearly 5 millimetres thick. This is clamped with one face in contact with a massive lead electrode and immersed in transformer oil contained in a small glass tank (Fig. 1). The second electrode, which is made of light copper foil, rests in contact with the other face, and both electrodes are connected to a powerful (3 kilowatt) valve-oscillator, executing half a million vibrations a second, or more. The use of the oil permits the application of very high voltages to the crystal, and also makes it easy to subject small objects to the influence of the very intense vibrations.

EXPERIMENTS WITH A HORIZONTAL BEAM OF SOUND.

Following Prof. R. W. Boyle, the production of *stationary waves* in the oil can be rendered visible by the striæ formed in coke dust scattered on a horizontal opal-glass plate placed in the sound beam. The distance between successive striæ, that is, half a wave-length of the sound in oil, is here between 1 mm. and 2 mm. This wave-length is so short in comparison with the dimensions of the crystal and other objects in the tank that these waves exhibit the directional properties ordinarily associated with light waves. Thus, by using plane and curved reflectors, the well-known laws of reflection are verified. In the same way refraction of sound waves by prisms and lenses can be demonstrated. Fig. 2 shows that sound waves travelling through pentane, and falling on a parallel layer of transformer oil, are transmitted if the angle of incidence is less than a certain value (critical angle), but totally reflected if it exceeds this value (total internal reflection). In fact, most objective optical phenomena, except polarisation, can also be faithfully paralleled by these means.

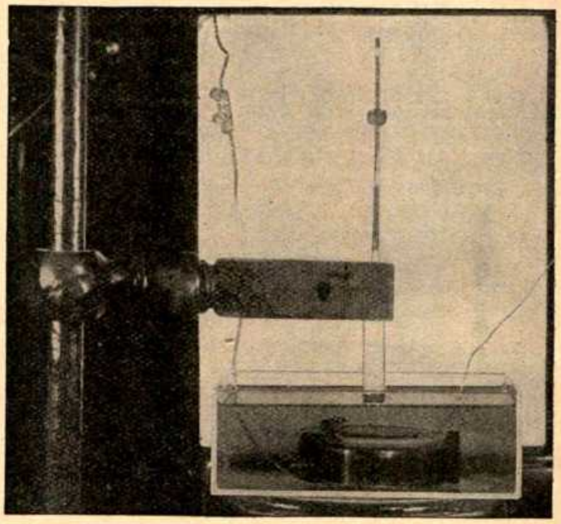

FIG. 1.—Arrangement of quartz crystal and electrodes in oil bath when projecting a vertical beam of sound.

Another application of the coke-dust method of showing stationary sound waves is to the study of architectural acoustics. Fig. 3 shows the 'whispering gallery' effect in a model of the lecture theatre of the Royal Institution, using ultrasonic vibrations instead of audible sound. The clinging of the waves to the circular wall is very marked.

The *pressure of radiation* to which an obstacle is subjected when sound waves fall upon it is shown by the rotation of the vane of a torsion pendulum placed in the horizontal ultrasonic beam. This affords a convenient method of estimating the intensity of the sound, which can be used for measuring the acoustic reflection and transmission coefficients of different materials.

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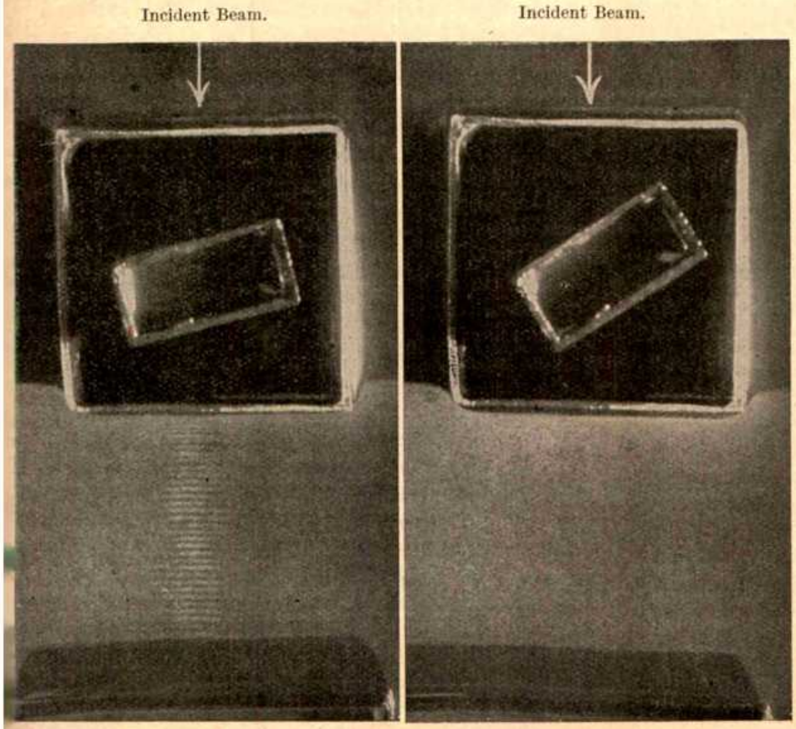
* From a Friday Evening Discourse delivered at the Royal Institution on Feb. 13.



(a) (b)

FIG. 2.—Transmission of ultrasonic waves through layers of pentane and transformer oil for (a) angle of incidence less than critical angle; (b) no transmission for angle of incidence greater than critical angle. The outer vessel contains pentane and the inner oil.

EXPERIMENTS WITH THE ULTRASONIC BEAM DIRECTED TOWARDS THE SURFACE OF A LIQUID.

The properties of ultrasonic waves described above were predicted from theoretical considerations before they were experimentally demonstrated by Langevin, Boyle, and others. Remarkable and hitherto quite unforeseen effects can, however, also be produced by ultrasonic vibrations when these are of great intensity and very high frequency.

With the crystal arranged as shown in Fig. 1, the ultrasonic beam is confined mainly to the column of liquid between the upper crystal face and the surface of the oil. Prof. R. W. Wood and Mr. Loomis have shown that in these circumstances the great concentration of energy causes the amplitude of vibration of the disturbed particles of liquid greatly to exceed the amplitude of vibration of the crystal itself. At the same time the pressure of radiation produces on the surface a mound of oil, several centimetres or even inches in height, which erupts droplets like a miniature fountain. On plunging vessels of appropriate form into this mound of oil, vibrations of great intensity may be communicated to the walls of the vessels, or through the walls to liquids contained in them. If a test-tube containing water is partially immersed in the oil, bubbles of dissolved gas are usually liberated in it (Fig. 4). These behave in a peculiar manner. For moderate intensities of vibration the bubbles form slowly and remain practically stationary at the nodes of the waves formed in the water. As the bubbles grow in size they oscillate and tend to rise to the surface in an irregular zigzag manner as if they were going up a staircase. For still greater intensities we have found that no visible gas bubbles can either exist or be formed. The density of the gas being much less than that of the liquid, the bubbles formed at low intensities must experience the same forces and therefore have greater amplitudes of vibration than the particles of liquid they displace. The result is that at high intensities they are deformed and shattered and so dispersed through the liquid as to become and remain effectively in solution.

Cavitation can be produced in liquids such as pentane or benzene, by using a U-tube closed at one end, the closed limb being filled with the liquid, and placed in the mound of oil above the vibrating crystal. The bubbles of vapour formed in the interior of the liquid and collected in the closed limb can be again condensed into liquid by raising the air pressure on the open limb. Using now an inverted U-tube or ∩-tube, which is completely sealed up and contains liquid in one limb only, we observe the rapid vaporisation of liquid in the agitated

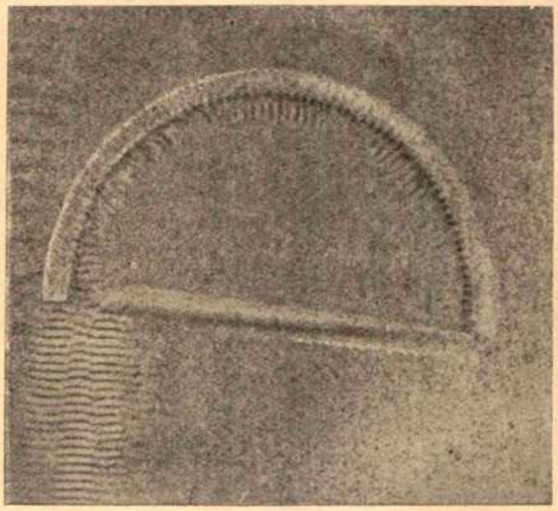


FIG. 3.—Model of lecture theatre of Royal Institution, showing 'whispering gallery' effect, illustrated by stationary waves of ultrasonic 'sound' of 2 mm. wave-length. Notice how the waves hug the wall.

limb and its deposition as liquid in the previously empty limb. This might appropriately be called *acoustic distillation*.

On substituting for the inverted U-tube a similar tube which contains a little dry lycopodium powder but is otherwise highly evacuated, an astonishing result is obtained. The powder sometimes moves in this case *towards* the limb which is subjected to the more intense vibration. This last effect is one of a number of phenomena due to the transverse vibrations of various types set up in the walls of the vessel itself. Another of these effects is the formation of ripples in the oil splashed on the tube and the repulsion of the oil drops away from the source of disturbance.

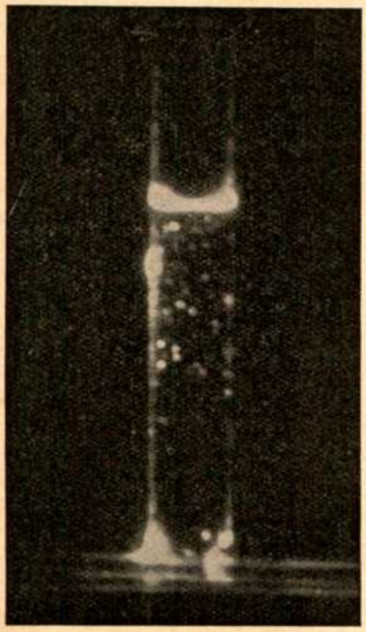


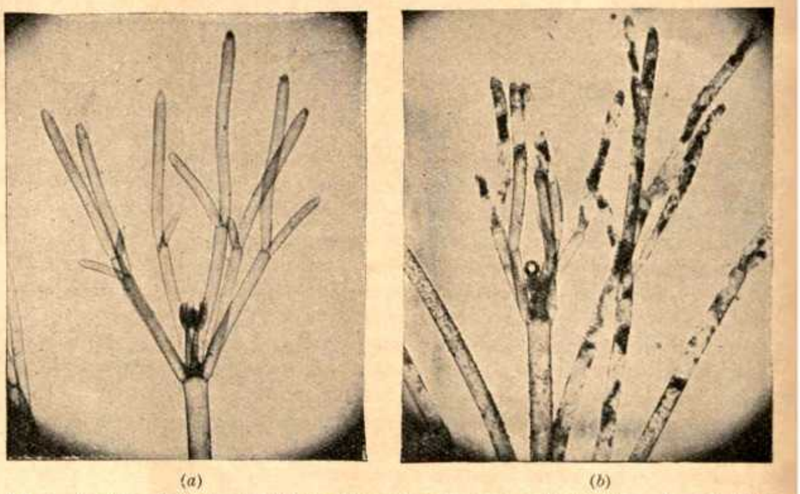
Fig. 4.—Expulsion from water of dissolved air as bubbles.

The most striking thing, however, about the oil drops is their behaviour at a constriction, or at the narrower parts of a tube such as is shown in Fig. 1. High inputs of ultrasonic energy cause intense local heating at such places, and the oil is thrown off as spray and jets of vapour as from diminutive geysers. If the tube is drawn off into a fine fibre and firmly grasped between the fingers, a severe burn is experienced. In addition to the calorific effects produced in the walls of various containers, the absorption of sound energy which occurs in their contents causes appreciable rises of temperature in them also. Amongst other effects which we can produce by our installation, we may cite the acceleration of certain chemical reactions, the flocculation of suspended matter, and the emulsification of oil and water, etc.

Most of the effects obtainable with the ultrasonic beam directed towards the surface of a liquid were discovered by Wood and Loomis in the United States. Acoustic distillation, the anomalous movement of lycopodium powder, and the non-liberation of bubbles from water with very high intensities are, we believe, described now for the first time.

Biological Effects of Ultrasonics.

Some fifteen years ago, while carrying out experiments at sea, Langevin and his co-workers observed that fish which swam into a beam of ultrasonic waves were disabled or killed. During the past few years I have been able to investigate this phenomenon. Quite independently, Wood and Loomis covered much the same ground. Let us notice first what happens to an object the dimensions of which are large compared with the wavelength of the sound waves which irradiate it. One result can be seen from Fig. 5. These are reproductions of photomicrographs of a freshwater plant —*Nitella*. The irradiated specimen shows how certain regions in a cell are denuded of their chloroplasts, which are then piled up in other spots. A gentler irradiation merely causes the streaming of the protoplasm to cease either temporarily or permanently according to the duration of exposure. The mechanical action which has taken place here can be understood when it is realised what occurs in the water in which the plant is immersed. Although the excursion of a disturbed particle during a single vibration is only equal to a few wavelengths of light, these vibrations, occurring at the rate of nearly a million times a second, cause the maximum velocity of the particle to be very high; its maximum acceleration may become as great as 10 km. per sec. per sec. We have, in effect, a *micro ultra-centrifuge*, which subjects specimens to very intense though highly localised forces.



(*a*) (*b*)

Fig. 5.—(*a*) Normal *Nitella*; (*b*) *Nitella* after exposure to ultrasonic vibrations. ($n = 750{,}000$.)

This explanation accounts quite satisfactorily for certain other effects we have obtained, such as the breakdown of the red blood-corpuscle and the disruption of Planaria and similar small living organisms. The same explanation may possibly account for the decreased response to stimulation of an irradiated muscle-nerve preparation and the arrest or retardation of the beating of the isolated frog's heart and embryonic heart of a chick.

Further explanation is required to account for the action on bacteria and viruses—bodies which are of microscopic and ultra-microscopic dimensions. We have found that the agglutinating power of certain streptococci is increased after irradiation, but the virulence of a strain of pneumococcus was unchanged or changed in an indefinite manner. (Preliminary experiments with bacteriophage have given a negative result.)

Positive effects have been obtained with one virus. The accompanying table shows the effect of ultrasonic vibrations in increasing the potency of the virus of vaccinia. Through the kindness of Dr. Mervyn Gordon, the irradiated and control lymphs in various dilutions were used to vaccinate the skin of a rabbit. The 'takes' were recorded after the requisite period of time had elapsed for the characteristic lesions to be produced. Two series of experiments were carried out, the lymph in the first case being given only one-fifth of the exposure given in the second case. It will be noticed that the result is the same in both cases. Presumably the effect of the exposure was merely to disengage inert foreign material from the virus so that the latter could exhibit its intrinsic potency.

EFFECT OF ULTRASONIC VIBRATIONS ON VACCINIA VIRUS.
(Frequency 700,000.)

Dilution.	*1st Expt.*	*2nd Expt.*	*Control.*
1/1	+	+	+
1/10	+	+	+
1/50	+	+	+
1/100	+	+	+
1/500	+	+	−
1/1000	+	+	−
1/2000	−	−	−

We have seen that fish may be killed by means of inaudible sound waves. With so many effects occurring simultaneously—the breaking up of blood corpuscles; liberation of dissolved gases; paralysis of muscle and nerve; localised mechanical action and heat production—this should no longer surprise us. In conclusion, it may be added that ultrasonic radiation is not a menace to human life. The vibrations are of necessity produced in a liquid because at these high frequencies the waves are so rapidly attenuated in air that their propagation through it is practically impossible.

Obituary.

DR. THOS. A. EDISON.

BY the death at Llewellyn Park, West Orange, New Jersey, on Oct. 18, of Thomas Alva Edison, America has lost one of its most famous men, and one whose name, like those of his countrymen Fulton, Whitney, Colt, Morse, Bell, Maxim, Westinghouse, and the Wright brothers, will always be remembered as that of a great inventor. When a youth, Edison bought a set of Faraday's works, and he afterwards said, "I think I must have tried everything in those books." It was in this direction his great strength lay; for, gifted with a vivid imagination and a quick and active mind, he possessed a remarkable willingness to put everything to the test, and to seek in any and every direction for a solution to the problem of the moment.

Edison came of Dutch and Scotch descent, and was born at Milan, Ohio, on Feb. 11, 1847. It was apparently from his mother that he inherited his intense mental activity, while from his father's side came his exceptional physique and powers of endurance. His great-grandfather lived to the age of a hundred and four years, his grandfather to a hundred and two, and his father and several uncles to more than ninety years of age. The romantic story of his early life has many parallels in American biography. Owing nothing to schools or masters, he was his own instructor and the founder of his own fortunes. As a train boy of fifteen years of age he printed a small newspaper, the first ever produced on a train in motion; at sixteen years he was a telegraph operator; at nineteen he took out his first patent; at twenty-two he was working for a telegraph company at 300 dollars a month, and soon afterwards was able to sell his improvements in 'stock tickers' for 40,000 dollars, and in 1876 to open his laboratory at Menlo Park, Newark, New Jersey.

The record of the work of Edison and his assistants during the next twenty years at Menlo Park and at West Orange, to which he removed in 1887, probably has no parallel in the history of invention, and it is no wonder he became popularly known as the 'Wizard of Menlo Park'. It has been said of him that "he could always be counted upon to play his part in the mechanical evolution of new inventive arts", but his part often became the principal one. In telegraphy he will be remembered for the invention in 1872 of the type printing receiver and his subsequent work on quadruplex telegraphy, while to telephony he contributed the important invention of the carbon transmitter. Bell invented the telephone in 1876, Hughes the microphone in 1878, and Edison the carbon transmitter in 1877. To that year also belongs his outstanding invention of the phonograph.

Two years later Edison successfully solved the problem of "the subdivision of the electric light" by the invention of his incandescent lamp, his work in this direction being contemporary with that of Maxim, Lane Fox, and Swan. His improvements in the dynamo, made about the same time, gave him a place beside Gramme, Siemens, Crompton, Brush, and Hopkinson; while the first central power stations in both the Old World and the New World, the former in Holborn Viaduct, London, and the latter in Pearl Street, New York, were the direct outcome of his many inventions. Both these stations began operations in 1882.

In Menlo Park, in 1880, Edison made experiments with electric traction, while he afterwards contributed to the advancement of photography and cinematography. One fruitful observation he made in 1883—the Edison effect—he left for others to utilise; and from this, through the work of Sir Ambrose Fleming, came the thermionic valve. The work of an inventor responsible for more than a thousand patents cannot be adequately dealt with in an obituary notice, but, in conclusion, mention may be made of his nickel and iron storage cell patented in 1900 and improved in subsequent years.

Many biographies of Edison have been written and many writers have put forward extravagant claims on his behalf. But he himself stood in need of no such panegyrists. His works speak for themselves, and the *Times* remarks that though his older friends and staff have passed away, "those who survive him retain an abiding impression of him as a great man, and a singularly delightful personality, devoid of egotism, inspiring enthusiasm and exceedingly human, as all who share his love of children must be".

For fifty years Edison's name has been a household word, and it is nearly forty years since it was included in the list of recipients of the Albert Medal of the Royal Society of Arts, where it is found beside those of Faraday, Wheatstone, Bell, Hughes, Kelvin, Swan, Parsons, Fleming, and Marconi. It is among such as these he rightly takes his place.

Dr. C. A. Keane.

Dr. Charles Alexander Keane, who died, at the age of sixty-seven years, on Sept. 18, had been identified for the last thirty years with the development of technical education in London. After studying at Manchester under Roscoe and at Erlangen under Otto Fischer, he served as lecturer and demonstrator in chemistry at Liverpool for fifteen years before coming to London to take up the post of first principal of the newly established Sir John Cass Technical Institute. This Institute was founded out of the increased revenues of the trust established by Sir John Cass (1661–1718) for the maintenance of a Foundation School for the children of the Ward of Portsoken. Appointed in 1901, almost a year before the opening of the new building in Jewry Street—now, in eloquent testimony of the success of his administration, undergoing extensive enlargement—Keane at once gained the confidence of the governors, and was able to determine from the very beginning the lines on which the Institute should develop. As soon as possible another building was provided for Sir John Cass's Day School, and all elementary teaching was given up in favour of more advanced work. Two chief principles were adopted: first, the encouragement of research among the teachers and senior students, and, secondly, close association with the industries of the district. In both these respects the Sir John Cass Institute has fulfilled the wishes of its promoters; a long list of original researches has been published from its laboratories, while its industrial classes, each controlled by a consultative committee representing its special subject, are a characteristic and flourishing feature of its work.

Keane contributed a number of papers on organic chemistry to the *Journal of the Chemical Society*, but his chief interests lay in applied chemistry, and he did pioneer work on electrolytic methods of analysis and the analysis of gases. He wrote a book on "Modern Organic Chemistry", intended for readers with no special chemical training, and edited the English edition of Lunge's "Technical Methods of Chemical Analysis", which was completed in 1914 and was followed by a revised edition on which he was engaged almost to the time of his death. He was an active member of the various societies associated with chemistry, and acted as chairman of the London Section of the Society of Chemical Industry in 1917–19, a position in which his sound common sense and business acumen proved of great value.

Keane retired from his post at the Cass in 1926 after a period of ill-health culminating in a serious operation, and spent the remaining five years of his life at his country home near Canterbury, actively engaged in local affairs. A man of wide interests and culture, and a charming companion, his loss will be severely felt.

A. H.

Prof. Fritz Foerster.

We regret to record the death on Sept. 14 of Prof. Fritz Foerster, Director of the Laboratory of Inorganic Chemistry of the Technische Hochschule, Dresden, and we are indebted to the *Chemiker-Zeitung* for Oct. 7 for details of his career.

Born in 1866 at Grünberg in Silesia, Foerster proceeded in due course to the University of Berlin, where he studied under A. W. von Hofmann. After graduation he became assistant to Mylius at the Physikalisch-Technische Reichsanstalt, and in 1894 he joined the staff of the Technische Hochschule in Charlottenburg, but in the following year he accepted a post as lecturer under Walter Hempel at the Hochschule in Dresden, where in 1900 he was appointed to the new chair of electrochemistry and physical chemistry. In 1905 a new laboratory of electrochemistry was established under his direction, and in 1912, on the retirement of Hempel, Foerster was elected to the chair of inorganic and technical chemistry. After the War he applied himself to the task of rebuilding the Chemical Institute, which was ready for occupation in 1925.

Foerster's experimental work lay chiefly in the field of electrochemistry, the bulk of his original papers being published in the *Zeitschrift für Elektrochemie*. The problems which he investigated cover a very wide field, and include the electrolysis of alkali chlorides and the salts of the halogen oxy-acids, as well as electro-analytical methods and technical applications. During the last twelve years he was particularly concerned with an investigation of the chemistry of the oxy-acids of sulphur and the electrolytic reduction of compounds of polyvalent metals. His well-known handbook "Elektrochemie wässeriger Lösungen" (1905) is recognised as a standard work on the subject. In 1923 he began to remodel the whole work, and the first volume was approaching completion at the time of his death.

News and Views.

THE Pedler Lecture of the British Science Guild was delivered to the University of Durham Philosophical Society at Armstrong College on Oct. 21 by Prof. J. Irvine Masson, who took as his subject "Problems in the National Teaching of Science". Reviewing, on a national scale, education in pure science, as it is carried on at our universities and in schools, Dr. Masson asked if the pendulum has overswung. Are we teaching too much science or teaching science too much ? To those who are going to be lifelong scientific workers we have to, and do, give an intensive training ; but every science is now swelling so quickly that it can no longer be confined within the three-year limit of the undergraduate course. Two more years are needed and are actually expected of a young man before he is eligible for a first post as a practising scientific worker. This needs universal recognition. Prof. Masson is of opinion that we are trying to teach too much and too specially to those who are not going to be professional scientific workers. The figures for the whole country show a great preponderance of 'honours' over 'pass' students, and a great many of these honours specialists do not go on with further training in their science, but turn to school-teaching, besides other occupations.

TEACHERS carry into schools the same exclusive specialisation, and a vicious circle is created, which is helped by the higher salaries paid to school-teachers who are honours graduates. Prof. Masson thinks that if this were altered, and the universities reformed their pass-degree courses, we should get much better balanced teaching in schools ; and the whole series of educational sieves through which our young people pass (or are forced) would work naturally. In the schools, especially the secondary schools, exaggerated science teaching is given on a very large scale from absurdly youthful ages, while other subjects (for example, German) are neglected. These things are as bad for the future scientific worker as they are for all other students. They can be cured by the reforms already mentioned, coupled with a change in the functions of the school certificate. In an appendix to the printed lecture, these arguments are supported by a statistical survey, which shows the trend during recent years in the choice of pursuits at the universities and schools of the realm.

DR. F. C. BENHAM, in a report on "Fluctuations in Employment in Great Britain", prepared for the recent meeting of the World Economic Congress in Amsterdam, stated that the general standard of living in Great Britain is now probably higher than before the War. A recent inquiry by the Ministry of Labour showed that weekly full-time rates of wages, for those classes of adult workpeople for which information is available, averaged between 70 and 74 per cent in December 1930 above the level of August 1914. Weekly earnings of which the wage index takes no account have increased still more, while there have been also considerable reductions in normal weekly working hours, which in effect mean that hourly rates of wages are between 90 and 100 per cent higher. The cost of living, however, is less than 60 per cent higher. Thus 'real' weekly wages are appreciably greater and hours of work are less. At the same time, the transference of income, through the machinery of public finance, from the relatively rich to the relatively poor is much greater. Yet against all this must be set the large numbers of unemployed, which tend to bring down average 'real' yearly earnings. During the past twenty years, methods of production have improved, technical efficiency has increased, and the productive capacity of the world appears greater than ever before. Undoubtedly a marked increase of economic welfare would take place if only the vast number of unemployed could be absorbed into industry. The problem, however, is a world problem, and will only be solved by intelligent co-operation between the various nations.

THE Annual Report of the Director of the Meteorological Office for the year ending March 31, 1931, which has just been published by H.M. Stationery Office, describes the principal activities of our national meteorological institution's seventy-sixth year. It records a steady all-round increase in the application of theoretical meteorology to the practical affairs of everyday life, shown by an always growing number of applications for expert advice in matters connected with climate and weather, in each of the various sections into which the Office is divided. We learn that in addition to activities of this kind, much of the time of the staff was devoted to carrying out decisions made at three important conferences held in 1929, namely, the International Conference on Safety of Life at Sea, the Conference of Empire Meteorologists, and the International Conference of Directors of Meteorological Services. Among the changes involved are those relating to the interchange of weather reports by wireless on land and at sea. Owing to the increasing amount of interference between the wireless issues on land of different countries consequent on expansion of programmes arising from the needs of growing aviation services, it was found necessary to arrange for fewer, but more comprehensive, wireless messages. These are issued by powerful stations in the United States, Great Britain, France, Germany, and Russia. The exchange of wireless weather reports at sea has been comparatively little affected. The increasing responsibilities of official meteorology have been met to a large extent by frequent revision of methods of work with the object of making the most efficient use possible of the available establishment, but the creation of a few new posts was found to be unavoidable, and among these may be mentioned the appointment of an officer to take charge of special investigations into problems of atmospheric visibility connected with aviation, naval operations, and lighthouses.

AT a recent meeting held at Locarno, the International Meteorological Committee agreed upon the programme of meteorological, magnetic, and electrical research to be undertaken in the Arctic regions during the winter 1932–33, in accordance with the decision to organise a second 'International Polar Year' on the fiftieth anniversary of the first undertaking of this character. The scheme involves the setting up of a circumpolar chain of temporary observatories, equipped with special apparatus for the work to be done. In view of the long Arctic coast-line in Russia and Siberia, it is obvious that the co-operation of the Russian Government is particularly desirable; it is satisfactory to learn, therefore, not only that such co-operation will be forthcoming, but also that the Russian contribution is likely to be the largest made by any one country. It is unfortunate that the organisation of an enterprise such as this, which involves financial expenditure without immediate economic return, should coincide with the 'economic blizzard'; but although this has prevented some governments from assisting financially, private help has generally resulted in the necessary funds being available, and on the whole the scheme promises well. Of the many great improvements in equipment that the past fifty years have made possible, those due to the development of wireless telegraphy may be noted especially. There is a possibility that the problem of obtaining observations of pressure, temperature, and humidity at high levels in the atmosphere, in regions where the ordinary instruments sent up in registering balloons are not likely to be recovered, may be solved by an apparatus which automatically emits wireless signals when the quantities to be measured reach certain predetermined values.

THE wet nature of the recent summer in England considerably increases interest in the results of the combined harvester-thresher machine trials. Demonstrations have been given in different parts of the country, and information from the Institute of Agricultural Engineering at Oxford regarding the performances of the machines is given in a recent statement issued by the Ministry of Agriculture. Eleven machines in all were used, one of which for the first time is owned by a contractor, while nine belong to private farmers. About 1500 acres of cereals was cut, most of which was barley, the superiority of the combine over ordinary methods of harvesting being particularly marked with this crop. Good malting samples, fetching prices of 45*s*.–50*s*. per quarter, have been obtained where, owing to the wet season, the crop would have been seriously damaged if exposed in stooks in the normal way. The additional use of a drying machine is not essential, but as it allows of starting harvesting operations much sooner after rain, the advantages may be considerable. The best day's work was done by a caterpillar combine used by Mr. G. H. Nevile of Wellingore, Lincs, and consisted of cutting 14 acres of oats, yielding altogether 144 sacks. The question of straw remains a problem, as the present type of combine, designed to suit American conditions, is unable to deal with a crop more than 3 ft. in length. Messrs. Clayton and Shuttleworth have, however, now produced a British machine which seems able to overcome this difficulty. As an alternative, in districts where the straw is very long and of sufficient value, a binder may be used in conjunction with the harvester-thresher, or shorter straw can be gathered with a hay-loader and put in a rick or baled in the field. Apart from these minor difficulties, it is evident from this year's experience that combine machines are a thoroughly practical proposition for use in England, and that they are of particular benefit to the barley grower in wet seasons.

A MEETING of the administrative council of the Empire Cotton Growing Corporation was held in Manchester on Oct. 21, and the Right Hon. the Earl of Derby, president, presented the quarterly Report of the Executive Committee. One important point in the Report is that the Committee has decided to recommend that each experimental station should only be required to produce a full report every third year. Thus each annual volume would contain four full reports, while the remaining eight stations would produce summaries only of the work of the last season. The stations would thus produce their full reports in rotation. The Committee recommends that stations from which summaries only are required should, nevertheless, take care to include in those summaries, or in a separate note if desired, any observations or results that may be of immediate use to co-workers. Lord Derby remarked that the finances of the Imperial College of Tropical Agriculture are a source of anxiety to the governing body of the Empire Cotton Growing Corporation, owing to a reduction made by the Empire Marketing Board in the grant and the possibility of a diminution in the amount of the sums receivable from overseas contributors. The Corporation takes the greatest interest in the work of the College, which has led to great improvement in the standard of the agricultural officers in the Colonial service. Any curtailment of the activities of the College or impairment of its efficiency would be a real calamity.

IN the Report are references to administrative changes and work at the various experimental stations. Before the Research Committee, Dr. Harland reported on the work of the Genetics Department, and gave a résumé of what had been accomplished during the first five years since the Research Station at Trinidad was established. The climate has provided no obstacle to progress which it was not possible to overcome, but it has been found necessary to adapt the technique of the work to meet difficulties that have arisen. Various insect pests have, however, proved rather a limiting factor, and for this reason Dr. Harland is extremely glad that the Corporation has reopened the Experiment Station in St. Vincent, where the obstacles to cotton growing are less formidable. At the same meeting, Sir James Currie, Director of the Corporation, reported certain matters which had arisen since the Report was drafted. In the Sudan this season, the crop has so far suffered much less from disease than last year, and it is hoped that satisfactory yields will be obtained. In the rainfall districts, it is interesting to note that the variety tests with American cotton have indicated that the Corporation's U.4 strain from Barberton has yielded better than all other varieties, both in Mongalla and in the Nuba Mountains. Its quality, moreover, appears to be satisfactory.

CAPT. J. M. DONALDSON in his presidential address to the Institution of Electrical Engineers on Oct. 22 dealt mainly with the work being done by the large electric power companies, which are out of touch with the national network of power lines now being rapidly erected round Great Britain. In London, the London Power Company has been carrying out in a quiet and unostentatious manner a remarkable work of unification and consolidation. The company controls and has linked up the power stations at Deptford, Bow, Grove Road, and Willesden, and the large Battersea station now being erected will form part of the group. Last year its output was 819 millions of units, and the maximum demand at any one time was 283,400 kilowatts. Another group consists of the County of London and City of London companies. The main power station of this group is at Barking, where plant producing 240,000 kilowatts is installed. At the present time this is the largest power station in Great Britain. A further extension of 150,000 kilowatts has been authorised. A large fraction of the output is sold outside London. The possibility of linking up the large private companies was considered, but it is very doubtful if the companies would have been willing to agree to this some years ago when the national scheme was first introduced. The dwellers in the country are well aware of the low prices of electricity which are charged in many towns. They naturally think, therefore, that the much higher price they have to pay is inequitable. This is not the case, for the cost of supplying electricity in the rural areas depends more on the density of the population than on other considerations. In technical language, it depends on the revenue per mile of the supply main.

IN a paper on radio research in the British Empire read by R. A. Watson Watt and O. F. Brown to the British Association on Sept. 28, an account was given of the collaboration between the home and dominion boards of radio research. The study of atmospherics has proved that in order to make real advances in our knowledge, the observing network must be spread over the whole surface of the globe. This problem is of vital importance to the radio engineer. Attenuation and fading may reduce the received intensities, but it is easy to compensate for them by gain control at the receiver. With atmospherics, however, the compensation can only be usefully carried to the point at which the noise level due to atmospherics, to artificially generated disturbance, or to internal set noise becomes comparable with the signal. Set noise can be mitigated, artificial disturbance avoided, but an irreducible minimum of atmospheric disturbance must be accepted along with the desired signal. The Radio Research Board, therefore, does not deal with the elimination of atmospherics but with their nature and origin. On the radio communications side the Board has made its contribution to the demonstration of the limits of atmospheric mitigation. On the geophysical side it is still exploring the possibilities of utilising atmospheric observations in practical meteorology. It is now proved that the interesting phenomena of reflection from the Kennelly-Heaviside layer are related to the terrestrial magnetic field. It will therefore be of great interest to compare the data obtained from observations made in the northern and southern hemispheres.

HIS MAJESTY THE KING has graciously placed on loan in the Department of Botany of the British Museum (Natural History) a collection of plants presented to him by the University of Buenos Aires. The collection contains 302 named plants, which are of great scientific and historical interest, as they were gathered during the Delimitation Expedition (1902–3) under Sir Thomas H. Holdich, the Royal delegate appointed by Edward VII. on the request of the presidents of Argentina and Chile to determine the Patagonian Argentine-Chile frontier. The University of Buenos Aires charged certain members attached to the Arbitration Commission with the making of a systematic botanical survey of the difficult areas. The dried specimens were divided into three lots—one was retained at Buenos Aires, another was presented to the Valparaiso Museum, and the third was preserved until an opportunity arose of delivering " with the homage of Argentina to His Britannic Majesty this historical material collected in the fulfilment of the judgment which re-established peace and harmony between the sister nations." The collection was entrusted to Lord Moynihan on his recent visit to Buenos Aires. It is accompanied by two volumes of collotype reproductions, one containing unpublished letters of A. von Humboldt, the other the botanical journal of his pupil, A. J. A. Bonpland. The Department of Botany has also been presented with a collection of 446 Angolan plants by Mr. J. Gossweiler, well known for his botanical exploration in Angola. Mr. J. J. Joicey has added to his previous benefactions to the Department of Entomology of the Museum by presenting the whole of his Indo-Australian Noctuidæ, the Geometridæ other than the African species, the Ægeriidæ (Clearwings), and the types of many species belonging to several other families. Recent acquisitions by the Department of Mineralogy include one of the many masses of meteoric iron found in June 1931 around the large meteorite craters near the Henbury cattle station, Finke River Central Australia, presented by Prof. Kerr Grant.

IN *Engineering* of Oct. 16 is an illustrated account, by Mr. A. E. Williams, of the coco-nut oil industry, with descriptions of the machinery in use. There are approximately 7,000,000 acres of coco-nut palms under cultivation, of which area more than one-half is in the British Empire. The chief botanical specimen cultivated is *Cocos nucifera.* Some seven or eight years elapse between the planting of the palms and the time they bear fruit, while the fruiting period is from sixty to seventy years. Each tree yields annually from eighty to ninety nuts. Of the nuts, the dried kernel, called copra, is used for its oil, the husk can be spun into coarse yarn, while the shell is used for fuel or for the manufacture of charcoal. The essential parts of a modern plant for obtaining coco-nut oil include drying furnaces for the copra, grinding mills for reducing the copra to meal, and hydraulic presses for expelling the oil from the meal. Before being pressed, the copra meal is heated in steam-heated kettles, and by this means it is possible to reduce the oil content from 70 to 6 per cent. The residual meal is valued as a cattle foodstuff. Coco-nut oil represents about twelve per cent of the total oils and fats used in soap manufacture in Great Britain and about twenty per cent in America, while it represents about fifty per cent of the total margarine made in America and about thirty-five per cent made in Great Britain. It is also used in chocolate and toffee manufacture.

THE Government of India has authorised the issue by the Zoological Survey of India of a third serial, additional to the *Records of the Indian Museum* and the *Memoirs of the Indian Museum.* Since the appointment of Dr. B. S. Guha as anthropologist to the Zoological Survey, provisionally for a period of two years in 1927 and permanently as from 1929, a considerable amount of research work in anthropology has been and is being carried out; while it is hoped that from time to time reports will be available for publication dealing with research on the population, both past and present, of India. Up to the present the *Memoirs* and *Records* have dealt solely with zoological subjects, with one exception, a paper by the late Dr. Nelson Annandale. In order to avoid a change in the character of these publications, it has been decided to inaugurate a new series of *Anthropological Bulletins,* with the first of which, a report on the human relics recovered by the Naga Hills (Burma) Expedition, we deal elsewhere (p. 762).

THE Report of the Irish Radium Committee for 1930 in *Sci. Proc. Roy. Dublin Soc.*, vol. 20 (N.S.), No. 10, p. 99 (also separate issue), states that the generosity of members of the Royal Dublin Society and of the general public enabled an additional amount of 496 mgm. of radium to be purchased, bringing the total quantity available up to 907 mgm. From the several medical reports included, it is evident that rodent ulcers and skin cancers react most favourably to radium treatment, with a cure in some 80-90 per cent of the cases. Cancer of the tongue, when not too extensive, and of the uterine cervix, yield 40-60 per cent of cures. Cancers of the breast, rectum, and other regions are seldom cured, though now and then a striking result is obtained. It has to be remembered, however, that most of these cases are too advanced for successful operation. Certain non-malignant conditions, such as uterine hæmorrhage, also react favourably to radium treatment.

IN NATURE for Sept. 12, p. 440, reference was made to the obscurity that prevails as regards the function of the forceps of the common earwig. We have since received letters from Mr. M. H. Lapidge, of Hampton Wick, and Dr. van der Sleen, of Haarlem, concerning this subject. Both correspondents mention having personally observed these insects to use their forceps in manipulating their wings. Mr. Lapidge states that he has several times seen earwigs use their forceps to fold up their wings beneath the tegmina. Dr. van der Sleen, on the other hand, remarks that he has observed these insects using their forceps for opening their wings. While it seems certain that one of the functions of the forceps is in connexion with the manipulation of delicate and complexly folded wings, their main use can scarcely be regarded as having been definitely settled.

THE monthly journal *Mikrokosmos* with the October issue commences its twenty-fifth annual volume. *Mikrokosmos* aims at extending knowledge of microscopy, and publishes papers on current topics and progress in all branches of microscopy. In the present number, Prof. W. J. Schmidt reviews the progress of histology during the last twenty-five years, Dr. H. Dohrer describes the infection of flies with the fungus *Empusa muscæ*, Dr. Karl Berger writes on the early 'flea' magnifiers, and Dr. G. Venzmer describes what tropical medicine owes to microscopy. Other articles deal with microscopy in schools and with laboratory technique. The journal is well produced on good paper, so that photomicrographs, of which there are several, are adequately reproduced. *Mikrokosmos* is edited by Dr. G. Stehli and published by Franckh'sche Verlagshandlung, Stuttgart, at 2·40 gold marks a quarter.

THE Council of the Institution of Chemical Engineers has appointed Mr. H. W. Cremer to be honorary secretary of the Institution in succession to the late Prof. J. W. Hinchley.

ON the occasion of the opening of the new laboratory of physical chemistry at the University of Freiburg im Breisgau on Oct. 30, honorary degrees were conferred on Lord Rutherford, Prof. Manne Siegbahn, professor of general physics in the University of Uppsala, and Prof. V. M. Goldschmidt, of Göttingen.

THE Ministry of Agriculture and Fisheries has appointed Mr. J. S. L. Gilmour, Curator of the University Herbarium and Museum, Botany School, Cambridge, to be Assistant Director of the Royal Botanic Gardens, Kew. Mr. Gilmour was educated at Uppingham School and Clare College, Cambridge, where he took the Natural Sciences Tripos, Part I. and Part II., Botany.

IT is announced in *Science* for Oct. 9 that Prof. Stephen H. Langdon, professor of Assyriology at the University of Oxford, and Dr. Ludwig Diels, Director of the Botanical Garden and Museum of Berlin-Dahlem, have been elected corresponding members of the Field Museum of Natural History, Chicago, by the board of trustees, in recognition of their eminent services to the museum.

A COURSE of twelve public lectures by Prof. Lancelot Hogben, research professor of social biology in the University of London, on "Genetic Principles in Medicine and Social Science", has been arranged by the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2. The first lecture will be given on Nov. 27, and the following eleven lectures on Fridays, at 5 P.M. Admission to the whole course is free and without ticket.

At the conversazione of the Belfast Naturalists' Field Club, which was held on Oct. 20 to mark the opening of the winter session, the Club medal was awarded to Mr. S. A. Bennett, formerly science master at Campbell College, for his scientific attainments and his work with the Club from 1908 until 1926. Mr. Bennett was on the Committee of the Club from 1913 until 1926, for three periods was secretary of the botanical section, and from 1919 until 1923 was joint editor of the *Proceedings*. In 1920 he was elected president of the Club, and held that office for two years. Mr. Bennett has contributed much to the knowledge of plant distribution in Northern Ireland, and has done valuable work in local geological and anthropological problems, especially on the recently discovered prehistoric site in County Antrim.

Prof. R. H. Dastur, of the Royal Institute of Science, Bombay, and his students arranged an interesting and instructive series of experiments illustrating the life processes and the life history of plants, on Sept. 30, at the C.J. Hall, Bombay. This date was arranged so that the exhibition should fall within the week of the centenary meeting of the British Association. Amongst the numerous exhibits were an apparatus for measuring the temperature of a leaf and an apparatus showing automatic records of the air diffusing into leaves through minute pores on their surface. The research work carried on in the Botany Department of the Royal Institute on the physiology of the rice plants has yielded results of practical value, and there were exhibits of living rice plants showing those results. The exhibition was followed by a lecture, illustrated with lantern slides, on "Plant Life on the Earth", by Prof. R. H. Dastur, when the vegetations of the different parts of the globe were illustrated on the screen, mostly in their natural colours.

The Worshipful Company of Woolmen gives a silver medal each session for theses relating to wool and the processing of wool. The nomination Committee this year has recommended that two medals be granted, namely, to Miss Emma Stott, of the University of Leeds, for a thesis entitled "A Contribution to the Theory of Milling", and to Mr. Kenneth Nicholls, of the Bradford Technical College, for a thesis entitled "Sulphur Content of Wools in Relation to Processing". The Committee has also recommended that certificates of merit be awarded for the following theses: Miss Evlyn Boyd (University of Edinburgh), on "Pigmentation of the Fleece of the Sheep"; Dr. R. O. Hall (University of Leeds), on "The Ventilating Properties of Textile Materials and Fabrics"; Mr. Arthur Johnson (University of Leeds), on "The Influence of Cloth Structure on the Rate of the Milling of Fabrics"; Mr. M. Tempelhof (University of Leeds), on "Studies in the Regularity of Yarns and Slivers by a New Mechanical Tester"; Dr. A. E. Wilson (University of Leeds), on "Physico-chemical Properties of Wool"; and Mr. George Bancroft (Bradford Technical College), on "The Influence of Environment on Wool". These recommendations have now been approved by the Court of the Worshipful Company of Woolmen.

We have received from Messrs. Gallenkamp the new issue of their "Catalogue of Chemical and Industrial Laboratory Apparatus". This is a handsome volume of 1471 pages, fully illustrated, and covers the scientific equipment applicable to practically every branch of industry. In a large number of cases brief but adequate descriptions of the use of the apparatus are included, so that the catalogue is much more than a mere list of prices. It should, in fact, be most useful in the school, university, or technical laboratory. The apparatus includes physical, botanical, and general biological equipment, and there is a detailed list of chemicals. At the end of the catalogue there is a useful list of books on various branches of chemistry, biology, medicine, and industry. Messrs. Gallenkamp are to be congratulated on the completeness of their catalogue and on the production of a useful and instructive volume.

Applications are invited for the following appointments, on or before the dates mentioned:—A senior assistant in the Bacteriological Laboratory of the Public Health Department, Glasgow—The City Bacteriologist, 20 Cochrane Street, Glasgow, C.1 (Nov. 7). An assistant in electrical engineering at the Wolverhampton and Staffordshire Technical College—The Clerk to the Governors, Education Offices, North Street, Wolverhampton (Nov. 9). A secretary of the Institute of Physics and Editor of the "Journal of Scientific Instruments"—The President, Institute of Physics, 1 Lowther Gardens, S.W.7 (Nov. 20). A secretary of the Welsh National School of Medicine—D. B. Anthony, University Registry, Cathays Park, Cardiff (Nov. 21). A superintendent of Greenwich Park—The Secretary (1A), H.M. Office of Works, Storey's Gate, S.W.1 (Nov. 21). An assistant in the Art and Ethnographical Department of the Royal Scottish Museum—The Director, Royal Scottish Museum, Edinburgh (Nov. 29). An assistant lecturer in physical chemistry at the Manchester Municipal College of Technology—The Registrar, College of Technology, Manchester (Dec. 1). A principal of the Borough Road Training College for Men, Isleworth—The Secretary, British and Foreign School Society, 114 Temple Chambers, Temple Avenue, E.C.4. A teacher of workshop practice (metalwork and technical drawing) at the Sheerness Technical Institute and Junior Technical School—The Principal, Technical Institute and Junior Technical School, Sheerness. Two resident masters for engineering, metalwork, woodwork, art, at Old Swinford Hospital, Stourbridge—The Headmaster, Old Swinford Hospital, Stourbridge. A director of research and head of the Research and Standardisation Department of the Institution of Automobile Engineers—The Secretary, Research and Standardisation Committee, Institution of Automobile Engineers, Watergate House, Adelphi, W.C.2.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Crystalline Vitamin D.

Four crystalline preparations of vitamin D have recently been described[1] having approximately equal antirachitic activities (20,000-25,000 International Units per milligram) and similar absorption spectra, but differing widely in their optical rotations. It follows either that there are several substances having antirachitic activity or that none of these preparations is pure, and that the varying optical rotation is due to the presence of one or more impurities.

When we described our own preparation, to which the name 'calciferol' was provisionally applied, we could not exclude the possibility that it contained a certain amount of an inactive impurity. We have since found that when the crystalline material is heated at 180°, an inactive substance of very high dextro-rotation, 'pyrocalciferol', is formed. Since calciferol was obtained by distillation, it seemed probable that it was contaminated with pyrocalciferol, which would account for its remarkably high dextro-rotation. Evidence of the existence of isomorphous mixtures was given, moreover, by the fact that different preparations on repeated recrystallisation retained constant but different optical rotations.

The preparation of crystalline esters, the 3 : 5-dinitrobenzoates, which was reported in a paper read by one of us (R. K. C.) at the meeting of Section B of the British Association on Sept. 25, made available a new method of determining the nature of our crystalline material. Evidence had been obtained of the separation of the ester into two components, and the hypothesis was put forward that the distilled product was a mixture, or perhaps a molecular compound, of a substance with a higher antirachitic activity than any product yet obtained, and pyrocalciferol. The provisional conclusions then advanced have now been confirmed. On the basis of the biological tests so far completed, it would appear that our original preparations contained 30-50 per cent of inactive material, the dominant impurity being pyrocalciferol. Nevertheless, we think it may be justifiable to retain the name 'calciferol' for the active main constituent.

The product obtained by the action of 3 : 5-dinitrobenzoyl chloride on the crystalline material in pyridine has been separated by fractional crystallisation into two esters, each of which has been repeatedly recrystallised. *Calciferyl* 3 : 5-*dinitrobenzoate*, lemon-coloured plates, m.p. 145°-147°, $[\alpha]_{5461}^{20} + 104°$ in acetone, $[\alpha]_{5461}^{20} + 68°$ in benzene, yields on hydrolysis *calciferol*, m.p. 114·5°-117°, $[\alpha]_{5461}^{20} + 119{\cdot}5°$, $[\alpha]_{D}^{20} + 105°$ in alcohol, $[\alpha]_{5461}^{20} + 99°$, $[\alpha]_{D}^{20} + 81°$ in acetone, antirachitic activity 40,000 International Units per mgm.; the solution in alcohol has an intense absorption band with a maximum of $\epsilon = 46{\cdot}0$ at 265 mμ. *Pyrocalciferyl* 3 : 5-*dinitrobenzoate*, orange-coloured prisms, m.p. 167·5°-169·5°, $[\alpha]_{5461}^{20} + 250°$ in benzene, yields *pyrocalciferol*, m.p. 92°-94°, $[\alpha]_{5461}^{20} + 608°$, $[\alpha]_{D}^{20} + 494°$ in alcohol, showing no antirachitic activity; the solution in alcohol has an absorption band with maxima of $\epsilon = 15{\cdot}7$ at 296 mμ, 27·1 at 284 mμ, and 26·1 at 274 mμ. Both calciferol and pyrocalciferol are shown by analysis to have the same empirical formula as ergosterol.

Prof. Windaus recently suggested that our crystalline material was a mixture of his vitamin D_1 with a substance of very high rotation;[2] but calciferol, as now separated from pyrocalciferol, is evidently not identical with vitamin D_1, since the latter has a lower antirachitic activity and absorption coefficient and a higher optical rotation. Calciferol, however, resembles closely, in such physical properties as have been described, the "vitamin D_2" (m.p. 114°-115°, $[\alpha]_D + 85°$ in acetone) which Windaus mentions in an addendum to his paper as having been more recently prepared by Linsert. By the courtesy of Prof. Windaus we have seen the proof of a forthcoming paper in which the absorption coefficient of vitamin D_2 at 265 *mμ* is given, and corresponds closely with that of calciferol. The identity of the two substances however, cannot be assumed unless further experiment should show that vitamin D_2, like calciferol, has a substantially higher antirachitic activity than vitamin D_1, and not approximately the same activity, as stated. The antirachitic activity of calciferol is the highest yet recorded in known units for any preparation. Identity of calciferol with the 'substance L' of Reerink and van Wijk seems to be excluded by the great instability, lower absorption, and lower antirachitic activity of their product.

The supposition that calciferol is a direct product of the irradiation of ergosterol has been confirmed by the preparation of the 3 : 5-dinitrobenzoate directly from the undistilled, crude irradiation product. The ester and the sterol thus obtained show complete identity of properties with those from the distilled product, and the yield is such that the greater part of the antirachitic activity of the crude resin can be accounted for by the calciferol actually separated as the ester.

We much regret that Dr. Bourdillon, the leader of our team, has been prevented by illness from taking a direct part in this stage of the work.

F. A. Askew.
H. M. Bruce.
R. K. Callow.
J. St. L. Philpot.
T. A. Webster.

National Institute for Medical Research,
Hampstead, London, N.W.3,
Oct. 22.

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[1] Askew *et al.*, *Proc. Roy. Soc.*, B, **107**, 76; 1930: Angus *et al*, *ibid.*, B, **108**, 340; 1931: Reerink and van Wijk, *Biochem. J.*, **23**, 1294; 1929: **25**, 1001; 1931: Windaus, *Proc. Roy. Soc.*, B, **108**, 568; 1931: and *Liebigs Ann.*, **489**, 252; 1931.

[2] Windaus *et al.*, loc. cit.

A New Type of Magnetic Birefringence.

It is well known that salts of cerium and other rare earths exhibit in aqueous solution a Faraday effect or magnetic gyration of light in the *opposite* sense to that shown by the great majority of fluids. The phenomenon has been explained by Ladenburg, Becquerel, and others as an effect connected with the paramagnetism of the ions and their orientation by the magnetic field. The study of magnetic gyration in paramagnetic substances generally therefore possesses great interest. Incidentally, also, the question arises if, as has been suggested by Ladenburg, the paramagnetic ions are orientated by the field, whether the solutions should not exhibit magnetic *birefringence* when observed in a direction transverse to the field. Investigations made on both these points have yielded very interesting results.

A magnetic birefringence of the kind suggested by the orientation theory is definitely shown by salts of cerium, praseodymium, erbium, and yttrium in aqueous solutions, when observed in strong magnetic fields. In every case, using light in the visible region of the spectrum, the birefringence is *negative*, that is, of the same sign as that exhibited by carbon disulphide; and appears to be proportional to the concentration of the solutions. Solutions of lanthanum and gadolinium, on the other hand, fail to exhibit the effect, though gadolinium is strongly paramagnetic. The effect in dilute solutions where it is observed is of the same order of magnitude as that exhibited by organic liquids of the aliphatic class.

So far, no investigation has been made of the variations of the effect with the wave-length of the light used or with the temperature. There appears, however, to be a significant parallelism between it and magnetic gyration in each of the substances studied. The fact that gadolinium salts exhibit neither a birefringence nor any marked magnetic gyration, though they are strongly paramagnetic, seems very significant. Evidently, the question whether the magnetic moment of the ions arises from orbital motion or spin of the electrons is all-important.

It may be mentioned in passing that ferric chloride solutions free from any suspended colloidal matter exhibit a noticeable magnetic birefringence.

C. V. Raman.
S. W. Chinchalkar.

210 Bowbazar Street, Calcutta,
Sept. 14.

Multiple Ionisation and Secondary X-ray Absorption Edges.

A good verification of the existence of multiple ionisation in X-ray spectra would be to find a secondary edge, corresponding to the simultaneous transition of one K- and one L-electron. This edge will be at a considerable distance from the main edge. Since in X-ray spectra the question of multiple ionisation is of great importance, I have undertaken to search for an edge produced by sulphur answering to the above mentioned condition.

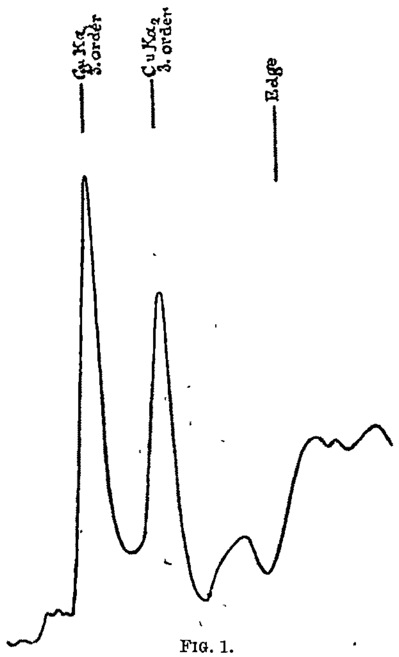

Fig. 1.

It is easy to calculate beforehand the approximate position of this edge. For sulphur the level M_{III} is incomplete. According to the selection rules,[1] a K-electron then jumps to M_{III}, but for an L-electron we have either $L_{\text{I}} \rightarrow M_{\text{III}}$ or $L_{\text{II, III}} \rightarrow M_{\text{IV}}$. However, since the three L-transitions will be difficult to separate and the difference between M_{III} and M_{IV} is small, we have only to consider the combined transition $\left\{\begin{matrix} K \rightarrow M_{\text{III}} \\ L \rightarrow M \end{matrix}\right.$. When calculating the energy of the L-transition, it should be noted that with one K-electron ejected the energy of an outer orbit should be estimated for an atom the nuclear charge of which is one unit higher than for the element considered. In the case of sulphur, we therefore use the L-energy value of chlorine. For the expected secondary edge we then find the wave-length to be 4635 X.U.; the value for the main K-edge being 5009 X.U.

Working with a Siegbahn vacuum spectrograph, the crystal being calcite, and pure sulphur as absorber, I found an edge with the wave-length 4644·0 X.U. There is a discrepancy between the observed and calculated values, the observed being 9 units larger, a discrepancy easily explained. First, the K-electron is not ejected to infinity; and secondly, the screening effect of the K-shell is not complete. Therefore the increase in nuclear charge as regards the remaining electrons is a little less than one unit. Hence the edge corresponds to an energy a little less than that calculated.

In Fig. 1 is shown a mean curve of three separate photometrical curves of one of the spectral plates. The two lines are copper $K\alpha_1$ and $K\alpha_2$ in the third order. They were used as reference lines. Between them and the new edge can be seen a region with increased blackening. Possibly another edge is to be found here, and further investigations may reveal its real nature. I also noticed an edge of this kind for the elements chlorine and calcium.

A fuller account of this investigation, now in progress, will be published in the *Zeitschrift für Physik*.

A. Sandström.

Physical Laboratory of the University,
Uppsala, Sept. 5.

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[1] M. Siegbahn, *Zeit. fur Physik*, 67, 567; 1931.

Isotope Effect in the Band Spectrum of Lithium Hydride.

In a recent paper,[1] I have analysed the band spectrum of lithium hydride. The general features of the band spectrum were somewhat different from ordinary molecular spectra, and definite edges or heads were hard to trace. Consequently, in the study of the isotope effect of lithium upon this spectrum, the vibrational isotope effect together with the rotational one have been examined in each line of the band spectrum.

The proportion of the two isotopes Li^7 and Li^6 should be about 13 : 1 from the chemical atomic weight 6·94 and Costa's values 7·012 and 6·012 for the isotope masses of lithium. Consequently, the expected isotope lines (Li^6H) should be found in the fainter lines which had not been classified in the former research.

The isotope effect is clearly established for each strong line in the spectrum due to the less abundant molecule Li^6H, the lines of which were found in their calculated positions within the error of measurement. This shows that our scheme in the numeration of the band spectrum of lithium hydride was correct.

Much experimental evidence concerning the relative abundance of the two isotopes has been offered by different workers. The results obtained by Thomson[2] and Dempster,[3] the former with the parabola method and the latter with a magnetic spectrograph and an ionisation chamber, showed that the relative proportion of the isotopes of lithium varied with the physical conditions, which are inconsistent with those obtained by Aston [4] and Bainbridge.[5]

In our optical method a definite change in the relative intensity of the isotope lines with the physical conditions has also been observed. At the initial stage of heating of the absorption tube, containing metallic lithium in a hydrogen atmosphere, lithium begins to combine with hydrogen, forming lithium hydride. In the absorption spectrum in such a condition numbers of fainter lines (those of $\mathrm{Li^6H}$) are greatly enhanced, the ratio of the two isotope lines ($\mathrm{Li^7H : Li^6H}$) being about 2 : 1. However, this value becomes larger as the vapour of lithium hydride tends to reach a stationary state up to about 8 : 1. This is in good agreement with the result of Dempster obtained by a different method and our latter value with 7·2 of Wijk and Koeveringe [6] from intensity measurements of isotope lines in the band spectrum of lithium. **Gisaburo Nakamura.**

Physical Laboratory,
Hokkaido Imperial University,
Sapporo, Sept. 5.

[1] *Zeit. für Phy.*, **59**, p. 218 ; 1930.
[2] *Phil. Mag.*, **43**, p. 857 ; 1920.
[3] *Phys. Rev.*, **18**, p. 420 ; 1921.
[4] *Phil. Mag.*, **43**, p. 420 ; 1920.
[5] *Phys. Rev.*, **37**, p. 1706 ; 1931.
[6] *Proc. Roy. Soc.*, A, **132**, p. 98 ; 1931.

Symbiotic Algæ of Corals.

In a recent contribution [1] Dr. C. M. Yonge, summarising his physiological work on corals published by the Trustees of the British Museum, took the opportunity to express his disagreement with Prof. Gardiner on the question of the significance of the symbiosis between corals and zooxanthellæ.

I am neither physiologist nor hydrologist, but it appears to me that Dr. Yonge may be basing on a false premise his argument that reef corals can get on quite well without the oxygen produced by the photosynthetic action of their zooxanthellæ. Dr. Jan Verwey, director of Den Helder Zoological Station, who has just returned to Europe after several years ecological study of corals in the East Indies, tells me that even when there is a good current flowing over a reef yet there may be a basal layer of very slowly moving water, so that a populous reef may easily suffer from a shortage of oxygen. It is, therefore, not by any means safe to assume that the movement of water round a reef always ensures a constant supply of oxygen.

Reviewing the ecological work of Vaughan, Mayer, and other Americans, the work of our own Great Barrier Reef Expedition, and that of a group of Dutch workers in the East Indies, it will be realised how rapidly our understanding of corals and coral reefs is being advanced. **A. K. Totton.**

Natural History Museum,
South Kensington, Sept. 3.

[1] Nature, 128, 309, Aug. 22, p. 309.

I have read Capt. A. K. Totton's letter and also Dr. J. Verwey's recently published paper [1] with the greatest interest. There can be little doubt that where reef corals grow in still water the oxygen produced by their zooxanthellæ may be of vital importance to them. Though here it must always be borne in mind that were not the zooxanthellæ present their place would be taken by a much more abundant phytoplankton continually producing oxygen in the water round about. But still water is seldom found (except during short periods of summer calms, and even then currents and upwelling continue) on the outer slopes of fringing and barrier reefs or of atolls, which are *the* essential areas of coral growth. In the case of the last two, indeed, which rise abruptly from deep water, there is frequently an upwelling of oxygenated water from deep waters as well as the continual agitation by the surf near the surface.

In enclosed areas, such as the Bay of Batavia, where Dr. Verwey has carried out his important work, or within atoll lagoons, the ability of corals to form reefs may well be controlled by the production of oxygen by their zooxanthellæ. But on the other hand, the vital factor even here may still be the removal of excretory products from the corals by the zooxanthellæ. It is very difficult to obtain adequate experimental proof one way or the other. For a long time during my work on the Barrier I believed that the production of oxygen by the zooxanthellæ was of vital significance to the corals, but, unable to obtain any adequate confirmation, I finally abandoned this belief. I hope to discuss the whole matter in detail in forthcoming papers in the Scientific Reports of the Great Barrier Reef Expedition.

Progress is certainly being made in the elucidation of the many biological problems connected with coral reefs, but each expedition raises almost as many problems as it, wholly or in part, solves. We are now, I think, nearing the solution of one most important problem, namely, the factors controlling the depth to which reef-building corals can live. For that reason I trust that an opportunity will soon present itself of making further progress towards the solving of this great oceanographical riddle, the key to which will probably be found in the nature of the relationship between reef-building corals and the zooxanthellæ. **C. M. Yonge.**

Marine Biological Laboratory,
Plymouth, Oct. 10.

[1] "The Depth of Coral Reefs in Relation to their Oxygen Consumption and the Penetration of Light in the Water", *Treubia*, **13**, pp. 169-198

The Comma Butterfly in England.

The Comma butterfly *Polygonia c-album* died out in the east of England early in last century but survived in the west, and of recent years has been extending its range to the east again, reaching Twickenham in 1928.

A Comma visited *Sedum spectabile* in my Chiswick garden on Sept. 21, 22, 23, and 24, 1929.[1] In October 1929 it was recorded at Surbiton in the *Times*. This year on Oct. 5, 6, and 9 this butterfly has again visited *Sedum spectabile* in my garden, a fact which suggests that the species is establishing itself in the district. As a rule every September, tortoiseshells and red admirals come freely to *Sedum spectabile* here, but in the cold, wet month we have just had, the only visitor has been this rare butterfly. **F. Sherwill Dawe.**

Ashburton, 67 High Road,
Chiswick, W.4,
Oct. 9.

[1] Nature, 124, 653, Oct. 26, 1929.

Since the publication of Dr. Dawe's letter in 1929, a good deal of evidence bearing on the spread of *Polygonia c-album* in south-eastern England has accumulated. At that time, only one definite record for Kent (in 1916) could be found ; it has now been seen in East Kent (1929) and at Sandhurst (1930). In Sussex it appears to have established itself fairly securely along the South Downs about Chichester and Arundel, and also farther east at Lewes and Eastbourne. In Surrey, from which county it had not been reported in 1929, except for one record of an occurrence at Walton-on-Thames, it has since been met with at Sutton, Farnham, and Grayshott (1930), and at Mickleham (1931). In what might be termed the London district itself, in addition to Dr. Dawe's record, it was seen at Surbiton again, at Hounslow, West Wickham, and Gravesend in 1930, and even, as reported in the *Times* of Oct. 10, at Kensington in 1931. From the repeated occurrence of the butterfly on the western outskirts of London, one is forced to the happy conclusion that this attractive species must really have established itself somewhere in that neighbourhood, in many parts of which indeed its food plant, hop, grows fairly freely, more or less as a weed.

N. D. RILEY.

British Museum (Natural History),
South Kensington, S.W.7,
Oct. 12.

Change of the Dielectric Constant of Carbon Disulphide with Temperature.

H. ISNARDI [1] has found that the dielectric constant of liquid carbon disulphide increases linearly with the lowering of temperature, up to a maximum at - 90°, and then decreases also linearly with further lowering of temperature. This author has not, however, made a sufficiently careful study on the neighbourhood of the congelation point. His data do not permit us, therefore, to draw inferences as to the behaviour of the dielectric constant of carbon disulphide at its freezing point (- 112°).

On the basis of analogy with ethyl ether, I have supposed that at - 112° there appears a jump in the value of the dielectric constant of carbon disulphide independently of the maximum at - 90°. To check this supposition, I have made a study of the dielectric constant of carbon disulphide, using a method depending on the beats of two high frequency oscillation circuits, as described by M. Wolfke and W. K. Keesom.[2]

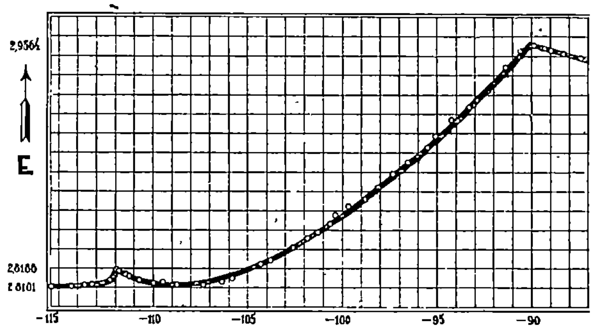

FIG. 1.

It appears that the value of the dielectric constant of carefully chemically purified carbon disulphide increases from 2·630 at 20° C. up to 2·936 at - 90° (maximum), and then decreases, to jump again at - 112°.

The accompanying curve (Fig. 1) represents these changes of the value. It can be seen that the dielectric constant of carbon disulphide behaves similarly to that of ethyl ether.[3]

J. MAZUR.

Physical Laboratory,
Technical Institute, Warsaw,
Sept. 22.

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[1] *Zeit. für Phys.*, 9, 153 ; 1922.

[2] *Comm. Leiden*, 190a.

[3] NATURE, 126, 649, Oct 26, 1930 ; and *Comptes-rendus* des Séances de la Soc. Polon de Physique, 5, 181 ; 1931.

Cosmic Evolution and Earthly Needs.

I IMAGINE that no journal has ever published even an approach to so wonderful a supplement as that to NATURE of Oct. 24 on "The Evolution of the Universe". The transcendental discussion reported is the more remarkable, as it is held at a time when ordinary folk are beginning to think that there may be difficulty in living much longer, in passable comfort, upon the pimple we are privileged to inhabit and are doing so much to spoil. From beginning to end, however, the British Association proceedings were Neroic: little effort was made by anyone to pay serious attention to our present earthly situation or to consider how we are to get out of the muddle 'science' has created. Pity 'tis that Sir Arthur Eddington did not "'eave 'is 'arf a brick" to this end. A century of science seems to have brought us to a wonderful understanding of things that do not matter, whilst 'larning us' little that will help to fill our bellies and suffer one another with equanimity, let alone gladly and with Christian amity.

The essays are not for the likes o' me to understand. Still, as a chemist, I should like Prof. Millikan to loan me a volt or two out of his visionary 25,000,000. He speaks of an atom-building act of this energy-order "that is more fundamental than all others and must take place more often than all others, . . . namely, the formation of helium out of hydrogen, because we have abundant evidence that all the elements are actually built out of hydrogen and helium", and so on. What is here meant by hydrogen? What is the process pictured? Have we such evidence? Physicists will use our words, unfortunately, in their own ways: as for example, *ion*, which is now used in so many ways that it means 'what you please', apparently. Whatever cosmic hydrogen may do in cosmic space, no laboratory hydrogen that we know gives helium, even in the Langmuir blowpipe.

While on words, may I take formal objection to my friend Dr. Aston's continued use of the term *constitution* when he means the *composition* of the mushes we still term elements. Constitution is used by the chemist only as implying structure in uniform materials.

HENRY E. ARMSTRONG.

Chemical Nature of the Tigroid.

THE chemical nature of the tigroid (Nissl's granules) of nervous cells is still unknown. On morphological grounds they are generally supposed to be related to the nucleus.

The brains of freshly killed guinea-pigs were fixed in alcohol, embedded in paraffin, and dissected. If stained with toluidine blue, the cells showed an abundance of tigroid. If, however, before staining, the slides were digested for thirty minutes with saliva, the cells no longer showed such granulation. This strongly suggests that the tigroid is a reserve polysaccharide of the nervous cells, similar to glycogen, but not identical with the latter, since it does not stain with iodine. This would be in good agreement with the disappearance of the granules after strong functional activity of the nervous system.

A more detailed report will appear in the *Acta* of the Hungarian Biological Research Station, Tihany.

A. SZENT-GYÖRGYI.

Biochemical Department,
University Szeged, Hungary,
Sept. 26.

Research Items.

Human Skulls and Bones from the Naga Hills.—The skulls and bones which are the subject of a report by Dr. B. S. Guha, anthropologist of the Zoological Survey of India, and Mr. P. C. Basu, published as the first *Anthropological Bulletin of the Zoological Survey of India*, were surrendered in 1926–27 to the expedition of the Burmese Frontier Service for the abolition of slavery and the suppression of human sacrifice among Naga tribes living in the unadministered area of Burma. The skulls and bones are those of human sacrificial victims from 41 out of the 70 villages in the Triangle which are under the influence of two Kachin families, the Ningmoi and the Shingbwiyang. Little information was available as to the tribe or place of origin of the victims, as they had passed through many hands and villages before reaching their destination. They would seem to have been forwarded from the south-west and west by middlemen engaged in the traffic. Though they probably belong to the head-hunting Naga tribes of south-west and west of the Triangle in the main, foreigners may have been included. At least one Assamese was sacrificed. Some of the heads had been smoked in accordance with custom, and each of the bones, some with flesh and shreds of skin still adhering, had been pierced by one or more holes for suspension. Some of the smaller bones were bound in lots. In one case a piece of skull and portion of radius were covered with leaves and bound to a bamboo which had two strings for suspension. The total number of bones was 217, of which 21 were whole, or portions of, arm and leg bones, and 117 and 43 were frontal and occipital bones respectively. The skulls and bones have been examined and measured exhaustively, the measurements being given in detail. The skulls fall into two classes, of which the first is markedly Mongolian, while the second in addition shows characteristics of the Australoid type.

Balun Bidai.—In the *Journal of the Federated Malay States Museums*, vol. 15, pt. 2, Mr. Ivor H. N. Evans records some information relating to a mythical aquatic animal, which will be of interest to students of folk-lore on account of analogous beliefs recorded from other parts of the world and from other times. While engaged in excavation work near Kuala Nyong, on the Timbeling River, Pahang, he was informed by his coolies of a curious mythical animal, known as Balun Bidai, which is supposed to live in a deep pool in the Timbeling. The word *balun* in the Malay language has the secondary meaning ‘ to roll as a mat or a cigarette ’. Further inquiry elicited the information that this mythical animal is also said to exist at Lahar Jintang, near Kuala Kitil, where it is known as Gulong Bidai. As *balun* and *gulong* are synonyms, the meaning in both cases is ‘ the enveloping chick ’ (native venetian blind), corresponding with the creature's reported habits. The Pahang Malays say that Balun Bidai is rectangular like a mat, with a mouth at each corner, and is ginger coloured. It used to attack boats on the river, wrapping itself around them. It lives in deep pools in rivers and brings up great masses of rubbish “ as big as a house ”, which are said to be quite dry when brought up. None of the coolies claimed to have seen it but one had seen the masses of rubbish. One of the animals is said to live at a village in Lower Perak called Balun Bidai, not far above Kuala Kinta. At Batu Kurau, Larut, Perak, Gulong Bidai kills men by enveloping them and sucking their blood, though leaving no wound.

Birds of the Galapagos Islands.—In 1905–6 an expedition was made on behalf of the California Academy of Sciences to study and collect the fauna and flora of these islands. The report on the bird collections by Harry S. Swarth is a memoir of ecological as well as taxonomic importance (*Occ. Papers Calif. Acad. Sci.*, **18**, 1931). There are 108 species and subspecies of birds in the Galapagos list. Eighty-nine are breeding and resident upon the islands, and of these the very large proportion of 77 are peculiar to the islands. The author supports the view that when the bird fauna arrived, Galapagos was already an island group, for although the birds which show clear affinities point unmistakably to American relationships, the islands are remarkably destitute of the highly characteristic bird life of the adjacent coast of South America. A very great amount of variation, however, has taken place since the islands were colonised by birds, and although the variations exhibit many extremes, intergradations between the extremes can always be traced, but not always between geographically adjacent forms. The extraordinary variants that crop up in many of the series, for example in the bill structure of *Geospiza fortis* and *fuliginosa*, give an impression of a process of change and experiment still going on. Here, in the very islands that aroused his mind to the possibility of evolution, appear to be the “ numerous transitional forms ” and the confusion in Nature, which Charles Darwin expected and looked for in vain.

Food of Australian Aborigines.—That a primitive people like the Australian aborigines should be skilled in Nature lore is not surprising, but the variety of methods they have devised in capturing food animals is a striking feature brought out in C. Daley's account of the “ Food of the Australian Aborigines ” in the *Victorian Naturalist* (June 1931). Kangaroos were captured by stalking, by tracking to exhaustion, by pitfalls, or by driving into corral-like enclosures. Wombats were smoked in their burrows ; emus were stalked, netted or run down by dogs; smaller birds were lured, or snared or captured with large nets, in the case of water-fowl up to 60 yards long. Crocodiles were taken with a slip-noose or speared, as were tortoises, turtles and dugongs. Fishes were trapped with a great variety of apparatus, or speared at night with torches, after the manner of our own salmon ‘ leistering ’, or they were impounded in artificial weirs or stone dams. The honey stores of wild bees were discovered by marking a bee by attaching a piece of white down to it, and tracing its flight home, and so on. The above gives some notion of the variety of food used by the aborigines, but a more vivid picture is contained in Major Mitchell's account of the contents of a ‘ lubra ’ or plaited bag of almost a hundred years ago : “ three snakes, three rats, about 2 lb. of small fish like whitebait, crayfish, and a quantity of the small root, tao, usually growing on the plains with a bright yellow flower, *Microseris Forsteri* ”. Nothing seems to come amiss, for, particularly in Queensland, clay from the outside of ‘ ant-hills ’, or kaolin, is freed from grit, made into a smooth stiff paste, dried, wrapped up, subjected to heat, and is much appreciated as an article of food.

Anal Gland of *Squilla*.—T. Komai and Y. M. Tung have examined the anal gland of *Squilla* (*Mem. Coll. Sci.*, Kyoto Imp. Univ. Ser. B, vol. 6, No. 1, 1931), which consists of two pairs, an anterior and a posterior, of small sacs communicating with the posterior end of the mesenteron by short ducts. The cells which compose the wall of each sac are secretory. The cells of the anterior sac are vacuolated, and in the lumen is either a number of secretory spherules or more usually a single concretion, formed of concentric layers, which is eventually passed out by the duct into the gut and so to the exterior. In the posterior sac the secretory substance is liberated as a vacuole constricted off from the distal part of each cell and no concretion is formed in this sac. The authors regard the sacs as carrying out the excretion of waste products in the posterior region of the body, acting as auxiliaries to the maxillary glands which are the primary excretory organs. In *Squilla* the proctodæum, which forms the rectum, is short—1·2 mm. in length. Details of the anatomy of the heart and the distribution of the arteries of *Squilla* are also given.

The Gondwana System.—A most important and interesting contribution to the geology of Gondwanaland has been written by Dr. C. S. Fox and published as *Mem. Geol. Surv. India*, vol. 58, 1931, pp. 241. It includes a summary of all the available information on the Gondwana System. This ' system ' represents more than a geological period; its formations cover a time interval from the Upper Carboniferous to the Lower Cretaceous, and thus represent an *era* which cuts across the division between Palæozoic and Mesozoic. The general classification now adopted in India consists of two chief subdivisions: Lower Gondwana (Talchir, Damuda, and Panchet) and Upper Gondwana (Mahadeva to Jabalpur), but the break occurs, not between the Permian and Triassic, but in the middle of the Triassic, when there was a cessation of effective sedimentation owing to widespread land conditions. Weighty evidence is presented to justify the abandonment of the tripartite classification formerly widely accepted. The climatic changes of Lower Gondwana times can be traced from the ice wastes of the Talchir epoch, through the damp, temperate conditions of the Damuda period, to the hot arid climate of the Panchet age. Following the regional uplift that marks the break, there was a return to humid conditions in Upper Gondwana time. The lake-waters of Central India found their way to the sea that was established during the Jurassic over the site of the Bay of Bengal, and later, especially in the Cretaceous, to the sea that extended from the west to Kathiawar. The valleys that then were formed were filled to overflowing with the lavas of the Deccan trap, and from then to the present day laterite formation, characteristic of tropical monsoon conditions, has been active. The memoir is enriched with a large correlation table, four palæogeographical maps, and a fine series of plates illustrating the plant life of Gondwanaland.

Cohesion.—The issue of the *Proceedings of the Physical Society* for Sept. 1 contains the address on " Cohesion " delivered by Prof. Lennard-Jones before the Society in May last. In it he shows how much the new wave mechanics has contributed in the last three or four years to our knowledge of atomic structure and of the interaction between atoms, in directions in which the orbital theory of the atom could provide no information. Many atoms may be pictured as globular clouds in which the density of the cloud at any point is proportional to the probability that an electron may be present in unit volume about that point. The motion of an electron in one atom tends to make an electron in a neighbouring atom move on the average in phase with the first, and this produces an attraction between the atoms inversely proportional to the seventh power of their distance apart and a slight deviation from the perfect gas law. This attraction is usually masked by the much greater one resulting from the migration of an electron from one atom to another, which in some cases is sufficient to produce the firm structure of a solid. These ' homopolar forces ' are shown to follow from the expression for the joint probability that an electron may be found in each of two specified small volumes. They are intimately connected with the spin of each electron, and the cohesion which results from them depends on whether these spins are in the same or in opposite directions. In the latter case the electrons are said to be paired, and the pairing of electrons provides for the valency rules of chemistry. (See also NATURE, vol. 128, p. 462, Sept. 12, 1931.)

The Cosmical Constant and the Wave Equation.—Sir Arthur Eddington has contributed a paper to the October issue of the *Proceedings of the Royal Society* in which he has attempted to weld together in a new way the ideas of the quantum theory and of the cosmical relativity theory. His idea is that the appropriate space-time in which the wave-equation for an electron should be considered valid is not the flat system which is ordinarily employed, but the more general and cosmically important curved space-time. So long as the former is employed, no light can be expected to be thrown on the nature of the term in the wave-equation representing the mass, but by introducing the latter the mass-term can be incorporated into the theory. The step involved is not really foreign to the ordinary ideas of quantum theory, for it is a fundamental conception in this that particles cannot be considered individually, but that their behaviour is conditioned to a greater or less extent by all other particles in the universe. The mass of an electron thus becomes an interchange energy with all the other charges in the universe suitably averaged. The mathematical development, which is indeed not very elaborate, leads, fortunately, to a prediction that can be tested experimentally from the speed of recession of the spiral nebulæ, Hubble's value of 465 km. per sec. per megaparsec being obtained to within fifteen per cent.

Ultra-Violet Spectrum of Ozone.—An investigation of the effect of temperature on the ultra-violet absorption spectrum of ozone, described by O. R. Wulf and E. H. Melvin in the second issue of the *Physical Review* for July, may be of importance in meteorology. The spectrum consists of diffuse bands on a continuous background. It has been shown that the relative intensity in the bands and background depends upon the temperature of the ozone, the contrast between the two increasing when this is reduced from 250° to $-78°$. The alteration is not large, but may, nevertheless, have a bearing on the interpretation of the changes observed in ultra-violet solar and stellar spectra, if fluctuations occur in the temperature of the ozone in the upper air. Alternatively, it may prove possible to obtain a new estimate of the temperature in the ozone layer from the appearance of the bands, and it is noteworthy that Prof. A. Fowler and Lord Rayleigh have stated that the bands are, as a whole, more diffuse in the photograph of Sirius than in the laboratory spectrum. Barring other complications, such as an effect of pressure, this could be taken to indicate that the temperature of the ozone layer was higher than that of the laboratory.

The Atomic Weight of Thallium.—A revision of the atomic weight of thallium which is in close agreement with Honigschmid's value, but markedly different from that of Crookes, is described by Prof. H. V. A. Briscoe and a number of collaborators in the October number of the *Proceedings of the Royal Society*. Crookes's work, which was published in 1873, was based on a determination of the ratio $Tl : TlNO_3$, and gave $Tl = 204·04$. This held the field until quite recently, when Hönigschmid, employing thallium halides and silver in a very concordant series of measurements, found the higher value 204·39. Prof. Briscoe, employing the ratio TlCl : Ag, has now obtained as a final result 204·34, with an average deviation of ±0·015. Apart from one point of technique—the fusing of thallium chloride in place of the process of sublimation adopted by Honigschmid—Prof. Briscoe makes no special claim for his own result in preference to that of Honigschmid, and suggests that the actual value is within one or two hundredths of a unit of 204·37. The large departure of the atomic weight from a whole number shows that it is a mixture of isotopes, a conclusion which is confirmed by Dr. F. W. Aston's announcement in Nature of Oct. 24, p. 725, that the mass-spectrum indicates two isotopes, of atomic weight 203 and 205 respectively.

New High Permeability Alloys.—Ordinary 'permalloy', the alloy of iron with 78·5 per cent of nickel, is specially suitable for direct current circuits. For A.C. circuits a higher electrical resistance is desirable to minimise eddy current losses, and in the *Bell Laboratories Record*, Sept. 1931, vol. 10, No. 1, G. W. Elmen gives an account of work done on similar alloys in which part of the iron is replaced with chromium or molybdenum. Both these elements increase the resistivity, and with 3·8 per cent peaks are obtained in the curve of initial permeability, which in the case of molybdenum actually rises above that for the original alloy. Above a flux density of about 2000, however, the plain nickel-iron alloy is the more permeable. This latter alloy also suffers from the disadvantage that in addition to an annealing treatment at about 950° C., further heat treatment at 600° C. followed by rapid cooling is necessary if the full magnetic qualities are to be developed. With some of the newer alloys the original annealing is unnecessary, and slower rates of cooling give the highest values of the permeability. It is of interest that the addition of a non-magnetic metal such as molybdenum may, in certain circumstances, render a magnetic alloy still more magnetic. For the annealed alloy, 3·8 per cent of molybdenum gives an initial permeability of 12,000, and when heat-treated in hydrogen, of 35,000, values far higher than that of ordinary 'permalloy' in the annealed state and three to four times that even of the material in the heat-treated condition. As the molybdenum content is raised, the Curie point—the temperature at which the alloy loses its magnetisability—is reduced, which is in accord with the general rule that the addition of a non-magnetic element to a ferro-magnetic one lowers the Curie temperature. It is concluded that no one such alloy is the best for all purposes, and that a range of materials will be developed each suitable for some specific electrical purpose.

Astronomical Topics.

Galactic Rotation.—Prof. P. Stroobant, Director of the Uccle Observatory, has been making a study of the radial velocities of the helium stars (types B_0 to B_7) in connexion with the problem of galactic rotation (*Bull. of Acad. Roy. de Belgique*, 1930, No. 10). His results indicate galactic longitude 141°, or 321° for the centre; the work of others leads to the selection of the second value. The centre is placed at a distance of 9250 parsecs from the sun; adopting 270 km./sec. as the sun's rotational speed, the period of rotation would be about 200 million years. The central mass required to control the motion is given as 16×10^{10} sun. The diameter of the galaxy is estimated as 23,000 parsecs. The Uccle Observatory is soon to have a new telescope with an aperture of a metre: also a new transit circle. Prof. Stroobant hopes to continue the research with the aid of these instruments.

The Variability of Betelgeux.—Sir John Herschel seems to have been the first to discover that this star was a variable. But it was not until the present century that any law was detected in its light changes. The evidence on the subject is collected and reviewed by B. W. Kukarkin in the *Bulletin of the Friends of Astronomy*, Nishni Novgorod, for June. A period somewhat less than six years is plainly shown by the curve that he gives. The observations of radial velocity at the Cape are of great use in the determination, as the change in this appears to be more regular than that in the light; but evidently both have the same period, which is given as 2070 days, or 5·67 years. The variable radial velocity is ascribed not to orbital motion but to expansion and contraction of the star. Assuming this, and taking the parallax as 0·015″ (which is the mean of the best five values), the radius of the star is found to change from 262 to 416 times that of the sun; this would make the diameter of the star change from 0·037″ to 0·058″, in fair agreement with the values given by the interferometer.

Both the radial velocity results and the light measures suggest that secondary oscillations may be superposed on the curve of principal variation, but the data are insufficient for determining them. The amplitude of the light-variation is close to 0·7 mag., but may be variable; in visual observations of brightness a comparison star at some distance has to be used, which adds to the difficulty. Aldebaran is often chosen, being of similar colour.

Quite a number of the red stars easily visible to the naked eye are variable; but comparatively few observers devote themselves to these bright objects; it is necessary in their case to use comparison stars at some distance, which adds somewhat to the difficulty. *Astr. Nach.*, No. 3817, contains a series of such observations, made at Prague by J. Mrazek and J. Plassmann.

The observations of α Herculis range from $2·73^{\mathrm{m}}$ to $3·88^{\mathrm{m}}$; those of Betelgeux (which was compared with Aldebaran) from $0·41^{\mathrm{m}}$ to $1·34^{\mathrm{m}}$; those of β Pegasi from $2·35^{\mathrm{m}}$ to $3·25^{\mathrm{m}}$. Unusually short intervals from maximum to minimum were noted in α Cassiopeiæ in 1927 and 1928; the maxima were on July 22, 1927, and July 8, 1928; the minima were 8 days and 7 days later, respectively.

Elements of the Trojan Planet Æneas.—Three new members of the Trojan group of minor planets were found in 1930. Æneas was found by Dr. Reinmuth at Königstuhl, Heidelberg, on Oct. 17, and was followed for five months at that observatory and at Yerkes by Prof. G. van Biesbroeck. C. J. Krieger has investigated its orbit, and gives the following elements in *Astr. Jour.*, 960:

Epoch 1931 Jan. 1·0 U.T.
M 97·7850°
$$\left.\begin{array}{ll}\omega & 45^\circ\ 2'\ 12·1''\\ \Omega & 246^\circ\ 31'\ 59·0''\\ i & 16^\circ\ 40'\ 32·3''\end{array}\right\}1931·0$$
e 0·100455
a 5·21903
n 297·592″

The mean position of the planet is 60° from Jupiter on the side of smaller longitude. There are now four known Trojans on this side of Jupiter and five on the other. It will be noticed that the mean distance of Æneas is practically the same as that of Jupiter; but owing to its large eccentricity its distance from Jupiter will fluctuate through about 12° on each side of the mean value.

It is curious that another Trojan planet, Anchises, was discovered on the same photographic plate as Æneas.

Modern Glasses at the Science Museum.

AN Exhibition of Modern Technical and Artistic Glasses at the Science Museum, South Kensington, to remain open until the end of the year, was formally opened on Oct. 21 by Sir Richard Gregory (see NATURE, Oct. 24, p. 697). The organisers, who represent the Society of Glass Technology and the Glass Research Delegacy of the University of Sheffield, have endeavoured in this exhibition to illustrate the more striking advances arising from scientific studies in glass technology during the past fifteen years. In doing so, it has been necessary, in view of the limitations of space, to make a selection of the subjects which are comprised within the term 'glass technology' and a further choice of material even in those subjects represented. Thus, in the main, the problems involved in the manufacture of glasses in modern times which have given rise to many important researches, such as the solution of gases in molten glasses, and the diffusion and flow of viscous liquids at high temperatures, receive no attention, and it has not been found possible to find space for exhibits illustrating researches on raw materials, on the special characteristics of refractory materials required for various manufacturing conditions, and the applications of glasses to the many types of scientific apparatus.

In general, the exhibition may be said to illustrate the relationships between the chemical composition and the physical properties of glasses, with indications of the industrial results of the researches involved. Fourteen sections are employed in classifying the subjects dealt with. Section *A* comprises a review of the most important literature on glasses (excluding works on optics and optical instruments) which has been published since 1915. In this collection are the journals of scientific bodies devoted to the study of glasses, trade technical journals, technical books, and works devoted to the historical and artistic side of glasses. Sections *B* to *E* are concerned with fundamental properties of glasses; *F* to *O* illustrate how the results of fundamental researches on the relationships between chemical composition and physical properties have been utilised in recent developments in the production of specific types of glasses, the types dealt with including coloured glasses for artistic and utilitarian purposes; optical, chemical, heat-resisting, illuminating, and electrical glasses; sheet and plate, safety or laminated, and fused silica glasses. Specimens, photographs, and numerous diagrams of data are employed to convey information to the visitor.

It is impossible to do more than refer to a few of the more interesting results of modern work. Section *B* is devoted to the nature of glass, and illustrates, amongst other matters, the study of the equilibrium diagrams of the complex systems in which glasses fall, and some pretty specimens of crystallisation from glasses are shown. The effect of heat treatment on crystal growth is set out pictorially. A whole case is also devoted to the most modern methods and results of the study of the nature of glasses by the X-ray method. Section *C* contains many interesting specimens, Roman, medieval, and modern, which have undergone weathering and decay as the result of unsuitable composition; and modern researches which have shown the way to produce very durable glasses are described and illustrated. Section *D* is devoted to certain physical properties of glasses. Particular attention is paid to modern work on the thermal expansion; and in this sub-section are shown examples of graded glass seals which enable a glass of low thermal expansion to be united to one of high expansion through intermediate joints, and of glass to metal joints. The mechanical properties of glass are illustrated, and types of fracture produced by thermal and mechanical forces are exhibited. The low thermal conductivity of glass is further reduced when drawn into a mass of fibres with intervening air spaces, and British glass 'silk', shown in various forms, is coming into widespread use for heat insulating purposes.

The most spectacular of the sections is *F*, dealing with the colouring and decolourising of glasses. The six cases devoted to this subject stand in the entrance hall of the Museum and at once arrest the eye. The first case starts with some beautiful specimens of coloured Egyptian glasses of the Eighteenth Dynasty. Below them, and extending to the second case, are numerous specimens, specially melted at the Department of Glass Technology, Sheffield, to illustrate the tremendous range of colouring materials available to the modern glassmaker. More effective illustrations of colouring than these are the specimens of artistic glasses. Three roses, with glass petals of white, pale yellow, and rich red, respectively, simulate the real flowers to a remarkable degree. Amongst the more striking colouring agents in the artistic glass exhibited are selenium (various shades) and the oxides of didymium, neodymium, and praseodymium. The utilitarian division of Section *F* includes such objects as Crookes glasses, various protecting glasses for furnace workers and welders, signal glass, and colour filters. An offshoot of this section is that devoted to illuminating glasses (*L*), where 'daylight' lamps and other objects are shown. Also in section *M* (sheet and plate glasses), reference is made to research on coloured glasses suitable for keeping away flies.

Toughened glass samples appear in Section *L*, and are referred to in Sections *E* and *J* also. The nature, methods of manufacture, and sources of defects in 'safety' or laminated glass are well set out in Section *N*. The neighbouring Section *O* (fused silica) contains a number of historical specimens, as well as others showing that many massive, as well as small, objects of fused silica are now obtainable.

Three cases are devoted to optical glasses and one to optical lens systems. One of the most important advances has been the improvement in transmission both in the ultra-violet and in the infra-red brought about by painstaking efforts to reduce the iron oxide content. A massive specimen shown contains only 55 parts of iron (as Fe) per million of glass, and it is claimed that British optical glass is now superior to any other in regard to transmission at both ends of the spectrum.

Foot-and-Mouth Disease Research.*

THE Fourth Progress Report of the Foot-and-Mouth Disease Research Committee, just issued, is a record of extremely interesting observations and experiments. We agree with the Committee when it says that "the knowledge of foot-and-mouth disease and the conditions which promote the infection and the means of its prevention have been materially advanced by work in many parts of the world, and that the researchers in this country have taken their fair share in furthering that progress". It is true that we have still no very clear vision of the time when scientific methods of prevention and spread are to be substituted for slaughter. The causal virus is familiar and the disease can be produced experimentally with it. Further, it has been clearly demonstrated that with this virus, weakened in various ways, immunity against the disease can be produced. This immunity, however, does not seem to last very long, and until the virus can be grown on artificial media, sufficient of it cannot be obtained to do a very large series of immunisation experiments. The work of Prof. and Mrs. Maitland in Manchester gives us hope of culture, for they have shown quite conclusively that multiplication of the virus will take place in the presence of living embryo tissue of guinea-pigs. This is a decided advance.

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* Ministry of Agriculture and Fisheries. Fourth Progress Report of the Foot-and-Mouth Disease Research Committee. Pp. 375+12 plates. (London: H.M. Stationery Office, 1931.) 7*s*. 6*d*. net.

Further evidence is given in the Report of the different types of the virus, but the most encouraging fact in relation to treatment, especially serological treatment, is that 92 per cent of the strains obtained from outbreaks in Great Britain belong to the *O* type. If, therefore, we were able to obtain an anti-virus of this type, we could deal hopefully with almost all the cases that occur.

Much valuable information has been collected on the survival of the virus in sewage, in milk, in carcases after storage at different temperatures, and of its resistance to pickling, etc. In administrative work these results should prove of great importance. Again, the infection of rabbits, hedgehogs, and rats opens up a suggestive field for investigation of the method of spread. In 1924, I reported to the Committee the results of experiments by myself and colleagues which showed that rats could be infected with the disease, confirmed this by further reports in 1928, and suggested that the rat, by its migratory habits, might be a carrier. The infection in rats has now been fully confirmed by the Committee, and in a note on the origin of fresh outbreaks it is stated that "the discovery of very inconspicuous signs of the disease in rats must increase the care with which symptoms of infection in these animals are sought, and add fresh importance to the warfare waged against these animals". To the farmer and dairyman this possible carriage is of the utmost importance.

The whole Report is full of interest, and the scientific workers under the Committee are to be congratulated. All their work is leading to the goal of prevention. J. M. BEATTIE.

Cotton Growing in Egypt.

DR. W. L. BALLS and his assistants in the Botanical Section of the Egyptian Ministry of Agriculture have published within recent years two bulletins on the "Operation of the Seed Control Law upon the Pedigree of Cotton Seed".* The first is a survey of the effect of the control during the first two years, and the second includes the first and extends the period to four growing years from 1926 until 1930. Egypt supplies the bulk of cotton for the fine spinning industry, in which quality is of great importance, and competition with lustrous fabrics made from synthetic fibres is making the use of good quality cotton more and more essential.

It would appear that the maintenance of the purity of good strain cottons is desirable for both the farmer in Egypt and the spinner in England, and that little difficulty should be met in operating a law designed to help in securing plentiful supplies of high quality pedigree stocks. Unfortunately, the tests applied by the botanical staff show that as the law becomes better known, methods of evasion are discovered and practised. Cotton seed is used both for growing and crushing, and it is this dual purpose which leads to malpractices. The law has improved commercial stocks with commendable rapidity, and the method of evaluating the improvement, and incidentally of detecting evasions, is surprisingly simple. There exists in Egypt a low quality cotton, known as Hindi, which is very easily recognised when growing and also in seed form. The percentage of Hindi seed has been found to be a very good index of the amount of contamination in seed stocks. A simple count is all that is required, and the method of plotting these counts shows very vividly how the law is operating.

The curves in these publications are so easily interpreted that it is possible to obtain from them the maximum allowable Hindi-content from year to year, although the legal limit has been reduced yearly to a very low percentage. There can be little doubt that deliberate adjustment of the Hindi-content to fall with the legal limit is being practised, but if mixing could be kept within the limit the purpose of the law would be fulfilled. There are many cases where the Hindi-content is well above the limit, and the system of analysis employed is searching enough to locate the law-breakers with scientific if not legal conviction. It seems that the offenders can only be made to mend their ways if the penalties for evasion are as carefully regulated as the system of diagnosing the culprits. While the Hindi-content is a simple and reliable index of either careless or deliberate lowering of the standard of purity of the seed stocks, it is not a true index of the purity of the cotton types, as natural crossing and other deteriorating influences are unavoidable in large scale cultivation.

The botanical staff clearly recognises that the most effective way of cleaning commercial stocks is by renewal of seed from clean stocks, and the methods adopted to achieve this are given in a bulletin entitled "Developments of the Existing System for Seed Supply of Cotton in Egypt".* Perhaps the most interesting technical item in this publication is the use of large cages of high light-transparency made of fine 'staybrite' steel wire, for the propagation of pure types. The mesh is fine enough to prevent natural crossing, and improvement in the design and production of these cages has advanced to the stage when the cost per unit area covered is little more than the cost of the pre-War cages made of corrodible wire.

The raising of sufficient seed from such small cage stocks to supply the extensive growing areas of Egypt is a story in itself, and the scientific organisation of the expansion process leads us almost to accept the statement that the botany of the cotton plant is better known than that of any other plant. It might be contended that the method of seed renewal is adequate for the maintenance of clean stocks, and that the pruning effect of the seed control law is antithetical. Assuming it is possible to provide adequate seed supplies from reliable sources at one or two years' remove, accident or carelessness will lead to premature contamination, but if all concerned in the handling of the stocks are compelled by rigorously enforced law to exercise necessary care to prevent mixing, the burden of seed renewal will be lightened. Pruning and seed renewal are thus complementary, and all who have an interest in the prosperity of the cotton industry will wish success to the botanical and agronomic sections in Egypt in their efforts to improve by both means the quality and uniformity of cotton seed stocks. F. P. SLATER.

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* Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No 85: The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Seasons 1926–27 and 1927–28 By Dr W. Lawrence Balls and Armenag Eff. Bedevian. Pp 61+27 plates 5 P.T Bulletin No 100: Developments of the Existing System for Seed Supply of Cotton in Egypt. By Dr W. Lawrence Balls. Pp 11+3 plates. 5 P T. Bulletin No. 104. The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Season 1926 to 1930, with a Discussion of Evasions of the Law. By Dr. W. Lawrence Balls and Armenag Eff. Bedevian. Pp. 28+23 plates. 10 P T. (Cairo: Government Press, 1929–1931.)

The Study of Forest Entomology in India.

THIRTY years ago the entomology of the forests of India and its study were still a closed book. Types of forest insects had found their way into the national museums and private collections in Europe, and thus received a name. But, as became apparent during the first decade of the present century, numbers of the insects of forest importance, as probable or possible pests, were unnamed and their biology unknown. The early pioneer work of the forest officers who were first set to grapple with the position proved by no means easy, but extraordinarily fascinating.

In India, during those first few years, the assistance of a dozen or two expert systematists was required to enable progress to be made at all, and the preliminary publications of results (expected by and demanded by Government) to be issued.

The *Indian Forest Records*, parts 9 and 10 (Calcutta: Government of India Printing Office, 1930), afford a typical example of this progress. Both these parts are devoted to the genus *Xyleborus*, a genus of wood borers (the so-called pinhole and shothole borers) well known to foresters. In part 9, Hans Eggers, of Stolberg, Harz, Germany, discusses "Neue *Xyleborus* Arten (Col. Scolytidæ) aus Indien". In this paper the author describes some forty new Indian forest species, and also proposes a new genus, *Pseudoxyleborus*, in which he describes one species, *P. Beesoni.*

Part 10 of the *I.F. Records* is written by Dr. C. F. C. Beeson, forest entomologist at the Dehra Dun Research Institute, and is entitled "The Biology of the Genus *Xyleborus*, with more New Species". Chap. i. is devoted to the new species, and is indicative of the valuable knowledge we now possess upon this important genus.

Chap. ii. is devoted to the main theme. "The present *Record*", the author says, "summarises the available biological information on Indian species of *Xyleborus*, their regional distribution, food plants, life histories, and gallery patterns." The importance attached to the systematic study of groups of pests of this type, if solely from the economic point of view, will become evident from the following remarks: "Pinholes and shotholes in timber in India are made by a specialised group of borers (often called 'ambrosia beetles') comprising the extensive genus *Xyleborus*, as also *Webbia* of the family Scolytidæ, and Crossotarsus, Diapus, and Platypus of the family Platypodidæ. The term 'pinhole' is applied to holes the size of a pinprick and 'shothole' to holes corresponding in size to various small shot up to 3 mm. in diameter; otherwise there is no fundamental difference in the mode of origin of the holes or in the habits of the borers in making them. The tunnels are bored in wood by the female beetle, and the wood-dust resulting from their excavation is thrown outside, so that a free space is provided in which eggs are laid and the larval breed is reared to maturity. Unlike the majority of borers of timber, the larvæ of ambrosia beetles do not feed on wood, but on fungus (the ambrosia) that grows on the walls of the tunnel in a mycelial layer of variable thickness and produces highly nutritious fruiting bodies. Tunnels that have been occupied for a short time get stained black, and in some species secondary saprophytic fungi develop, that discolour the wood vessels for a little distance around the tunnel. Timber that has been attacked by pinhole and shothole borers thus shows defects in the form of black spots and lines on the sawn surfaces, which spoil it for ornamental purposes and for special uses as matches, veneer, plywood, etc.; unless heavily attacked, it is not seriously weakened for structural purposes."

The paper ends with an excellent index to food plants of Indian species of *Xyleborus*. The author is to be congratulated upon an excellent piece of work.

Of a different type, emanating from the same research branch at Dehra Dun, is the series of papers dealing with the immature stages of the Indian Coleoptera, by Mr. J. C. M. Gardner (*I.F. Records*, Entom. Ser., vol. 16, part 3, 1931). Mr. Gardner produces his eighth paper, "*Cerambycidæ* (Continued)", which completes the description of the identified material in the Dehra Dun collections. The classification of the family Cerambycidæ, and, says the author, "especially of the sub-family Laminæ, has always presented difficulties to workers, who have relied almost entirely on the external morphology of the adult; the study of immature stages should help in a more satisfactory phylogenetic grouping of genera. So far, attention has been concentrated on larvæ, but the pupal stage certainly deserves more attention than it has received."

That Indian research work should be giving what might almost be termed a lead in a branch of study which may prove of considerable practical importance, would seem to merit being placed on record. Certainly, Mr. Gardner's admirable and patient work should enable the forest officer out in the forest, or in the temporary timber depot, to recognise a pest, abundantly represented by the larvæ in the timber but with no trace of the perfect insect; a position only too well known to many forest officers.

Palæolithic Flint Implements.

IN the course of the work in southern Palestine of the British School of Archæology in Egypt, a large number of palæolithic implements of early type have been collected near Gaza. A number of these were exhibited at a meeting of the Royal Anthropological Institute about two years ago by Sir Flinders Petrie, and it was then determined to submit them to Mr. Reid Moir for inspection and report.

In making his report, which is published in the Institute's *Journal* (vol. 60, pt. 2), Mr. Reid Moir finds that the implements fall into two clearly defined groups. The first consists of massive specimens, produced by the removal of thick wide flakes, and much abraded: the second is formed by the detachment of thin flakes tending to be of greater length than width, for the most part showing no sign of abrasion and clearly the product of a different technique. The difference in morphology is fundamental. Mr. Reid Moir considers that the first group belongs to the series worked out for East Anglia by him, which exhibits the transition from the rostro-carinate to the earliest palæolithic hand-axe. Rostro-carinates and transitional forms have been found in Uganda, Rhodesia, India, and now Palestine. Notwithstanding the fact that the Palestine implements have not been found in any ancient deposit, Mr. Reid Moir is still inclined to assign them to the early Pleistocene. The second group is classified as Acheulean, comparable with Acheulean implements of the second inter-glacial in East Anglia.

This conclusion raises the question, as Mr. Reid Moir puts it, "how to account for the presence in southern England and in Palestine of groups of flint implements made upon precisely the same definite and specialised plan". It seems scarcely probable that a race of people in Palestine worked out a series of this kind of flint implements on exactly the same lines and produced identically the same technique as another race living in southern England and—unless the early Pleistocene age of the Palestine implements is accepted—at a much later date. Mr. Burkitt, in discussing implements from India (see *Antiquity*, September 1930), compared them with implements from South and East Africa, and suggested that they were on a periphery of distribution of a single industry. Mr. Reid Moir is now strongly inclined to the view that the implements of Early Chellean type from Africa, India, and Palestine are to be referred to the same age as those in England, the early Pleistocene, and that at certain periods of past geological time stone implements were being made on the same highly specialised plan over enormous areas of the earth's surface, having started from a common centre. Hence it is not surprising to find that Mr. Reid Moir accepts the almost inevitable corollary that in the conditions governing movement, whether of culture or of race, at this early age, great periods of time must have been involved, with the implication that in most of the current computations man's antiquity is much underestimated.

Development of Weather Forecasting.

The *Quarterly Journal of the Royal Meteorological Society* for July 1931 contains an interesting survey of the present position of weather forecasting, by C. K. M. Douglas. The author pays tribute to the work of J. Bjerknes and other Norwegian meteorologists, who have developed in greater detail the system of analysis of synoptic weather charts according to the past history of the different air streams begun by Shaw and Lempfert many years ago in "The Life History of Surface Air Currents". He points out that for short-period forecasting the value of the method is undoubted, especially for periods up to twelve hours ahead. Any adequate discussion, however, of practical forecasting must always take note of peculiar tendencies observed, at least in European weather, described as 'persistence of type' and 'mood'. An excellent example of the first is mentioned, that of the severe spring snowstorms of April 2 and 11, 1917. The synoptic charts that accompanied these storms are said to have had features in common not shared by any other charts during the present century. The second tendency is for rain to be absent in certain seasons when the distribution of pressure is such that in an ordinary year it would be accompanied by rain at that season.

The mere recognition of these two tendencies does not greatly help the forecaster, but does indicate a line of research that might lead to important advances. In the case of persistence of type, it may be that by using synoptic charts covering a very wide area, most cases where a particular type of pressure distribution over, say, the British Isles and the North Sea appears to return after an interruption of two or three days, there will be seen to be a distribution of pressure over a much larger area that has been persistent during the interruption, the latter appearing as a mere local disturbance.

'Mood' is less easy to explain, and very difficult to investigate with our present limited information about the upper atmosphere, if, as seems probable, it is due, as the author suggests, to long-period fluctuations of temperature and humidity in the upper atmosphere.

University and Educational Intelligence.

Cambridge.—The treasurer of the University has received a cheque for £1000 from the Worshipful Company of Goldsmiths, for the better equipment of the Metallurgical Laboratory.

Mr. J. W. A. F. Balfour-Browne has been elected to a Frank Smart studentship in zoology at Gonville and Caius College.

At St. John's College, G. Bateson and R. O. Redman have been elected to fellowships. Mr. Bateson is an anthropological student, while Mr. Redman is assistant director in the Solar Physics Observatory.

For the eleventh year in succession, Trinity College announces the offer of a research studentship open to graduates of other universities who propose to come to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be as much as £300 a year. The same College offers, as usual, dominion and colonial exhibitions to students of dominion and colonial universities who wish to come to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. These exhibitions are of the titular value of £40; if the financial need of an exhibitioner cannot possibly be met by this amount, the Council has power, if it sees fit and if funds are available, to award him an additional payment. Candidates must apply through the principal authority of their university. Applications for the studentship and exhibitions should reach the Senior Tutor (from whom further particulars may be obtained) by July 1, 1932.

Oxford.—Dr. Herbert H. E. Craster, fellow of All Souls College, has been elected by the curators of the Bodleian Library, to be Bodley's Librarian, subject to the approval of Convocation on Nov. 3.

Applications are invited by the Grocers Company, Grocers Hall, E.C. 2, for research scholarships in sanitary science, each of the annual value of £300, plus an allowance for expenses. The necessary form of application and information respecting the scholarships are obtainable from the clerk to the company.

The Council of the Institution of Naval Architects has made the following awards: Vickers Armstrong scholarship in naval architecture (1931) to Mr. Leonard Redshaw, of Messrs. Vickers-Armstrongs, Ltd., Barrow-in-Furness—the scholarship is of the value of £150 per annum and will be held at the University of Liverpool for three years; and the Duke of Northumberland prize (in connexion with the 1931 examinations for national higher certificates in naval architecture) to Mr. James Irwin, of the Royal Technical College, Glasgow.

Birthdays and Research Centres.

Oct. 31, 1872.—Sir **John Russell**, O.B.E., F.R.S., Director of the Rothamsted Experimental Station, Harpenden.

My work—indeed, my whole life—is so intimately bound up with Rothamsted and my colleagues there that I find it difficult to disentangle myself from them. Our general purpose is to see how far science can go in solving the problems of country life. The most fundamental problems are those associated with crop production: the management of the soil, the nutrition of the plant, the ways of dealing with destructive insects, fungi, and other pests, and the ways of utilising the crop to the fullest advantage in the service of men and of animals. These problems, therefore, form the basis of our work.

The method is to gain knowledge about the soil, the growing plant, and the animal. Experience has shown that this is incomparably better than the search for ways of overcoming particular difficulties; it gives a solid foundation of knowledge on which to develop agricultural education, advisory activities, and further research, and it has proved highly successful in adding to the resources of the countryman in his hard task of wresting a living from the soil.

Nov. 1, 1857.—Prof. John Joly, F.R.S., professor of geology and mineralogy in the University of Dublin and president of the Royal Dublin Society.

In 1914 I contributed to the *Proceedings of the Royal Dublin Society* a paper on the subject of the radioactive treatment of malignant disease and urged that uniformity of radiation would seem to be more hopeful than the use of concentrated central dosage as then generally practised. Ultimately the present extensively used ' needle method ' of application resulted, and was first put into practice by the late Dr. Walter C. Stevenson.

I have since contributed to the Royal Dublin Society suggestions for the use, in certain cases, of bi-radiant needles, namely, needles emitting rays differing unilaterally in density. Suggestions regarding deep-seated radium therapy have also been contributed to this journal as coming from our Irish Radium Institute. No problem is more urgent than this.

I have also in view considerations arising out of the surface history of the earth; the elements of which history I believe to be now well established.

Nov. 4, 1855.—Prof. F. O. Bower, F.R.S., formerly regius professor of botany in the University of Glasgow.

Since my retirement from the chair of botany in the University of Glasgow in 1925, circumstances have not been favourable for continuing detailed observation as in former years. The opportunity has, however, been used for completing " Ferns ", vol. 3, published in 1928, and a small volume on " Size and Form in Plants " in 1930. This leaves me free to draw together many facts and arguments—partly included in volumes already published, partly scattered in isolated memoirs and addresses—into a collective and revised statement relating to archegoniate plants. This will take time, and its completion—if it ever be completed—cannot be expected at any early date. All my available time will now be devoted to this end.

Nov. 5, 1876.—Prof. H. B. Fantham, professor of zoology in the University of the Witwatersrand.

The study of animal parasites has always interested me, and for some years I have been working on surveys of the parasitic and free-living Protozoa found in South Africa. The former have been considered from the morphological, biological, and experimental points of view with the view of shedding light on the evolution of pathogenicity among them. The free-living Protozoa have been studied ecologically, while making a first survey of those occurring in various types of soils and fresh waters. Human biology is also of deep interest to me. My investigations have been chiefly on cases of human heritable conditions and on racial admixture, a problem of increasing importance in South Africa, as well as in other parts of the world.

Nov. 5, 1892.—Prof. J. B. S. Haldane, Reader in Biochemistry in the University of Cambridge, head of the Genetical Department, John Innes Horticultural Institution.

I am directing and conducting research into the biochemistry of individual and specific differences, both in higher plants and bacteria. Progress in genetics demands as exact a knowledge as possible of what genes do. For example, it would appear that one gene may cause the oxidation of a particular substance, another its methylation, and so on. In some cases at least, this is done through a definite enzyme. Exact data as to the effect of genes on viability are also being collected with the view of quantitative testing of the Darwinian theory. I am developing a mathematical theory of natural selection, in which a population is represented by a point in many-dimensional space, and its trajectory under a given selective system is investigated. A number of differential, integral, and finite difference equations arising in this theory demand investigation.

Nov. 6, 1886.—Prof. I. M. Heilbron, D.S.O., F.R.S., Heath Harrison professor of organic chemistry in the University of Liverpool.

My main interests at the present time are directed towards: (*a*) the chemistry of the sterols with special reference to ergosterol and vitamin D, and (*b*) investigations relating to the occurrence, isolation, and structure of vitamin A. Under the first heading, I am attempting to elucidate the structure of the ergosterol molecule, concerning which, apart from its obvious relationship to cholesterol, little is definitely known.

Under the second section, I am continuing, in conjunction with Dr. R. A. Morton, a spectrographic and chemical investigation of vitamin A and related substances.

When time permits, I intend to extend my investigations so as to include a detailed study of the unsaponifiable matter of many animal and vegetable oils, preliminary work upon which has revealed the presence of many interesting substances.

Nov. 7, 1888.—Sir C. V. Raman, F.R.S., Palit professor of physics in the University of Calcutta, and Nobel laureate in physics, 1930, honorary secretary of the Indian Association for the Cultivation of Science, Calcutta.

During the last ten years, the attention of the workers at the Indian Association for the Cultivation of Science has been principally directed to the study of the scattering of light and its relation to the nature of radiation and the constitution of matter. Since 1928, monochromatic light has been exclusively employed and the scattered radiations have been analysed spectroscopically. This has led to a very great extension of the field of study. Probably the most important problem now under investigation is the nature of light itself. The phenomena of light-scattering make it clear that we have to atomise light and ascribe to it a specific quantum of energy and also definite values of linear and angular momentum. They also suggest that we must atomise sound, and consider it as being associated with molecular aggregates of variable size. The discovery of the phenomenon of anomalous polarisation in light-scattering has also opened up new vistas of research, which are being actively pursued. Light-scattering is also being applied to numerous physico-chemical problems.

Magnetic and magneto-optical researches are also receiving attention at the present time at Calcutta.

Societies and Academies.

London.

The Optical Society, Oct. 15.—F. Twyman and A. Harvey: The validity of the Schwarzschild relation as applied to the use of the logarithmic sector. A direct experimental test is made of the Schwarzschild relation as applied to the logarithmic sector used in conjunction with a quartz spectrograph. The relation is found to hold within the limits of the experiments, from which it follows that the length of a spectral line on the photographic plate is proportional to the logarithm of its intensity.—**F. Twyman**: The 'Spekker' photometer for ultra-violet spectrophotometry. With the original Hilger sector photometer a glass disc was supplied, with its absorption curve in the ultra-violet. This was to enable a calibration of the sector to be made on each photographic plate, and thus to avoid errors due to any assumption concerning the Schwarzschild constant. Although the original rotating sector withstood the criticisms levelled against it on the score of intermittency, there were a number of real objections to its use. The photometer described in the present paper is now made by Adam Hilger, Ltd., under the trade mark 'Spekker'. The risk that the intensity of illumination from the two aspects of the light source may be unequal is overcome by the use of two rhombs.

Paris.

Academy of Sciences, Sept. 14.—Serge Bernstein: The absolute maximum of a trigonometrical summation.—**E. Bataillon and Tchou Su**: The experimental dissociation of the male and female kinetic rhythms in the normally impregnated egg of *Bombyx*.—**Depreux**: The resistance of the air behind projectiles.—**P. R. Bohn**: The mechanism of the synthesis of fats at the expense of glucides. A comparative study of the action of *Sterigmatocystis nigra* on cultures containing dextrose and levulose, to see if there is any relation between the presence of the aldehyde and ketonic group and the formation of fat. The proportion of fat in the mycelium is higher as the concentration of the sugar increases. the change in the amount of proteins is sufficient to prevent any positive conclusions being drawn regarding the effect of substituting levulose for dextrose in the cultures.—**Raoul Lecoq**: The production of an osteo-dystrophic syndrome in the guinea-pig by disturbance of the mineral equilibrium.—**H. Quéré**: The oxidation of the alcohols by the acetic ferments, considered as a form of cell respiration. A comparison of the oxidation of ethyl, propyl, isobutyl, and isoamyl alcohols shows that the amounts of oxygen used up are approximately in inverse proportion to the molecular weight of the alcohol. The mechanism of oxidation is analogous with the mechanism of respiration.—**P. Cayrol**: The action of various halogen derivatives on alcoholic fermentation. From a study of the action of a number of halogen compounds on the process of fermentation, the conclusion is drawn that the action of the halogen atom depends on its position in the molecule: the most active halogen derivatives appear to be those which are hydrolysed at the ordinary temperature.—**Paul Wintrebert**: Sketches of *Discoglossus pictus* at the end of the blastula and at the end of the neurula stages.—**P. Delanoe**: The jackal and hedgehog reservoirs of the Moroccan spirochæte *Sp. hispanicum* var. *marocanum*. The following animals have now been proved to be carriers of the Moroccan spirochæte: porcupine, merion, fox, jackal, and hedgehog.

Sept. 21.—**Louis Lapicque**: The measurement of large chronaxies. Remarks on a note by M. Bourguignon. The author states that there is no reason to use different methods for measuring large and small chronaxies.—**Lucien Féraud**: The periodicity conditional to the neighbourhood of a point of stable equilibrium.—**A. Etévé**: Anemogirouttes. A discussion of instruments in use for the automatic control of aeroplanes.—**P. Fourmarier**: Studies of photoelectric cells as depending on the frequency of illumination.—**J. Fallou**: Measurements of the propagation constants of an aerial cable with earth return, as a function of the frequency.—**J. Bougault and J. Guillou**: Some reactions of certain barbituric derivatives (veronal, dial, gardenal, etc.). Study of the reaction of bromine and iodine in alkaline solution on some barbituric derivatives in use in medicine.—**P. Fallot**: The marginal inequalities of the limestone chain of the Rif to the north of Oued Lau.

Leningrad.

Academy of Sciences—*Comptes rendus*, No. 5, 1931.—**L. Berg**: The Black Sea sprat. A description and discussion of the synonymy of the Black Sea sprat, which is considered to be a subspecies of the Atlantic sprat and named *Spratella sprattus phalerica* (Risso).—**N. Vlodavec**: The extraction of alumina and alkalis from the nephelines and nephelinites of the Chibin Mountains. Discussion of commercial methods based on laboratory experiments.—**S. Kurbatov**: The pyrophyllite from the Tchistaya-Gora deposits in the Southern Ural. A talcum-like rock from the Tchistaya-Gora proved to contain 73·55 per cent of pyrophyllite, 23·63 per cent of quartz, 1·68 per cent of sericite, and 0·62 per cent calcium and magnium carbonates. This is the fifth known bed of pyrophyllite in Russia.

Comptes rendus, No. 6, 1931.—**V. Vernadskij**: (1) Biogeochemical studies of the phenomena of life. (2) The influence of living organisms on the isotopic mixtures of chemical elements. Both papers contain an exposition of general theoretical ideas on the subject.—**V. Vernadskij and A. Vinogradov**: Chemical composition of *Lemna* as a specific character. Analysis of four different species of *Lemna* proved that there exist definite and constant differences in chemical composition between species. Thus *L. polyrrhiza* and *L. trisulca* contain more carbon than *L. minor* and *L. gibba*, while *L. trisulca* is richer in manganese than any other species. In all Lemnaceæ the quantity of manganese is higher than that of iron.—**K. Nenadkevic**: An electro-colorimetric method for the determination of small quantities of manganese. The method is based on the electrolytic oxidation of manganese salts by ozone and oxygen *in statu nascendi*.—**V. Barovskij**: The first representative of the genus *Plateros* (Coleoptera, Lycidæ) in the Russian fauna. Description of *Plateros ussuriensis*, sp. n. from the Ussuri region.

Official Publications Received.

British.

The Edinburgh and East of Scotland College of Agriculture. Calendar for 1931-1932. Pp. 96. (Edinburgh.)

Philosophical Transactions of the Royal Society of London. Series A Vol. 230, A687: A Research on Faraday's "Steel and Alloys". By Sir Robert Hadfield. Pp. 221-292+plates 4-12. (London: Harrison and Sons, Ltd.) 14s. 6*d.*

First Annual Report of the Sugarcane Research Station of Department of Agriculture, Mauritius, for the Year 1930. Pp. 21. (Mauritius.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 8, August Abstracts Nos. 1339 1546. Pp. 259-294. (London: H.M. Stationery Office.) 9*d.* net.

Foreign.

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1931. 97e annee. Pp. 282+6 planches. (Bruxelles: Maurice Lamertin.)

Suomen Geodeettisen Laitoksen Julkaisuja: Veröffentlichungen des Finnischen Geodätischen Institutes. No. 17. Über die Beziehung zwischen Lotabweichungen und Schwereanomalien sowie uber das Lotabweichungssystem in Sud-Finnland. Von V. R. Ölander. Pp. 23. (Helsinki.)

Catalogues.

Synthetic Organic Chemicals Vol. 5, No. 1, October. Pp. 4. Eastman Organic Chemicals. Supplementary List, October. Pp. 4 (Rochester, N.Y.: Eastman Kodak Co.)

Watsons' Microscopic Record. No. 24, September. Pp 24. (London: W. Watson and Sons, Ltd.)

The Mercury-in-Steel Thermometer. Pp. 39. (London: Negretti and Zambra.)

Africana. (Catalogue No. 541.) Pp. 72. (London: Francis Edwards, Ltd.)

List of Books and Periodicals on Agriculture, including Horticulture and Forestry and Animal Husbandry. Pp. 82. (London: Baillière, Tindall and Cox.)

Sotheran's Price Current of Literature. Annotated and Classified Catalogue of Ancient and Modern Books on Exact and Applied Science. Part 2, including Astronomy, Dialling and Horology, Physics (No. 828.) Pp. 153-292. (London: Henry Sotheran, Ltd.)

Diary of Societies.

FRIDAY, October 30.

Association of Economic Biologists (in Botany Department, Imperial College of Science and Technology), at 11.30 A.M.—R H. Stoughton: Nuclei, Reproductive Bodies, and Cell-fusion in a Bacterium —T. H. C. Taylor: Control of the Lavuana Moth in Fiji.—Dr. P. H. Gregory: The Fusarium Bulb Rot of Narcissus.—At 2.30.—Dr. W. B. Brierley, Prof. J. W. Munro, and others: Discussion on The Training of Biologists for Economic Posts.

Royal Astronomical Society (Geophysical Discussion), at 4.30.—Isostasy. Speakers: Sir G. P. Lenox-Conyngham (who will communicate a paper by Dr. De Graaf Hunter), Prof. A. M. Davies, Dr. Harold Jeffreys, H. L P. Jolly, Prof. O. T. Jones. Chairman: Admiral H. P. Douglas.

Royal Sanitary Institute (at Town Hall, Wolverhampton), at 5.—W. Clifford: The Flow of Sewage through a Sewage Works.—Miss M. R. Baskett and Dr. H. Paul: Experiments in Reconditioning of Houses.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Anatomy of the Pyloric Sphincter in Cases of Hypertrophic Enlargement.

North-East Coast Institution of Engineers and Shipbuilders (in Mining Institute, Newcastle-upon-Type), at 6.—Mrs. E. M. Smith-Keary: The Effect of Immersion on Propellers.

Institution of Electrical Engineers (London Students' Section), at 6.15.—G. J. Shaw and G. A. M. Hyde: The Business of Electrical Apparatus Manufacture.

Institution of Chemical Engineers (at Institution of Civil Engineers), at 6 30.—Dr. E. F. Armstrong: Hydrogenation (Lecture).

Illuminating Engineering Society (at Royal Society of Arts), at 6.30.—P. Good and others: Discussion on Some Impressions of the I.I.C. Floodlighting.

Institution of Mechanical Engineers (East Midland Branch) (at University College, Nottingham), at 6.30.—Prof. C. H. Bulleid: The Importance of Metallurgy to the Engineer

Institute of Transport (Manchester, Liverpool, and District Section) (at Adelphi Hotel, Liverpool), at 6.30.—T. E. Jones: The Horse—Its Place in the Scheme of Transport.

Institution of Mechanical Engineers (Informal Meeting), at 7.—R. Borlase Matthews and others: Discussion on Engineering in Agriculture.

Iron and Steel Institute (jointly with West of Scotland Iron and Steel Institute) (at Royal Technical College, Glasgow), at 7.15.—J. H. Andrew, W. R. Maddocks, D. Howat, and E A Fowler: The Equilibrium of Certain Non-Metallic Systems.—B Matuschka: The Solidification and Crystallisation of Steel Ingots: the Influence of the Casting Temperature and the Undercooling Capacity of the Steel.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry—South Wales Section) (at Technical College, Cardiff), at 7.15.—R. D. Owen: Chemistry of Dairy Products.

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.—J. N. Waite: Combustion and Boiler-house Efficiency.

Society of Chemical Industry (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Dr John A. Cranston: The Chemist, the Community, and the Individual (Chairman's Inaugural Address).

Junior Institution of Engineers, at 7 30.—S. J. Clifton. Automatic Combustion Control.

Institute of Chemistry (Belfast Section) (at Royal Belfast Academical Institution), at 7 45.—R. G. Baskett: Recent Advances in Animal Nutrition.

Royal Aeronautical Society (at Eton College).—The Master of Sempill: Lecture.

SATURDAY, October 31.

North of England Institute of Mining and Mechanical Engineers (at Newcastle-upon-Tyne), at 2 30.—W. Cochran-Carr: Inaugural Presidential Address.—Dr. A. Crawford: The Hydrogenation of Coal.

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.—J. N. Waite: Combustion and Boiler-house Efficiency.

MONDAY, November 2.

Royal Society of Edinburgh, at 4 30.—G. W. Tyrrell and M. A. Peacock: Petrology of Iceland Part II. The Petrology of the Acidic and Intermediate Intrusives and Extrusives, by M. A. Peacock.—Dr. Tudor Jones: The Primitive Conducting Mechanisms of the Vertebrate Heart: An Introduction to the Study of their Appearance and Development in *Lepidosiren paradoxa*.—G. W. McCrea: An X-ray Examination of *d*-Manitol and *d*-Mannose.—W. O. Kermack and W. H. McCrea: An Operational Method for the Solution of Linear Partial Differential Equations.—H. S. Ruse: On the Definition of Spatial Distance in General Relativity.

Royal Institution of Great Britain, at 5.—General Meeting.

Royal College of Surgeons of England, at 5.—C. P. G. Wakeley: Demonstration of Secondary Tumours of the Bone.

Society of Engineers (at Geological Society), at 6.—T. J. Gueritte: Esperanto in the Field of Engineering.

British Psychological Society (Education Section) (at London Day Training College), at 6.—F. Schonell: Research of Specific Disability in Spelling.

Society of Chemical Industry (Yorkshire Section) (jointly with Hull Chemical and Engineering Society and Institute of Chemistry—Leeds Area Section) (at Station Hotel, York), at 6.45.—Emulsions:—A. H. Dodd: Types of Industrial Emulsions.—J Pryce Jones: Some Aspects of Thixotropy.—Dr. A N. Mosses: One Molecule Thick.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at University, Liverpool), at 7.—R. M. Charley: Recent Progress in Large Transformers.—W. E. M. Ayres: The Application of the Induction Voltage Regulator.

British Kinematograph Society (in Gaumont British Theatre, Wardour Street), at 7.45.—B. Pontifex: Nickel Alkaline Storage Batteries

Society of Chemical Industry (London Section) (at Chemical Society), at 8.—Drs H. A. Auden and W. P. Joshua: The Saccharification of Wood

TUESDAY, November 3.

Royal Institution of Great Britain, at 5.15.—Prof. G. I. Finch: The Combustion of Gases in Electric Discharges (1).

North Staffordshire Institute of Mining Engineers (in North Staffordshire Technical College, Stoke-on-Trent), at 5 30.—B. R. Lawton: The Aneroid Barometer as an Aid to Improvement of Atmospheric Conditions in Deep Workings.

Zoological Society of London, at 5.30.—T. L Green: On the Pelvis of *Anura*.—C. C. John: On the Anatomy of the Head of *Sagitta* (Chætognatha).—Dr. Susan Finnegan: On a New Species of Mite of the Family Heterozerconidæ.—Prof. F. Werner: Further Notes on the Indian Mantids or Praying Insects.

Mineralogical Society (Anniversary Meeting) (at Geological Society), at 5.30.—Dr. F C. Phillips: On Crystals of Brookite, Tabular, Parallel to the Basal Plane.—Prof. T. Ito: On Scorodite from Japan.—Dr. E. S. Simpson and D. G. Murray: On a New Siderolite from Bencubbin, Western Australia.—W. Campbell Smith: On a New Meteoric Stone from Suwahib, Arabia, found by Mr. Bertram Thomas in 1930.

Institution of Civil Engineers, at 6.—Sir Cyril Reginald Sutton Kirkpatrick: Presidential Address and Presentation of Medals.

London Natural History Society (at London School of Hygiene), at 6.30.—Exhibition of Ciné Films of The Buzzard, Crabs and Camouflage, The Ant Lion, and The Swallows.

Institution of Automobile Engineers (at Royal Society of Arts), at 7 45.—B. G. Robbins: The Training of Young Automobile Engineers

Abernethian Society of St. Bartholomew's Hospital, at 8 30.—Dr. W. Langdon Brown: Dr. Robert Bridges, the Poet of Evolution (Inaugural Address).

Royal Geographical Society, at 8.30.—F. S. Smythe: The Garwhal Himalaya around Kamet

Royal Photographic Society.—T. Thorne Baker: The Spicer Dufay Colour Process.

Institution of Gas Engineers (at 28 Grosvenor Gardens).

WEDNESDAY, November 4.

Royal Society of Medicine (History of Medicine Section), at 5.—Dr. Meyerhof: A Short History of Ophthalmia during the Egyptian Campaigns of 1798-1807.

Geological Society, at 5.30.—Prof. A Holmes and Dr. H. F. Harwood: The Petrology of the Volcanic Fields East and South-East of Ruwenzori, Uganda.

Institution of Electrical Engineers (Wireless Section), at 6.—Col. A. S. Angwin: Chairman's Inaugural Address.

Institution of Heating and Ventilating Engineers (at 20 Hart Street W.C 1), at 7.—S. J Benham: Recent Developments in Cooking Apparatus.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—D. Tagg and R. G. P. Weighton: Supercharging: its Aims and Application.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—Dr. W. R. Schoeller and H. W. Webb: The Separation of Tin from Tantalum and Niobium.—Dr. W. R. Schoeller and C Jahn: A Reliable Method for the Quantitative Separation of Titanium from Tantalum and Niobium.—Dr. J. Reilly, N. Noonan, and P. J Drumm: The Evaluation of the Menthone Content of Peppermint Oil.—D. M. Freeland: The Extraction and Estimation of Vanillin in Chocolate and Cocoa Butter.—H. R Ambler: The Direct Determination of Nitrogen in Gases.

Royal Society of Arts, at 8.30.—Sir Edward A Gait: British Research Work in India, in the Fields of History, Archæology, Philology, and Ethnology.

Royal Society of Medicine (Surgery Section), at 8.30.—G. Williams and others: Discussion on Treatment of Acute Osteomyelitis.

Institution of Gas Engineers (at 28 Grosvenor Gardens).

Royal Microscopical Society (Biological Section) (at B M.A. House).

THURSDAY, November 5.

Royal Society, at 4.30.—Sir F. Gowland Hopkins and K. A. C. Elliott: The Relation of Glutathione to Cell Respiration with Special Reference to Hepatic Tissue.—Lord Rutherford and Dr. C. D. Ellis: The Origin of γ-Rays.—Prof. A. V. Hill: Myothermic Experiments on the Frog's Gastrocnemius.—*Papers to be read in title only*:—J. L Burchnell and T W. Chaundy: Commutative Differential Operators II.—F. Relton: The Steady Broadside Motion of an Anchor Ring in an Infinite Viscous Liquid.—L. E. Sutton: The Significance of Difference between the

Dipole Moments of Saturated and Unsaturated Compounds.—Prof. W. A. Bone and R. P. Fraser: Photographic Investigations of Flame Movements in Gaseous Explosions. (IV., V, and VI.—Sir Robert Hadfield, Bt.: A Research on Faraday's Steel and Alloys.—A F. H. Ward: The Sorption of Hydrogen on Copper. I., II.—T. Iredale and A. C. Mills: Absorption Spectra of the Alkyl Halides: Energies of the C–I and C–Br Bonds.—Prof. G I. Finch and H. H. Thompson: The Effect of Frequency on the Condensed Discharge Ignition of Carbonic Oxide-Air Detonating Gas.—J. H. Gaddum · A Simple Method of Measuring Surface Tension.—K. Lonsdale. An X-Ray Analysis of C_6Cl_6 using the Fourier Method.—M. G. Evans: The Sorption Process in the Zeolite Chabazite —S. Werner: Electron Scattering in Helium at Low Velocities. —E. J. Brown, C N. Hinshelwood, and E. A. Moelwyn-Hughes: The Kinetics of the Decomposition in Carbon Tetra-Chloride Solution of Ozone and of Ozone-Chloride Mixtures.—H. B. Heywood: On Finite Sequencies of Real Numbers.—Prof. J. C. McLennan, E J. Allin, and K. E. Hall: The Nuclear Moment of the Indium Atom.—C. V. Jackson: Interferometric Measurements in the Spectrum of the Iron Arc in Air in the Region λ3100-λ3500.—K. R. Rao. The Third Spark Spectrum of Arsenic (As IV.).—Prof. J S E. Townsend: Elastic Collisions.—H M. Taylor: The Interaction Energy of Two α-Particles at Close Distances, Determined from the Anomalous Scattering in Helium.—R. W. Gurney: The Quantum Mechanics of Electrolysis —W. Riezler: The Scattering of α-Particles by Light Elements —Prof. R. Whytlaw-Gray, H. S. Patterson, and W. Cawood: The Atomic Weight of Xenon —D. T. A. Townend and L. A. Bhatt: Isotherms of Hydrogen, Carbon Monoxide, and their Mixtures —G. S. Hartley and C. Robinson: The Diffusion of Colloidal Electrolytes and other Charged Colloids —L Rosenhead: The Formation of Vortices from a Surface of Discontinuity.—E. C. Bullard and H. S. W. Massey: The Elastic Scattering of Slow Electrons in Gases. II.—A. Michels and R. O. Gibson: The Measurement of the Viscosity of Gases at High Pressures: The Viscosity of Nitrogen to 1000 ATMS.—Sir William Pope and J. B Whitworth: The Optically Active Spiro-5:5-Dihydantoins.—Lord Rutherford, C E. Wynn-Williams, and W. B. Lewis; Analysis of the α-Particles emitted from Thorium C and Actinium C.—C Gratias and C. H. Collie: The Half Life Period of Uranium γ.—B. Lambert and A G Foster: Studies of Gas-Solid Equilibria III.—Sir Arthur Eddington: On the Value of the Cosmical Constants.—Prof. J. C. McLennan, A. B. McLay, and M. F. Crawford: Interpretation of Hyperfine Structure.—Prof. E. N. da C Andrade: (a) On the Circulation caused by the Vibration of Air in a Tube; (b) On the Groupings and General Behaviour of Solid Particles under the Influence of Air Vibrations in Tubes.—G. D. Bengough, A. R. Lee, and F. Wormell: The Theory of Metallic Corrosion in the Light of Quantitative Measurements. V.—Dr. F. D Chattaway and E J. F. James. The Condensation of Chloral with Urea and Phenyl Urea.—Prof. J. C. McLennan and A. B. McLay: Arc Spectrum of Gold. —Prof. J. C. McLennan, A. B. McLay, and M F. Crawford: Spark Spectrum of Mercury HgII.—C. W W. Read: Intensity Distribution in the Band Spectrum of Helium (He) for the Region λ6100-λ6500.—G. V. Praagh and Prof. E. K. Rideal: An Investigation of the Attack of Platinum and Tungsten by Iodine.—A. R. Ubbelohde and A. Egerton: The Kinetics of Adsorption Processes

Linnean Society of London, at 5.—Prof. F. E. Weiss: Naturalisation of *Sarracenia purpurea* in Switzerland.—H W. Pugsley: A New *Juncus* in Scotland.—A. G. Lowndes · Elutriation and some of its Applications to Biology.—Major R W. G. Hingston: Artificial Concealment Devices in Nature

Institution of Electrical Engineers, at 6.—E A. Watson: Coil Ignition Systems

Institution of Civil Engineers (Birmingham and District Association) (at Midland Institute, Birmingham), at 6 —T. J. Gueritte. The Construction of the Reinforced Concrete Bridge over the Mouth of the River Elorn between Brest and Plougastel, in Brittany.

Royal Aeronautical Society (at Royal Society of Arts), at 6 30 —H B. Irving and A. V. Stevens: Safety in Spinning

Institution of Automobile Engineers (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 7 —B. G Robbins The Training of Young Automobile Engineers.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.

Society of Chemical Industry (Bristol Section) (at University, Bristol), at 7.30.—Drs. L. A. Jordan and W. H. J. Vernon: The Relation between Corrosion and Paint.

Chemical Society, at 8.—H. L. Riley and V. Gallafont: A Potentiometric Investigation of Electrolytic Dissociation Part I. Cadmium Halides. —Prof. G. T. Morgan and F H. Burstall: Dehydrogenation of Pyridine by Anhydrous Ferric Chloride.

Diesel Engine Users' Association (at Caxton Hall).—R B. Grey. The Elimination of Vibration.

Electrical Association for Women (at Institution of Electrical Engineers) —Dr. Elizabeth Sloan Chesser: Electricity and Health (1).

FRIDAY, November 6.

Royal Society of Medicine (Otology Section), at 10.30 a.m.—N. Patterson: The Training of an Oto-laryngologist (Presidential Address). —E. W. Williams: Treatment of Suppurative Meningitis.—Dr. D. McKenzie: Some Graphs Illustrating Otosclerosis.

Royal Society of Medicine (Laryngology Section), at 5.

Physical Society (at Imperial College of Science), at 5.—Sir Arthur Eddington: The Expanding Universe (Presidential Address).

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Pathology of Hydrocephaly

Institution of Mechanical Engineers, at 6.—Ll. B. Atkinson: The Mechanical Aspects of Electricity (Thomas Hawksley Lecture)

Society of Chemical Industry (Manchester Section) (jointly with Manchester Sections of Society of Dyers and Colourists, Institute of Chemistry, and Chemical Section of Manchester Literary and Philosophical Society) (at College of Technology, Manchester), at 7.—Prof. H. Mark: The Significance of the New Cellulose Models (Molecular Structure) for the Technical and Dyeing Properties of the Fibre.

Institution of Electrical Engineers (Meter and Instrument Section), at 7.—F. C. Knowles: Inaugural Address.

Society of Chemical Industry (South Wales Section) (jointly witl South Wales Institute of Chemistry) (at Thomas' Cafe, Swansea), a 7.30.—Dr. Sladden: Chemistry in the Service of the Doctor.

Junior Institution of Engineers, at 7.30.—A. P. Quarrell: The Coolin of the Crude Oil Engine.

Oil and Colour Chemists' Association (Manchester Section) (a Liverpool) —N. Heaton · Modern Developments of Inorganic Pigments

Royal Photographic Society.—Pictorial Photography.

SATURDAY, November 7.

Royal Institution of Great Britain, at 3.—F. E. Yerbury: Present Day Architecture on the Continent (1) Modern Buildings in Holland.

Gilbert White Fellowship (at 6 Queen Square W.C.1), at 3 —W. B Gourlay. Plant and Animal Collecting in Chili (Lecture).

Institution of Mechanical Engineers (Graduates' Section—London (Informal Meeting), at 6 45 —Debate on: That a College Education i Desirable in the Training of a Mechanical Engineer.

North-East Coast Institution of Engineers and Shipbuilders (Tees Side Branch—Graduate Section) (at Cleveland Scientific and Technica Institution, Middlesbrough), at 7.30.—J Lang: Chairman's Address.

PUBLIC LECTURES.

FRIDAY, October 30.

British Medical Association, at 5.15 —Dr. F. J. McCann: Th Prevention of Cancer (Chadwick Lecture).

SATURDAY, October 31.

Royal Institute of British Architects, at 3.—H. B. Creswell: Th Uses of an Architect.

Horniman Museum (Forest Hill), at 3 30.—J. E. S. Dallas. A Naturalis in Western Cornwall.

MONDAY, November 2.

University of Leeds, at 5.15.—Prof. J. A. Crowther: The Life and Worl of Michael Faraday.

Royal Anthropological Institute (at University College), at 5.30.—F. J. Richards: From Pariah to Brahman in Southern India.

King's College, London, at 5.30.—Prof. H. Cloos: Problems an Methods of Structural Geology. (Succeeding Lectures on Nov. 9 and 11

University College, at 5 30 —Col. T. C. Hodson: Caste and Creed i Northern India.

National Institute of Industrial Psychology (at Royal Society o Arts), at 6.—Eric Farmer: Recent Research into the Causes o Industrial Accidents. (Succeeding Lectures on Nov. 9 and 16)

University of Leeds, at 8.—Prof F. Challenger: The Chemistry of th Friendly Microbe.

TUESDAY, November 3.

King's College, London, at 5.30.—Sir Bernard Pares · Russian History to 1861: Western Neighbours. Novgorod.

WEDNESDAY, November 4.

Royal Institute of Public Health, at 4.—L. E. Clarémont: Th Dental Health of the Citizen.

London School of Economics and Political Science, at 6.—Capt P. F. Knightley · Practical Uses of Office Machinery in the Registratio Department of a Company.

THURSDAY, November 5.

Royal Society of Medicine, at 5 —W. D. Harmer. The Relative Valu of Radio Therapy in the Treatment of Cancer in the Upper Ai Passages (Semon Lecture).

King's College, London, at 5 30.—Dr. Eveline Martin: West Afric of To-day: The Gold Coast: the Old English Forts on the Coast, an the New Inland—Kumasi.

King's College, London (at 16 Russell Square), at 5.30 —S. P. Turin Economic Conditions in Russia To-day, the Five-year Plan in U.S.S.R.

FRIDAY, November 6.

Geologists' Association (at University College), at 7.30.—Conversazione.

SATURDAY, November 7.

Mathematical Association (London Branch) (at Bedford College fo Women), at 3 —A. W. Siddons: The First Two Years of Geometry i a Secondary or Preparatory School.

Horniman Museum (Forest Hill), at 3.30.—D. Martin Roberts: London in the Age of Dr. Johnson.

ANNUAL MEETING.

October 31 to November 2.

International Society of Medical Hydrology (at American Hotel, Amsterdam) —Discussions on the Influence of Chill in the Causation o Disease, opened by Profs. Schade and van Loghem, and on Factors i Marine Treatment, opened by Prof. Möll and Dr. Haberlin.

CONFERENCE.

November 16 to 21.

International Conference on Bituminous Coal (at Carnegie Institut of Technology, Pittsburgh, U S.A.) —Subjects for discussion:—Coal a Locomotive and Steamship Fuel; Coal in the Electric and Gas Industries Competition of Coal with other Fuels in Heating Buildings; Coal in th Metallurgical Industries, Coal and its By-products in the Chemica Industries; Problems of Coking; Origin and Classification of Coals Cleaning and Preparation; Mechanism of Combustion; Pulverised Coal Relationships of Coal, Oil, and Natural Gas; Coal versus Water Power Hydrogenation and Liquefaction of Coal; Fertilisers from Coal Economics of Low Temperature Carbonisation; Storage and Weatherin of Coal, Smoke Abatement; Stream Pollution.

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NATURE

SATURDAY, NOVEMBER 7, 1931.

CONTENTS.

PAGE
Industrial and Social Economics 773
History of Alchemy. By Dr. E. J. Holmyard . . 774
The Prehistoric Colonists of Yorkshire and their Economics. By Prof. V. Gordon Childe . . 776
The Behaviour of Young Children. By Jean Ayling 777
Short Reviews 778
The Advancement of Botany. By Prof. T. G. Hill . 780
Forms of the Solar Corona and their Origin. By Dr. William J. S. Lockyer 784
Gassendi and the Transit of Mercury . . . 787
Obituary :
  Dr. David Starr Jordan. By A. S. W. . . 788
News and Views 789
Letters to the Editor :
  Branching of Lightning.—Dr. B. F. J. Schonland, O.B.E., and Dr. T. E. Allibone . . . 794
  Atoms and Molecules as Fitzgerald Oscillators.—Sir C. V. Raman, F.R.S. 795
  The Jumping Negative Glow.—W. A. Leyshon . 795
  Raman Spectra of Benzene and Toluene.—Leslie E. Howlett 796
  A New and Peculiar Marine Nemertean from the Australian Coast.—Prof. William John Dakin and Mahalah G. C. Fordham . . 796
  Anisotropy Due to Flow in Cellulose Sols.—J. M. Preston 796
  The Oldoway Human Skeleton.—J. Reid Moir . 797
  Priestley and Lavoisier.—Sir Philip Hartog, K.B.E. 797
  A New Locality for *Gammarus chevreuxi* Sexton.—F. T. K. Pentelow 797
Research Items 798
Astronomical Topics 800
The South African Association. GRAHAMSTOWN MEETING. By H. B. F. 801
Metallurgical Spectrum Analysis. By Dr. A. A. Fitch 802
Work of the Radium Commission 803
Human Embryology 804
University and Educational Intelligence . . . 804
Birthdays and Research Centres 805
Societies and Academies 805
Official Publications Received 807
Diary of Societies 807

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Industrial and Social Economics.

THE proceedings of the recent World Social and Economic Congress at Amsterdam, organised by the International Industrial Relations Association, are of the greater interest in view of the political and financial crisis which has since developed. An important paper on the principles and practice of scientific management, by Dr. H. S. Person, throws a searching light on the rationalisation movement and its applications, and discloses reasons for the apparent failure of rationalisation to effect industrial stabilisation and avert the present world-wide trade depression and unemployment. While this failure or partial failure is due in part to the misuse of rationalisation, to failure to pass on its benefits, and disregard of the principle of service, a major factor has been the limited scale on which rationalisation has been attempted. Stabilisation of a restricted area may increase the instability of the surrounding area, and complete stabilisation may be impossible owing to the impact of disturbing external forces which are outside the control of the management.

Scientific management has thus been forced continuously to extend its area of operations, and from the application of scientific principles to individual workshops has been compelled to extend them successively to the supply as well as to the production departments, to relations between workers and management, then to relations between production and markets and general administration. It is now considered necessary to apply the same principles to whole industries collectively, not merely on national but also on international lines, and it is the backward condition of many individual industrial and national units which has largely restricted the benefit to the world of the application of scientific management and rationalisation methods elsewhere.

It has already been admitted by authorities in widely differing walks of life that lack of economic statesmanship in general and of national planning in particular are the causes of depression, and the Macmillan Report asserted that an era of conscious and deliberate management must succeed the era of undirected natural evolution and haphazard development which has characterised the past. The recognition that economics acknowledges no frontiers prepares the way for an era of co-operation in which the disturbing intensive competition in basic necessities on a world scale is eliminated.

The keynote of the new era, as suggested by Dr. Lewis Lorwin, is to be economic planning, and this should be distinguished from both rationalisation and scientific management, of which it is a development. Although rationalisation implies a wide application of scientific methods and increased productivity, and has sometimes made for low prices, high wages, and mass prosperity, it has more often been used to maintain levels of prices out of proportion to decreasing costs of production. Experience shows, further, that combination for business purposes alone tends to restrict production and to maintain profitable price levels. What is now contemplated goes far beyond such conceptions and involves planning national and world development to give maximum satisfaction of the economic and the social needs of a people within a definite period. Essentially it attempts to correlate production and distribution on a world scale. It is offering new conceptions of economic life and methods of promoting a steady growth in standards of living.

Various attempts at social-economic planning have already been made. The voluntary business type is familiar and its limitations have led to the emergence of a social-progressive type of planning, which is that apparently contemplated by the Macmillan Committee. Such planning implies that economic leadership is not a monopoly of the business man, and involves a measure of governmental authority. It is a further break from the policy of *laissez faire*, and is in line neither with the traditions of free trade nor of nationalistic economic policies which since the War have developed protective tariffs to a height entirely disproportionate with economic need and rational development of industry and trade.

Scientific workers will welcome this movement as promising to relate administration and policy to the basic facts of the industrial, economic, and social system, and to liberate them from their bondage to political prejudices. Fundamentally, economic and social planning of national or industrial life involves research on the various factors involved before the successive stages of standardisation, control, stabilisation, co-operation, and planned development, can be realised, leading us to scientific management on a world scale. It involves the balancing of opposing group interests on the basis of ascertained facts and not on the self-valuation of the groups concerned.

Dr. Lorwin considers that there is nothing in the present situation to justify the easy belief that the depression will right itself without conscious effort, that the world need not be troubled with the spectre of its recurrence, or that the rapid economic changes which have persisted since the War will come to an abrupt end. On the contrary, as emphasised by Mary van Kleeck, vice-president of the International Industrial Relations Association, in summarising the discussions at the final session, the security of civilisation demands the exercise of the most expert intelligence which the world's intellectual and technical resources can bring to bear on the common world task of maintaining and raising the standards of living of all people. This involves not merely the handling of the immediate critical problems but also the direction of the resources of intelligence towards the constructive upbuilding of social economic life. Statistical research must indicate the ways in which the world's productive capacity, so greatly increased by technical developments in the last twenty years, can be utilised to raise the standards of living.

Social-economic planning is thus no simple conception. Mary van Kleeck suggested that a world research centre is needed to co-ordinate technical effort, to secure uniformity in statistics bearing upon economic planning, develop greater precision in the methods of economic and social research, and to focus investigations upon practice, in the same way that scientific discoveries are applied in engineering and other industries.

Such planning postulates an adventurous spirit, a greater faith in the possibilities of life, a sense of social and ethical values; and holds out to man, through the synthesis of science and vision, a prospect of ordered evolution. As Dr. Lorwin points out, it is based on a philosophical faith in the power of man to promote orderly economic and social change through scientific research and constructive imagination.

History of Alchemy.

Entstehung und Ausbreitung der Alchemie. Von Prof. Dr. Edmund O. von Lippmann. Band 2: *Ein Lese- und Nachschlage-Buch.* Pp. vii + 257. (Berlin: Julius Springer, 1931.) 26·60 gold marks.

OF all works on the history of alchemy and early chemistry, that to which reference is made most frequently and with most confidence is Prof. E. O. von Lippmann's "Entstehung und Ausbreitung der Alchemie". Published in 1919, it immediately became indispensable to every student of the subject, and in the twelve years that have elapsed since its first appearance, its reputation as a masterpiece of wide learning and careful scholarship has become thoroughly established. Those twelve years have, however, seen the publication of much research upon the history of chemistry and alchemy—an amount probably greater than in any previous period of the same length—so that we must count ourselves fortunate in the fact that Prof. von Lippmann's seventy odd years have apparently in no degree diminished his prodigious activity.

This second volume is supplementary to the first. The articles in it are arranged alphabetically, as in an encyclopædia, and since the book is provided with three excellent indexes, reference to any particular topic can be made quickly and exhaustively. Some idea of the mass of new information that the author has collected may be gained from the fact that this supplementary volume is more than one-third of the size of the first, running to 257 pages. The sources of this abundant new matter are fully indicated, and Prof. von Lippmann has enriched the whole with that careful criticism and sound judgment so characteristic of all his historical writings.

To do justice to the book, a detailed review of considerable length would be necessary, but some of the most interesting features may be considered here. The problem of alchemy in China has attracted a good deal of attention lately, some authorities having suggested that alchemy was practised in that country centuries before the Christian era. If this suggestion were to be confirmed, it would be necessary fundamentally to revise our present views on the origin of alchemy, though on other grounds these would seem to be well established in broad outline, if not in detail. Prof. von Lippmann mentions the work of O. S. Johnson, who regards Chinese alchemy as an indigenous growth arising from the system of Taoism, and the more recent article of Davis and Lu-Ch'iang Wu, who suggest that alchemy may have flourished in China so early as the second century B.C. He himself agrees with Laufer that alchemy is an entirely foreign element in Chinese thought; but while Laufer believes that alchemy appeared in China in the second century B.C., " when China was actually flooded by an invasion of influences rushing on from the West ", von Lippmann, on the contrary, is of the opinion that the introduction was made by the Arabs towards the beginning of the ninth century A.D. This appears to be the more likely, inasmuch as Chinese alchemical writings are said to be clearly affiliated to the early form of Arabic alchemy, in which the Greek influence was more fully apparent than it became later. Prof. von Lippmann would regard alchemical passages in Chinese works definitely earlier than the ninth century A.D. as skilful interpolations of a considerably more recent date.

On the discovery of alcohol, the author finds no reason to alter his previous conclusion: that is, that alcohol was first obtained by distillation in southern Italy in the twelfth century. He regards as erroneous the old tradition that alcohol was first prepared by the Arabs—a tradition that certainly finds no support from any Arabic alchemical treatises hitherto studied.

The perplexing problem of Jabir or Geber has undergone yet a further transformation through the work of Kraus, Schaeder, and Husain Hamdani. From a study of certain Arabic works of Jabir published by the reviewer, these scholars conclude that while the books in question were undoubtedly written by a single author, they must be assigned to the end of the ninth century or the beginning of the tenth. An earlier date is impossible, since the books are steeped in the doctrines of the Isma'ilite sect, which arose in the latter half of the ninth century. The conclusion is supported by the fact that the author uses terms of ophthalmic medicine which did not appear in Arabic literature before A.D. 860. The provisional identification of Jabir's father with the Abbasid agent Hayyan, who lived at the beginning of the eighth century, must consequently be regarded as untenable, and we are still left in ignorance of the life of the greatest chemist of Islam.

Prof. von Lippmann would make the discovery of the mineral acids contemporaneous with the improvements in distillation that led to the discovery of alcohol in the twelfth century. On general grounds, however, this late date seems improbable, since alum and blue and green vitriols were well known in earlier times and must have been heated occasionally in such a way that Nordhausen acid was obtained. There is, moreover, an Arabic work ascribed to Jabir (" The Chest of Wisdom ") in which the preparation of nitric acid is clearly described, though—as is so often the case—the work may not be authentic. Later Arab chemists were certainly well acquainted with nitric acid, which they called " parting-water " on account of its use in separating gold from silver.

Among the etymologies mentioned by von Lippmann are several of interest. Thus ' sory ', a mineral name of frequent occurrence, is derived from the Egyptian ' se-ur ', the great salt; ' kassíteron ', the Greek name for tin, probably comes from ' kassitira ', meaning ' from the land of the Kassi ' or Kassites, a people first mentioned about 2100 B.C.;

while the suggested derivation of indigo from the Egyptian 'n-tinkon' or 'dinkon' has not been confirmed.

The extraction of zinc probably arose in Persia, where it was certainly practised towards the end of the sixth century A.D. There was, however, confusion of this metal with tin for nearly another thousand years, though Boyle always clearly distinguished between spelter (zinc) and pewter (here tin or an alloy of tin and lead). The extraction of zinc was introduced into England by Lawson, about 1700, who had learnt the process in China, and the chief centre of production was Bristol. Zinc oxide was used in the treatment of disease so early as 1150.

Antimonium, as the name of antimony sulphide, is derived from the Greek ἀνθεμώνιον, and may be explained by the characteristic appearance of the naturally occurring crystalline mineral. The element itself has been known for at least 4500 years, since a large antimony bowl of the time of King Gudea (about 2600 B.C.) has recently been discovered.

Such are a few samples of the interesting fare that Prof. von Lippmann sets before us. So far as we have been able to ascertain, very little has escaped him, however obscure the source, and his book is bound to prove of the utmost possible value to historians of chemistry. We feel that perhaps he has not made as much use as he might have done of Dr. Campbell Thompson's investigations into the chemistry of the ancient Assyrians, and that more attention might have been paid to alchemical theories as distinct from facts; but these are minor points that in no way detract from the excellence of a wholly admirable book.

E. J. Holmyard.

The Prehistoric Colonists of Yorkshire and their Economics.

Early Man in North-East Yorkshire. By Frank Elgee. Pp. xvi + 259 + 30 plates. (York: The Author, Shirley House, Commondale, 1930.) 25*s*. 9*d*.

A MINUTE field study of a quite small area often paves the way not only to a vivid realisation of the life of our forerunners in the region studied, but also to the solution of problems of much wider scope. Mr. Elgee has not only tramped the moorlands and vales of north-eastern Yorkshire, closely scrutinising the humblest traces left there by prehistoric man, but he has also ransacked the obscure records left by early antiquarians. The results of this labour of love, embodied in the eminently readable and richly illustrated volume before us, will be welcomed both by the specialist, as a solid contribution to prehistory, and by the layman, as a fascinating picture of early life in a delightfully scenic background.

The first inhabitants of the region would be the makers of the mysterious pygmy flints, many of which the author has himself detected. They would have been followed by wielders of stone axes, but it may be doubted whether these can, as here suggested, be separated from the builders of long-barrows and Beaker folk, who certainly used such tools. A rectangular cross-section in celts of stones other than flint does not necessarily betoken Scandinavian influence, since fine-grained rocks are often shaped by sawing. The long-barrow builders in any event represent an influx from the west; for Mr. Elgee successfully defends the connexion of the Yorkshire monuments with those of western England against Kendrick's attacks, though he is not attracted by my suggestion of a wooden chamber under such barrows, and is convinced of the deliberate intention of the incinerations noted by Greenwell. The arrival of these colonists from the west did not long anticipate the advent of invaders from the east, here divided into two groups—Beaker folk and battle-axe folk of more northern affinities. In this connexion a remarkable (?) copper double-axe of pure Cretan type from Whitby is here described, though its ancestry must lie in the south, and it is the prototype rather than the descendant of the Danish stone axes with which it is justly compared. Both groups settled in north-eastern Yorkshire, in only small numbers in comparison with the intensive occupation of the Wolds, and avoided the bleak moorlands altogether, as had the long-barrow builders, with whom the easterners eventually amalgamated.

In the later Bronze Age, on the other hand, cinerary urns are more abundant in the north-east than in the south, and spread right into the moorland wastes. Mr. Elgee argues that the vessels were made by descendants of the earlier Bronze Age population, and that the cinerary urn was developed out of the food vessel in Yorkshire itself. The spread of the autochthonous population on to the inhospitable moors would result from the pressure of fresh invaders, characterised by new types of bronzes, who by virtue of their superior weapons would have been able to occupy the more fertile wolds and vales. These intruders would be Peake's sword-bearers and the 'Hallstadt' folk

(Hallstatt is thus misspelt throughout the book) whose settlement at Scarborough has recently been discovered. To the same people are attributed the lake-dwellings in Holderness and near Pickering, two of which have yielded bronzes of the foreign types, though most of the pottery has been called Romano-British.

In any event, our author establishes a sufficient discrepancy between the distribution of the 'native' cinerary urns and that of the 'foreign' bronzes to confirm Crawford's view that the latter were introduced by Continental invaders. The last wave of intruders before the Romans was the people of La Tène, a culture responsible for the famous chariot burials. This people can be with some confidence identified with the Parisii of Ptolemy. Their neighbours, the Brigantes, must then have been descended from the sword-bearers, and Mr. Elgee advances an ingenious argument to prove that these spoke a Goidelic language.

Thus Mr. Elgee's researches seem to have cleared up the ethnological history of his district in a manner calculated to throw light on the general problems of British archæology. But even more interesting is the fresh evidence on primitive economics here collected. The use of Whitby jet in prehistoric times is critically and cautiously studied. It does not afford any support for the thesis that 'megalith-builders' came to Yorkshire to exploit the deposits of this commodity. The distribution of the monuments seems to be bound up with that of suitable pasture-land.

Then our author has identified on the moors the settlements of the late Bronze Age people, their fields and their routes. The major barrows covering cinerary urns are found to be strung out along natural ways exactly as Sophus Müller found in Denmark. The lines of large howes link up regular cemeteries of smaller barrows which, though they seldom yield datable objects, must be regarded as the graves of commoners of the same culture. In the immediate vicinity of the cemeteries Mr. Elgee finds stony areas, sometimes defended by banks and ditches, which he plausibly interprets as the settlements of the barrow-builders; and near by are irregular enclosures comparable to the cultivation plots found near hut-circles on Dartmoor. Such big stones have been left in the plots that they must have been tilled with the hoe rather than the plough. Thus a peculiar system of rural economy which can be paralleled on other moorlands in the British Isles is logically attached to a specific phase of the Bronze Age culture, and its cultural age, recently called in question, is convincingly established. We say 'cultural age' advisedly, since it is here very properly admitted that many barrows with cinerary urns are posterior to the advent of the Hallstatt and even of the La Tène invaders.

Less convincing is the theory borrowed from Mortimer, that the barrows are laid out to represent constellations, thus indicating star worship. Prehistoric man did not view the cemeteries from an aeroplane, and from the ground can scarcely have seen the similarity of a barrow-cluster to the Plough that we can observe on a drawn plan.

V. GORDON CHILDE.

The Behaviour of Young Children.

Intellectual Growth in Young Children. By Susan Isaacs. With an Appendix on Children's "Why" Questions, by Nathan Isaacs. Pp. xi + 370. (London: George Routledge and Sons, Ltd., 1930.) 12*s.* 6*d.* net.

THIS book, the first instalment of a three-volume work on the behaviour of young children, is a valuable contribution to a vitally important subject. The last few decades have seen the emancipation of psychology from the dead hand of traditional philosophical thinking: the last few years, the partial emancipation of child study from the tyranny of outworn ideas. Dr. Susan Isaacs has based this volume on the records of work carried on under her direction at the Malting House School for young children at Cambridge in the years 1924–27. The school consisted of a group of intelligent children ranging at the outset from 2½ to 5 years of age. Its aim (so far as intellectual development is concerned) was to stimulate the active inquiry of the children themselves by bringing within their immediate experience every range of fact to which their interests reached out. This was indeed a formidable undertaking, but one of real importance and profound interest.

Indications are not lacking that the intelligent child is capable of taking a scientific interest in the external world, even in the so-called pre-school period. It becomes, then, a matter of great urgency to obtain accurate and full records: these records must represent first-hand observations by skilled and unprejudiced inquirers. How else can a start be made on solving the problem of successfully fostering the scientific interests of the young child?

The intensive study of the behaviour of young children is also of significance from the point of view of pure science. The disastrous effects of allowing untested *a priori* ideas to dominate psychology can only be counteracted by the careful study of human beings from the cradle to the grave, in which facts are the basis for cautious inductions and tentatively constructed concepts. It may also well be the case that full and deep knowledge of the mental functioning of human beings depends fundamentally on knowledge of this functioning in the young.

The importance of the problem of behaviour to be attacked in this trilogy needs no stressing, but it may be useful to point out that the method of the inquiry will repay the attention of the methodologist. Here we have a domain where even careful observations and simple experiments are comparatively few in number. In this book the records are presented dispassionately, with a detailed account of the conditions under which they were made. One of the difficulties has evidently been how to select from so great a wealth of material, without falling into the errors of those older psychologists who made their particular psychological generalisations first and selected their instances after. Particularly interesting in this connexion is the inclusion of the full records for four distinct weeks in the life of the school. Here there is no selection of data: a fair sample of the available data is recorded impartially for the use of the students of the subject, in accordance with the best canons of scientific method.

Side by side with the collection of scrupulously careful first-hand observations are certain sections in which the author gives an account of the theoretical views to which she has thereby been led. As a specially interesting example of this, we may cite the work on the biological interests of the young child. Some of this work was originally published in the *Forum of Education* and so is known to those who are interested in suggestions which scientific theorising has to offer as to the optimal education of the young child. In its more complete form, it should attract the attention of the professional educationist and also of the parent who seeks to assist his child to a fundamentally sound conception of living things. The records deal with a period of three years and range from the growing of mustard seed to the care of tortoises, worms, tadpoles, salamanders, and lizards, from the observation by the children of pregnant and suckling mice to the dissection of a crab, a toad, and a mouse.

Just how important in the emotional and intellectual development of the individual this early acquaintance with the essential facts of life, death, and reproduction may prove is still, I take it, an open question. However, according to current psychological theories, the probability is that it has considerable value. In the further development in the future of this problem of educational technique, this clear-cut contribution must prove of value. The actual records are here for all to use who care to do so. There are, besides, inductions from these records as to the conditions which should be satisfied if we are to make (p. 164) " a positive educational use of the child's impulses, so that they shall be fertile in skill and imaginative understanding and lead out of themselves to the world of objective knowledge and common human purpose ".

Mention should also be made of appendices from the pen of Mr. N. Isaacs on children's 'why' questions, an essay of great interest and high epistemological worth, and his short article on " Education and Science ", originally published in NATURE for July 23, 1927, p. 105, which is here reprinted.

Dr. Isaacs' book is destined to take its place among the classics on the behaviour of young children. Educationists, psychologists, and intelligent parents will await with lively interest and considerable impatience the second volume, which will deal with the social development of young children, and the third, which will contain individual histories of some of the child collaborators, to whom the author has dedicated the work.

JEAN AYLING.

Short Reviews.

Fifth International Botanical Congress, Cambridge, 16–23 August, 1930. Report of Proceedings. Edited for the Executive Committee by F. T. Brooks and T. F. Chipp. Pp. xiv + 680. (Cambridge: At the University Press, 1931.) 21*s.* net.

THE publication of the Report of the Fifth International Botanical Congress within little more than a year after the close of the meeting reflects credit on all concerned. In the preface to the volume, the president, Prof. A. C. Seward, pays a tribute to the efficiency of the two honorary secretaries and editors and to the memory of one, Dr. T. F. Chipp, who died while the book was passing through the press.

The Report records the history of the Congress from its inception in 1926, the personnel of the officers and of the executive and sectional committees, and also the names of delegates, representatives, and members. The detailed programme of the meetings, excursions, and social activities will recall to those who participated the interests and experiences of a crowded but enjoyable week in Cambridge in August 1930. A volume of abstracts of communications provided by authors was prepared for use during the Congress; these have been incorporated, with some additions, in the present report, and the recorders of sections have also supplied a précis of the various discussions. A very full report of the work of the Congress thus becomes available, and will be valued not only by members, but also by botanists generally as providing expression of opinion by experts on subjects of current interest. An index of authors of papers and speakers in discussions facilitates reference. The *compte rendu* of the discussions in the subsection appointed to revise the rules of botanical nomenclature, prepared by the *rapporteur général*, Dr. John Briquet, will be of special interest to many botanists.

A photograph of the president forms a frontispiece to the volume, and one of the executive committee and officers is placed at the end. The book is clearly printed and of attractive appearance; a word of thanks is due to the Cambridge University Press for its share in this production.

Acoustics: a Text on Theory and Applications. By Prof. G. W. Stewart and Prof. R. B. Lindsay. Pp. ix+358. (London: Chapman and Hall, Ltd., 1931.) 25*s.* net.

THE revitalisation of the subject of acoustics brought about by applications of the thermionic valve is reflected in all the newer books on the subject. The present volume, based upon lectures in a graduate course in electrical communications given at Yale University by Prof. Stewart, who is known for his pioneer work on acoustical filters, is no exception. So good is the book that one can merely note two minor defects, the omission of authors' names from the index and the rather too comprehensive title.

Since the plan followed is to give only as much of general acoustical theory as is necessary for the treatment of the topics selected, omitting such subjects as vibrating strings and bars, the title "Theory of Applied Acoustics" would perhaps have expressed better the scope of the book. Needless overlapping with standard general works on sound is avoided and the space so saved is used to give remarkably lucid expositions of modern developments. Of necessity a good deal of difficult mathematics has to be used, but one feels that the mathematics has been written in a physical laboratory, as, for example, on p. 22, where in the midst of a derivation of the general wave equation a pause is made to examine the actual numerical values of the quantities represented by the symbols.

The book is so written that the treatment of many particular subjects can be read without further reference to other pages. Many readers will be thankful for such foresight as that shown on pp. 55-56, where the authors take care to explain not only their own use of the term 'acoustic impedance' but also the three other different uses in the literature. The book can be heartily recommended to all interested in modern acoustics.

W. H. G.

Handbook of Cornish Geology. By E. H. Davison. Second edition. Pp. 114+4 plates. (Truro: Oscar Blackford, 1930.) 6*s.*

SINCE the first edition of this excellent little book was issued, in 1926, many investigations of the mineral veins and igneous rocks of Cornwall have been made, largely as a result of the work and influence of the author and of Dr. A. Brammall. Mr. Davison is well known as an authority on the Cornish lodes, and Dr. Brammall's unsurpassed petrological work on Dartmoor has stimulated his colleagues and students to apply his methods to the Cornish granites. In consequence, though only five years have elapsed, the second edition marks a very considerable advance on the first. Many parts of the chapters on contact metamorphism, volatile constituents, and lodes have been rewritten, and a new chapter has been added on china clay.

As an outline of the geology and mineralisation of one of the most interesting of English counties the book should be widely welcomed by teachers and students of petrology and of mining and general geology. It is simple and lucid in style, and clearly and effectively illustrated with maps, sections, and photographs. There is certainly no better guide to the visitor who takes an amateur interest in his geological surroundings. Brief descriptions of localities of geological interest are given, and of the chief mines and their minerals. It is recorded that, although most of the mines are at present perforce closed down, specimens worth collecting can usually be found on the waste heaps. A bibliography is added of the Survey maps and memoirs and of the chief papers published since 1906 relating to the district.

The book can be warmly recommended to all who are interested in the geology and economics of Cornwall.

Physical Metallurgy Laboratory Manual. By Dr. Norman E. Woldman. Pp. v+259. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 17*s.* 6*d.* net.

THIS manual is intended to give the student of metallography a series of exercises with the object of familiarising him with the structure of the most usual metals and alloys. The theory of the subject must be studied elsewhere, and stress is here laid on the practical methods of metallographic examination. The book contains a very large number of illustrations, mostly photomicrographs, and detailed directions for the development of each structure are given. The taking of heating and cooling curves and the determination of the effects of heat treatment on the structure of steel are also described. A short section on the subject of X-rays is useful so far as the detection of blowholes and cracks by that means is concerned, but the pictures of crystal structure obtained by the passage of X-rays through metals would be unintelligible without further explanation than is given here. The use of high magnifications is illustrated by some of the well-known photographs of Lucas, but a warning that only investigators of quite exceptional experimental skill can obtain such results at a magnification of several thousand diameters would not have been out of place. Most of the photographs are of very satisfactory quality, and the book will be found useful for reference, even by those who do not wish to work through its exercises.

The Advancement of Botany.*

By Prof. T. G. HILL.

DOUBTLESS it is a coincidence that the year 1831 marks not only the founding of the British Association but also, so far as a date can mark, the beginning of a threefold epoch in botany: the search for a natural system of classification; the emergence of morphology as a study separate from taxonomy; and the development of physiology.

In the first, Britain gave a full share; but in morphology and physiology, on the other hand, the tale of British activity is dismal indeed: against a battalion of Continental workers we could barely range a section, and British work caused only a ripple on the botanical surface. But there is one exception: the brilliant generalisations of Charles Darwin.

MORPHOLOGY.

In 1831, morphology for the most part had relation to the phanerogams only; the structure and life history of no plant was completely known; the fields of the vascular cryptogams, the bryophytes, and the thallophytes were almost untrodden. It is not surprising, therefore, that when ontogeny came into being the trickle of investigations fast developed into a flood, and for this the greatest honour is due to Schleiden, Nägeli, von Mohl, and Hofmeister, for they showed the way and contributed the most.

A welter of facts was discovered, many of which, especially those relating to the Thallophyta, had to await the arrival of a new technique, that of cytology, before co-ordination was possible; but for the Muscineæ, the vascular cryptogams and the angiosperms, the times produced the man whose patient and detailed work, directed by a keen intellect, gave cosmos to morphological inquiry. I refer to Hofmeister, one of the greatest botanists of all time. He first traced the development of the sexual organs and of the embryo. He was the first correctly to interpret heterospory: he discovered the alternation of generations. Nowadays, alternation of generations is accepted as a matter of course, but when it is realised that Hofmeister was working it out, almost cell for cell, more than eighty years ago without the aid of the microtome and of cytological technique, as we know it, it will be appreciated how great was his work.

Although many contributed to anatomical knowledge, the great advances were associated with the names of relatively few men. Of these, Schleiden and Schwann, the zoologist, are the first to be commemorated since they laid the foundation of the scientific study of anatomy in their theory of the cell, which enabled others, especially von Mohl and Nägeli, to build a knowledge of the anatomy of plants on a sound basis. Von Mohl discriminated the tissue elements and traced the course of the vascular system. He was the first accurately to trace the development of vessels and gave the first correct account of stomates. His observations on periderm and cambial activity are of first-rate importance.

Nageli made several well-known anatomical investigations. His investigations on the cell wall and on the starch grain are classical: the recognition of the cell wall as a product of protoplasmic activity, growth by intussusception and the occurrence of granulose and amylose in the starch grain, need only be mentioned. The results he obtained by the use of polarised light were as important as those of Sponsler and others by the use of X-rays in our own times.

In the earlier study of cytology, von Mohl and Nägeli were the pioneers. Von Mohl was the first to see cell division. Later, he studied the 'mucilage' described by Schleiden in 1838; he recognised it as a distinct component of the cell and gave it its present name, protoplasm. He described the primordial utricle and realised that the streaming movements of the cytoplasm were independent of the cell sap. Further, von Mohl perceived that the matrix of the chloroplast was protoplasmic.

Nägeli more carefully observed the nucleus and appreciated the facts of cell division more truly; and in this he was the first to recognise that the nucleus is the starting-point. With the passing of time it was recognised that the protoplasm of the plant and of the animal is identical and that it is the basis of life, a conclusion to which Payen, Cohn, and Max Schulze contributed much.

The improvement of microscopical technique led to great discoveries in the details of nuclear division. In this the work of Strasburger is outstanding, and to him is due the main credit of firmly establishing that aspect of botany now called cytology. The contributions of Fleming and of Schmitz must, however, not be overlooked, nor those of Guignard, who, unfortunately, prejudiced his own work by his description of structures which had no existence.

PHYSIOLOGY.

Our knowledge of osmotic phenomena is founded on Dutrochet's studies (1827) on differential diffusion through a colloidal membrane. Graham showed (1854) that the rate of this diffusion depends, *inter alia*, on the nature of the membrane. This led to Traube's discovery of the so-called artificial cell produced by dropping a crystal of copper acetate into a solution of potassium ferrocyanide. This observation was used by Pfeffer (1877), who supported the membrane of copper ferrocyanide in the wall of a porous pot and with it made many highly important observations. Thus was born a branch of physical chemistry, and one of the first results was van't Hoff's theory of solutions. At this time de Vries also was busy on the problem and contributed a great deal to it.

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* From the presidential address to Section K (Botany) of the British Association in London on Sept 28.

Hales, Priestley, Senebier, Ingen Housz, and de Saussure were the pioneers in the study of carbon assimilation, with the result that the more obvious facts were known before 1831. Of these men, de Saussure was the greatest: he was the first to strike a balance which indicated the unity of the photosynthetic quotient, and to show that water and salts, as well as carbon dioxide, are essential for the nutrition of the green plant. His work, however, naturally did not convince the upholders of the humus theory; the problem was settled beyond dispute by Boussingault, who, in 1851, introduced the method of water culture.

Dutrochet (1837) correlated carbon assimilation with chlorophyll and was the first to use the 'bubbling method', a method adopted and improved by Sachs and used by him in quantitative experiments.

Von Mohl (1851) considered that a carbohydrate was formed from the carbon dioxide, but it was Sachs who proved that the starch grains in the leaf were produced from carbon dioxide. Sachs considered that starch was the first product of carbon assimilation; it was not until some years later (1885) that Meyer showed that there were sugar leaves as well as starch leaves and thus indicated that sugar preceded starch in the process.

Turning to the pigments associated with photosynthesis, Grew was the first to suggest that chlorophyll, using the word in its loose sense, was made up of more than one pigment, but to Stokes (1864) is due the credit of making the first real advance; he demonstrated the presence of two green and two yellow pigments. The methods of separation of the mixed pigments were in time refined and culminated in the work of Tswett (1906), who, by his chromatographic method, separated two chlorophylls and five carotinoids, of which one was carotin and the others xanthophyll.

Many years were to elapse before the chemical constitution of chlorophyll was to be elucidated, but Hoppe-Seyler was the first to make the significant discovery, in 1879, that there is a chemical relationship between the green pigment of the plant and the hæmoglobin of blood. The formaldehyde hypothesis was originated by Butlerow (1861) and developed by Baeyer (1870).

Before 1831 certain fundamental facts of respiration were known: Ingen Housz had shown that the plant absorbed oxygen and evolved carbon dioxide, and de Saussure had discovered that a continuous supply of oxygen was necessary for the life of the ordinary plant, that the more vigorous the organ the greater was the amount of oxygen consumed. Dutrochet (1837) confirmed the work of de Saussure and showed that responses to stimulation are not made in the absence of oxygen. He distinguished between the evolution of oxygen in carbon assimilation and the evolution of carbon dioxide in respiration, which facts were confused by many subsequent workers.

The reasons for our deficiencies during this epoch are patent. In the first place, the classical traditions of our old universities dominated teaching, with the result that the approach to biology was, in the main, through medicine. Other reasons lie in the facts that the period was one of exploration, expansion, and development of the Empire, which meant an inflow of great numbers of plants for identification, and the labourers were few. Finally, the systematists did not entirely favour the new movement and, if not actively antagonistic, they looked upon it with amused tolerance.

THE RENAISSANCE OF BOTANY IN BRITAIN.

The botanical renaissance in Great Britain began about 1875 and it happened in the Royal College of Science. The credit for it is due to Thiselton-Dyer, who, as Huxley's demonstrator, instituted and conducted the first laboratory classes in botany. University College, London, immediately followed. At Cambridge was Sydney Howard Vines.

In 1882 in all branches of botany there were masses of well-ascertained facts; the principles appeared to be settled and the problems formulated. Some aspects, such as anatomy, were in an advanced stage and were developing in various directions; other aspects, physiology, for example, were relatively backward.

In Germany especially, causal morphology was more dominant, in which development von Goebel played a pre-eminent part. His work and his teaching on the influence of the environment on the configuration of plants cannot be too highly appraised; he with Wiesner, Haberlandt, Stahl, Bonnier, and other pioneers stripped morphology of its formalism and revealed the plasticity of the plant.

Of the lower groups I shall say but little; one name, however, leaps to mind, that of Klebs, whose work on the conditions governing the reproduction of the green Algæ is classical. In mycology, Marshall Ward laid the foundation of the modern British school. Of a later date, Blakeslee's discovery of heterothallism was of the greatest importance and led to far-reaching results.

A great contribution to our knowledge during this period was given by the palæontologists. Stur and Williamson recognised the occurrence of fern and gymnosperm characters in certain fossil plants, and with the increase of evidence a separate phylum was recognised and named Cycadofilices by Potonié in 1899. Later, in 1906, Oliver and Scott made known their observations on the seed-like structures attached to the fronds of *Lyginodendron*. Passing on to the gymnosperms, the work of Strasburger and others was continued and many gaps in our knowledge were filled; but of all these investigations the most sensational was the discovery in 1896 of the motile sperms in *Ginkgo* and *Cycas revoluta* by Hirasé and Ikeno respectively. Mention also must be made of Wieland's important work on Cycadeoidea and other fossil cycads.

This progress was accompanied by that of detailed cytology, which immediately reacted to the conception of Strasburger and Weismann that the nucleus is the bearer of heredital qualities (1884). The reduction in the number of chromosomes was discovered in the parasitic worm *Ascaris* by van Beneden in 1883; the next year Strasburger observed it in the Angiosperms, and this was followed by similar observations by Overton and by Farmer in other groups. Thus was initiated a period of intense cytological study.

The condition of anatomy in 1882 is shown by De Bary's "Comparative Anatomy of the Phanerogams and Ferns": the fundamental facts were well ascertained and the application of those facts determined the direction of increasing knowledge. In Germany the trend, initiated by Radlkofer, was taxonomic, and Solereder took the leading part; in Austria, Haberlandt developed physiological anatomy, whilst in France the drifts were various. The study of purely descriptive anatomy was continued by Hovelacque, for example; Sauvageau, Costantin, and others studied structure in relation to environment, and van Tieghem was the father of stelar theories. In Britain the main morphological interest was phylogeny and this gave the bias to anatomical study. Its principles were first applied by Williamson and Scott in their studies of the fossil plants of the coal measures.

In 1883 van Tieghem and Duliot published their theory of the stele. Their deductive conclusions were not checked by ontogenetic studies, with the result that their theories were discredited soon after the intensive investigations on vascular anatomy were begun in Great Britain. In remembering those who contributed most to this aspect of vascular anatomy, Gwynne-Vaughan comes first, not only on account of his sustained work, but also for the fact that he recognised and demonstrated the importance of the leaf trace.

In the year 1900 came the independent discovery of Mendel and the confirmation of his work by de Vries, Correns, and Tschermak. The effect was immediate; for the first time genetics had definite laws which clarified many problems and disclosed others. It is doubtful if any other botanical work caused such an outburst of activity over so wide a field: a period of intense plant breeding set in; the transmission of colour factors stimulated the investigation of the flavones and other petal pigments and also the distribution of oxidases; and a new field of vast area was opened to the cytologist.

This period is remarkable also in that it saw the growth of ecology. The first ecologist was Humboldt, who was the first to realise the units of vegetation and to essay their ordering (1805). His system, however, was unsound. Interest in the subject was resuscitated by Grisebach in 1872.

Ecological study now became very active: in France, Bonnier was at work on the influence of edaphic factors on plant form and Flahault on vegetation surveys. In Belgium, Massart was studying littoral vegetation (1893), and in Switzerland there was Schröter. A few years later saw the entry of the American vanguard—Clements, Cowles, Harshberger, Livingstone, and Pound, and in New Zealand Cockayne followed his lonely bent (1901). Robert Smith was the pioneer in Great Britain: in 1898 he published his observations on the plant associations of the Tay Basin, and this was succeeded by various other communications. He was followed by his brother, W. G. Smith, Moss, Rankin, Lewis, Tansley, Yapp, Oliver, and others.

Another noteworthy series of observations of this period was those on the ascent of sap. Strasburger's experiments pushed home the idea that the phenomenon was entirely physical, a view which was adopted by Askenasy, and Dixon and Joly (1895), who realised the significance of the tensile strength of water and on it founded their well-known explanation. Concurrently, the splendid lead given by Pfeffer and de Vries was vigorously followed, and the problems of permeability, osmotic pressure, and, in general, the water relations of the cell, were the subject of hundreds of papers.

Mention also must be made of the progress of knowledge of the gaseous diffusion into and out from the ordinary leaf. F. F. Blackman showed that the evolution of carbon dioxide during respiration and its intake during carbon assimilation was, in general, proportional to the number of stomates on the leaf surfaces. These results were confirmed by Brown and Escombe (1905). Their classic work on the static diffusion of gases was published in 1900, the kernel of which is that the rate of diffusion through the pore of a stomate is governed by the law of diameters.

Turning to metabolism, this third period is remarkable for the clearer focusing of the circumstances attending metabolic activity, and especially of the action and interaction of those factors which influence the rate of particular activities. Before 1905 these factors were considered separately and various optima were given for various functions. The insufficiency of this was soon appreciated by F. F. Blackman, and his application of Liebig's law of the minimum to physiological processes led to his conception of limiting factors. The truth of the doctrine is generally admitted, but the observations of Boysen-Jensen, Harder, Lundegardt, Warburg, and others indicate that a particular factor is only strictly limiting when it is very much weaker than the others.

It has been mentioned that Hoppe-Seyler established a chemical relationship between chlorophyll and hæmoglobin. His work was carried much further by Marchlewski, Nencki, Schunck, and Zaleski. Their work paved the way for Willstätter, who with his fellow-workers, by improved methods of experiment, obtained a number of products—the phytochlorins and the phytorhodins. The fact was established that magnesium is an essential constituent of chlorophyll and that the pigment is an ester of the alcohol phytol. These facts led to the chemical characterisation of two chlorophylls, and, later, of carotin and xanthophyll. A few years after Willstätter and his collaborators elucidated the composition of many anthocyanins.

Of the sequence of events in the elaboration of food stuffs, but little real progress was made. The work of Brown and Morris (1893) on the chemistry and physiology of foliage leaves, in which they recognised sucrose as the sugar first formed in carbon assimilation, is outstanding and was the first of many investigations amongst which the work of Parkin, Davis, Daish and Sawyer, Gast, Kylin and Weevers may be mentioned.

The work of the Darwins, Sachs and Pfeffer on irritability was continued throughout this period, and, indeed, to the present day.

The natural sequence of this tropistic work was an inquiry into the mechanisms of the sense organs. The statolith theory of graviperception, due to Haberlandt and Němec, was, in general, accepted. In addition to those mentioned, Noll, Czapek, Jost, Vöchting, Oltmanns, de Vries, and Rothert contributed much to the elucidation of the problems. There remained the question of the transmission of the stimulus from the perceptive organ to the motive region. Boysen-Jensen (1910) showed that a stimulus could pass through a water-gap but not through a thin plate of mica. Thus arose the idea that definite bodies, hormones, were generated in the perceptive region by the action of the external agents and travelled to the motive organs to activate the visible reaction. These observations were continued, and amongst those who contributed were Nielson, Paàl, Purdie, Rothert, Stark, Dreschel, Snow, and especially Went.

Present-day Botany.

The present period is chiefly remarkable for the great output of work in those branches of botany which have an applied aspect. Thus mycology, plant pathology, genetics and cytology occupy a prominent position. In physiology, but little progress has been made in the elucidation of the serial events of the various metabolic changes. But the closer examination of the governing factors, the conditions of growth and the more detailed analyses of these activities, have secured our knowledge, inadequate though it be, more firmly, and also have disclosed certain relationships of first-rate importance, hitherto unsuspected —photo-periodism, in which Garner and Allard were the pioneers; the carbohydrate-nitrogen ratio, to our knowledge of which Kraus and Kraybill have contributed much; and the principle of predetermination so clearly demonstrated by Balls. The application of the principle of the hydrogen ion concentration has given an instrument of great precision capable of use in the investigation of a wide range of problems. The cell wall constituents have been the subject of intensive investigations, some dictated by the requirements of industry, and important discoveries and elucidations have been made.

A survey of this period shows two well-defined tendencies: specialisation and the obliteration of the artificial margins between botany and cognate studies.

The study of physiology in particular and of many aspects of ecology require the application of the technique and conceptions of physics and especially of chemistry: this will increase in the future; if the approach to such problems be made from the biological point of view, progress will be more assured.

The stress of the War soon forced lessons home, and amongst other things learnt was the dependence of man on the plant. The experience of the War was, curiously enough, not forgotten when peace came, with the result that the training of young botanists for economic work and for the investigation of definite problems became with time a settled policy. But other nations also have learnt the lesson—low living ever has been an incentive to high thinking—with the result of gross over-production—some prefer to call it under-consumption—of essential commodities such as wheat, sugar, and rubber. This is mostly due to the unconsidered use of the great advances of applied botanical knowledge and of agricultural engineering without regard to economic consequences. The present tendency in States and industries to curtail expenditure on research and expert knowledge is a wrong policy: "They that be whole need not a physician, but they that are sick".

The successful conduct of these and many like activities is impossible without expert advice. In Great Britain this is provided by many research stations, and their development is all to the good. But there are a few dangers. The founders of new research institutions may be unmindful of the fact that results cannot be commanded. This may react on the investigators, who may be tempted to justify themselves by the dissemination of unripe fruit. Again, the promotion of applied research may tend to obscure the value of pure research. Lastly, there is the comparative isolation of the workers from their academic brothers so that both lose a source of stimulation and ideas. These possible dangers will be eliminated if there be some connexion, the closer the better, between the botanical departments of universities and the research institutions, accompanied by an occasional interchange of the workers in both.

The British Commonwealth of Nations is, in the main, an agricultural Empire: the great need for trained botanists for its administrative and technical service is patent; the problem is their supply and their training. The increased demand is slowly having its effect in the universities, and more students are taking botany for their finals, but their numbers are too few. In the university the training of young botanists for the first three years must be in pure science; this is absolutely essential, and should be followed by a period of appropriate specialised training.

This raises the problem of the manning of our botanical departments: universities cannot compete with industry in matters of salary, and this in the past has resulted in good men being lost to academic work, especially in plant physiology. If good material for the service of the State and of industry is to be provided and pure research maintained, an adequate flow of recruits of the highest quality into academic life is essential.

Forms of the Solar Corona and their Origin.

By Dr. WILLIAM J. S. LOCKYER, Norman Lockyer Observatory, Sidmouth.

IT has long been known that the solar corona undergoes cyclical changes of form synchronising approximately with the eleven-year period of solar activity as determined by the variation of the spotted area on the solar surface from year to year.

These forms are so pronounced and distinctive that they can be classified into three main types, known as 'Polar', 'Intermediate', and 'Equatorial'. The characteristics of the types are as follows :

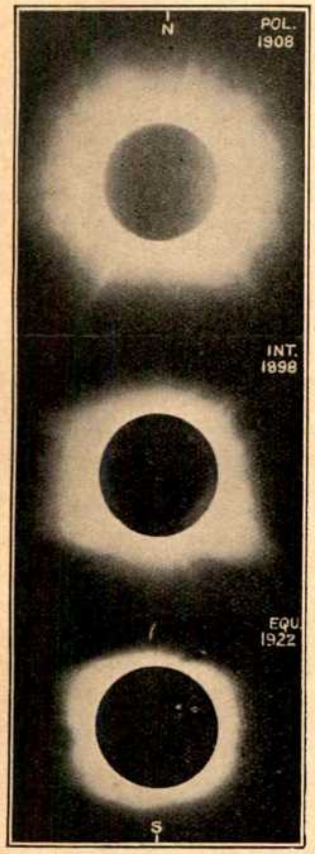

FIG. 1.—Types of solar corona.

(1) The 'polar' type includes those irregular forms in which the streamers are situated all round the solar disc; the polar 'rifts' or 'plumes' in this type are conspicuous by their absence. This type is usually termed the 'maximum' or 'maximum sunspot' type.

(2) The 'equatorial' type is exhibited when the streamers are restricted to comparatively low solar latitudes, and the poles display the 'polar rifts' to the best advantage and have a large spread in latitude. This type is sometimes termed the 'minimum' or 'minimum sunspot' type, and also the 'wind-vane' or 'fish-tail' form.

(3) The 'intermediate' type displays the streamers in mid-solar latitudes. The 'polar rifts' are present, but not so extensive in latitude as in the 'equatorial' type. The streamers also approach nearer the polar regions than in the 'equatorial' type, while the equatorial extensions are not in such great evidence. This type is sometimes referred to as the 'square corona', and 'intermediate' between sunspot maximum and minimum type.

Illustrations of these types are shown in Fig. 1, and the coronas are so oriented that their north poles are situated at the top of each, and can therefore be compared directly with one another as regards the positions of the polar 'rifts' and 'steamers'. The corona at the top represents the 'polar' type (1908), and it will be seen that long streamers are situated in nearly all solar latitudes and the polar rifts are absent. The corona is very extensive all around the dark moon, owing to the sun being at its maximum state of activity.

The next lower figure represents the 'intermediate' stage (1898), the polar rifts becoming apparent. The corona takes a square form, the main streamers radiating more in mid latitudes. In the last form, that of the 'equatorial' type (1922), the polar rifts are well pronounced and the whole corona is not so extensive all round the disc. It is difficult, however, to show the extent of the equatorial streamers, as they are much fainter than usual and to some degree become lost in the reproductions.

Owing to these changes of form varying with the sunspot curve—that is, the 'polar' forms synchronising approximately with the maxima of spotted area, the 'equatorial' with the minima of spotted area, and the 'intermediate' with the intervals between these maxima and minima—all investigators who have studied this subject have concluded that these changes of form were due to the sunspots themselves.

When we come to examine the positions of spots on the solar surface, it is found first of all that they are never near the poles at all. The highest latitude they ever attain is somewhere about 45° north or south, and this occurs only at about the time when the spots are very small and the sun at a low state of activity. When, however, the sun is most active and the spotted area at a maximum, their mean latitude is only about 15° north and south.

It will thus be seen that the presence of the spots themselves cannot possibly be the origin of the coronal streams at the poles of the sun, because at the epochs of the occurrence of the latter phenomena the spotted activity is at a maximum in latitude 15°, a very long way away from the poles. If, therefore, the spots do not cause the polar streamers, then there is no reason why they should account also for the streamers which occur in the spot zones. There must, therefore, be some other form of solar activity which gives rise to these brilliant streamers which can radiate from any latitude.

When the frequency of occurrence of solar prominences is studied closely it is found that, from year to year, they wax and wane, synchronising approximately with the variation of the sunspot areas. Thus it may be said that the curves representing prominence frequency and spotted area are very closely allied or similar, and if the changes in the coronal forms follow closely those of spotted area, they may equally be stated to follow also those of the prominence frequency.

Prof. Ludendorff, in 1929, made a very detailed study of this subject of the cause of the changes of coronal form, and concluded that this change varies with the sunspot period. He did not add that it corresponds with the frequency of prominences as well, but if he had, his deduction would have been correct. The great advantage of accepting prominence action rather than spot action as the cause of the coronal streams is that prominences *can occur in any latitude*, even at the solar poles.

To illustrate the distribution in latitude of the prominences on the solar disc year by year, reference may be made to Fig. 2, where the latitudes are given for each year from 1870 to 1929 for both hemispheres of the sun. In this figure the other solar changes already mentioned are also inserted, so that they can all be compared with one another on the same time scale. Thus, the first two curves show the strong similarity between the variations of the spotted areas and the prominence frequencies, and the approximate similarity of epochs of their maxima and minima. The third curve displays the change of latitude of the mean spotted area for each year for both hemispheres, demonstrating the movements towards the equator of the spot zones from a sunspot minimum to the following minimum. The vertical continuous lines show the epochs of sunspot maximum, and the vertical broken lines those of sunspot minimum.

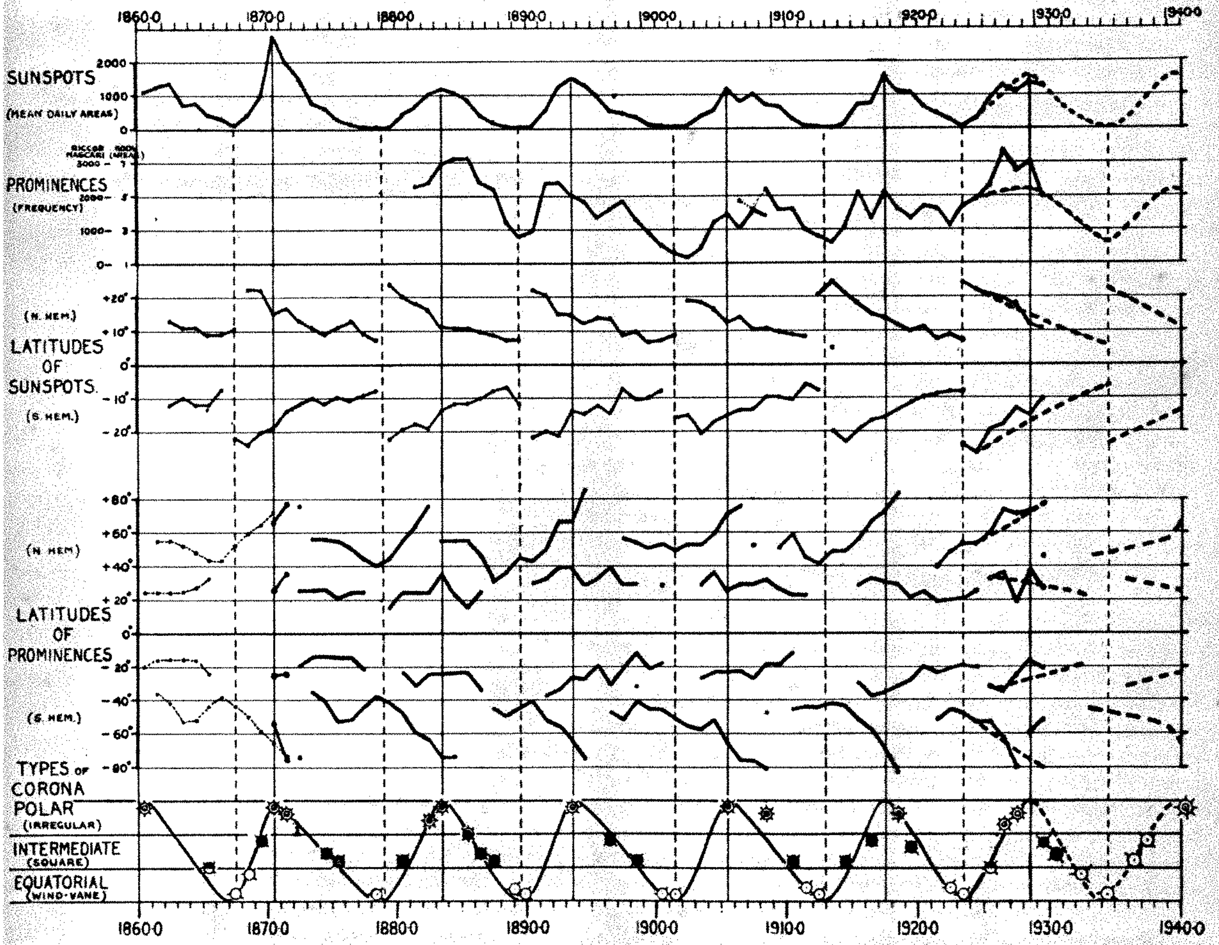

FIG. 2.—Periodicity of solar phenomena. Reproduced by courtesy of the Royal Astronomical Society from *Mon. Not. R.A.S.*, vol. 91.

Coming now to the fourth series of curves, namely, those showing the latitudes of the prominence zones from year to year, it will be seen that in both hemispheres there are nearly always two zones of prominences in action simultaneously.

That which may be termed the 'low-latitude zone' commences two to three years after sunspot minimum, tends to move (like the spot zone) to lower latitudes, and disappears generally about two years before the next sunspot minimum. The other zone, which may be called the 'high-latitude zone', commences about three years after sunspot maximum, and moves towards the poles in each hemisphere, terminating generally very abruptly close to the poles about a year after sunspot maximum. At about the sunspot minimum there is usually a period of about two or three years when only one prominence zone is in operation, and that is the 'high-latitude zone', which is then situated in about latitude 45° in each hemisphere.

When the sun is most active, as exhibited by either spots or prominences, the latitudes of the prominences exceed 60° in both hemispheres *in every case*, except in the year 1928, when it was at 60° in the southern hemisphere only. Attention should specially be directed to the fact that the *highest* prominence latitudes do not necessarily occur *at* the sunspot maxima, but more generally about a year later, and in one instance, namely, in 1908, the highest latitude was attained in the southern hemisphere *three years* after the sunspot maximum.

Below these prominence latitude curves are shown the forms of the corona as observed at each eclipse. These are arranged in three horizontal strips, the uppermost one containing all the 'polar' forms, the middle the 'intermediate', and the lowest the 'equatorial' forms. Each eclipse is placed in the year of its occurrence, according to the time scale given at the top and bottom of the figure. The continuous curve represents simply a smooth curve passing through the maxima and minima points, thus representing the sunspot curve.

An important comparison can now be made between these coronal types and the prominence latitudes. The first point to be noticed is that when the prominences exceed 60° in latitude in either or both hemispheres, the corona is of the 'polar' type in every case. Here, therefore, we have a distant connexion between prominence activity and coronal streamers in the same high latitudes, where spots are never found.

There is also a very close association between the prominences and the other two coronal types. Thus the 'equatorial' forms are recorded when the zone or zones of prominences are in their lowest latitudes; in general, this form is exhibited when there is only one prominence zone in operation. In nearly every case the 'intermediate' types are associated with two zones of prominences in each hemisphere.

Another interesting point arising out of these prominence latitude curves is that, according to the distribution of the prominences, there seems little doubt that the 'intermediate' type of corona takes on two forms, one as it occurs when the sun is increasing its activity and another when the sun's activity is on the wane. This difference is shown in the following table. In this the mean latitudes of both the high- and low-latitude prominence zones for each hemisphere, as shown in Fig. 2, are tabulated for each form of corona, and the 'intermediate' type is divided into two forms, 'intermediate up' and 'intermediate down'.

Corona Type.	Prominence Zones.						No. of Eclipses.
	High Latitude.			Low Latitude.			
	S.H.	N.H.	Mean.	S.H.	N.H.	Mean.	
	°	°	°	°	°	°	
Equatorial . .	45·5	44·4	44·9	20·0	22·5	21·2	9
Intermediate up .	51·5	58·5	55·0	30·6	30·6	30·6	4
Polar . . .	71·6	70·5	71·0	26·5	29·5	28·0	10
Intermediate down .	46·8	51·7	49·2	20·7	25·0	22·8	9

While there are only four eclipses of the 'up' type, but nine of the 'down', the latitudes of both the high- and low-latitude zones are greater in the former than in the latter.

Thus for the high-latitude zone the mean latitude for the 'up' is nearly six degrees higher than that for the 'down', and for the low-latitude zone the 'up' exceeds the 'down' by nearly eight degrees. This difference, which is in the same direction for both zones, seems to be sufficiently large to suggest that there may be a small change of type at the times of the rise and fall of solar activity.

It seems most probable that the form of the corona seen at any eclipse is not the immediate result of the presence of prominences at that particular moment. It seems more likely that the form is the result of long-continued action of the prominence zones, for weeks or maybe months, previous to the eclipse. If, for example, the prominences recorded on the sun for two or three months previous to an eclipse occurring were examined, it is most probable that the form of the corona could be well anticipated.

Using data selected from the years 1912, 1916, 1918, 1919, and 1923, since eclipses occurred in these years in which the coronal forms were recorded as of the equatorial, intermediate up, polar, intermediate down, and equatorial types respectively, an attempt was made to see if they reflected the chief types of the corona.

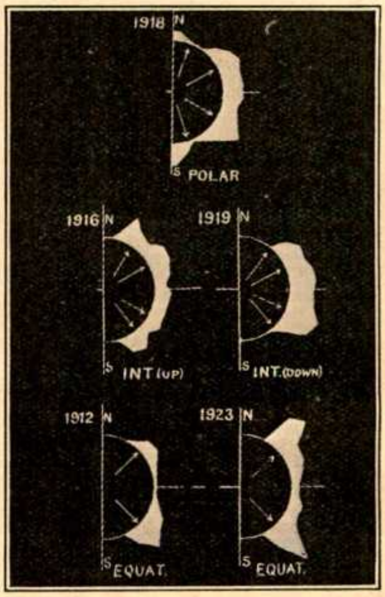

FIG. 3.—Coronal types in relation to latitudes of prominences. Reproduced by courtesy of the Royal Astronomical Society from *Mon. Not. R.A.S.*, vol. 91.

These yearly mean prominence areas were then plotted for each ten degrees of latitude, as shown in Fig. 3, for each of the five years, the same scale being used throughout; this scale has, however, no special relation to the areas of the dark half suns, which are all of the same size. The sequence to be followed is from bottom left-hand side up to top right-hand side down.

It will be seen that the main features of the coronal types are all reflected in the prominence distribution in latitude, the high-latitude zones moving towards the poles simultaneously with the greater area of prominence activity, and reaching the poles at the epoch of the 'polar' type of corona. The 'equatorial' type is conspicuous by having only one prominence zone in each hemisphere.

There is here a decided difference between the prominence distribution in the 'intermediate up' and the 'intermediate down', the latter, in this instance, conforming more to the equatorial type, disregarding the greater area of prominence activity there displayed.

The white arrows in each of the five half suns are the plotted positions of the latitudes of the high and low prominence zones extracted from the table previously given, and show the *mean* positions of these zones from all the eclipses of each type. It will be seen that, for this single series of years, the arrows conform very well to the actual positions of the prominence zones.

Another attempt was made, but this time only using data for the second half of the same years as indicated in Fig. 3. In this case the prominence areas displayed, quite astonishingly, practically the same distribution in latitude, and thus exhibited the same forms. These computations suggested very strongly that an actual corona is really the sum total of a prolonged prominence action previous to its appearance at an eclipse.

It will be noticed in Fig. 2 that from the year 1925 all the curves have been continued up to the year 1940 by broken lines. These were inserted in 1925 to attempt to forecast the changes in the different solar phenomena from year to year. Comparing those curves with those now available up to the year 1929, it will be seen that they conform fairly well with the actual facts. It was at that time considered probable that the high-latitude prominence zone would be still in evidence in both hemispheres in the year 1929 in about latitude 80°, and would therefore give rise to a 'polar' type of corona for that year. The latitude of this zone was, however, not so accommodating, but only actually reached 52° in the southern hemisphere and 44° in the northern hemisphere, so that an 'intermediate' type of corona should have been expected and was actually recorded.

In the case of the next few total solar eclipses following that of 1930, namely, those for the years 1932, 1934, 1936, 1937, and 1940, the forecast curves suggest that the 1932 corona may be of the 'equatorial' or on the boundary between an 'intermediate' and 'equatorial' type; that the 1934 corona will be of the pure 'equatorial' type; that the coronas of 1936 and 1937 should display an 'intermediate' type; and, finally, that the 1940 corona should be of the 'polar' type, owing to the position of the high-latitude prominence zone, which should then be in about latitude 70° in both hemispheres.

It is satisfactory to record that, since my first communication to the Royal Astronomical Society in 1903, showing that the prominences are responsible for the varying shape of the solar corona, this view has been endorsed by J. Evershed in 1908 and by Prof. Osten Bergstrand in 1930.

Gassendi and the Transit of Mercury.

THREE hundred years ago, in November and December 1631, the first accurately predicted transits of both Mercury and Venus took place, but only the transit of Mercury was observed. Kepler many years before had stated that Mercury would cross the sun's disc on May 20, 1607, and carefully but vainly watched for it. With the completion of the Rudolphine Tables in 1627, he again took up the problem of determining the times of transit, and in a small tract published in 1629, entitled "Admonitio ad Astronomos rerumque celestium studiosos, de miris rarisque anni 1631 phaenomenis . . .", announced that Mercury would pass over the sun's disc on Nov. 7, 1631, and Venus on Dec. 6, 1631. He announced at the same time that there would not be another transit of Venus before 1761, but in this he was in error.

Only one person was fortunate enough to observe the transit of Mercury predicted by Kepler, and this was Gassendi, who then, at the age of thirty-nine years, was already recognised as one of the foremost French philosophers. Some years afterwards, Gassendi became professor of mathematics at the Collège Royale in Paris and by his lectures and writings did much to stimulate an interest in science, but in 1631 he was provost of the Cathedral at Digne, near which he was born. He had been a precocious youth, lecturing at the age of sixteen and at the age of twenty-one becoming a professor of theology and philosophy at Aix. Among his contemporaries he counted Mydorge, Mersenne, and Descartes, while among his correspondents was Galileo. He was in Paris at the time of the transit and he gave an interesting account of his observations to Schickhard, professor of mathematics at Tubingen, a man as learned as himself.

Speaking of his observations, Gassendi said: "The crafty god had sought to deceive astronomers by passing over the sun a little earlier than was expected, and had drawn a veil of dark clouds over the earth in order to make his escape more effectual. But Apollo, acquainted with his knavish tricks from his infancy, would not allow him to pass altogether unnoticed. To be brief, I have been more fortunate than those hunters after Mercury who have sought the cunning god in the sun. I found him out, and saw him, where no one else had hitherto seen him."

Gassendi had arranged to see the transit by admitting solar light into a dark room through a small hole and receiving the image of the sun upon a white screen marked with a circle divided into sixty parts. He placed an assistant in a room above, to observe the altitude of the sun with a 2 ft. quadrant, and to signal. Nov. 5 and Nov. 6 were both rainy and overcast and the morning of Nov. 7 broke with the weather still changeable. But fortune favoured him in the end and he was able to observe the planet some time before it passed off the disc about 10.30 A.M. He calculated that the transit had taken five hours and had occurred about four and three-quarter hours before the predicted time.

The second predicted transit of Mercury occurred on Nov. 3, 1651, and was observed at Surat in India by the young English astronomer, Jeremy Shakerley, who had gone to that country for the purpose; while the third transit recorded by astronomers was on May 3, 1661. This was observed by Hevelius at Dantzig and by Huygens, Street, and Mercator in London.

Immediately after his observation of the transit of Mercury, Gassendi prepared to observe, if possible, the passing of Venus across the sun; for although this had been predicted to take place about sunset on Dec. 6, he considered that a possible error in the calculations might afford him the opportunity of seeing it. Dec. 4 and Dec. 5 were both stormy; Dec. 6 gave him glimpses of the sun, and the sun was visible all the forenoon of Dec. 7. He saw nothing, however, and it was afterwards shown that the transit took place during the night between Dec. 6 and Dec. 7. Eight years later, the first recorded transit of Venus was observed, on Nov. 24, 1639, at Hoole, eight miles from Preston, Lancashire, by the young clergyman, Jeremiah Horrocks, and his companion, William Crabtree.

Gassendi died in 1655 at the age of sixty-three years and was buried in the Church of St. Nicolas-des-Champs, Paris; while Horrocks died in 1641 at twenty-three years of age and was buried in the ancient chapel of Toxteth Park, a monument being erected to him in Hoole Church in 1826 and another in Westminster Abbey in 1874.

Obituary.

DR. DAVID STARR JORDAN.

DR. DAVID STARR JORDAN, who died in California on Sept. 20, was for many years a prominent leader in the promotion of biological science and higher education in the United States. He was born at Gainsville, in New York State, on Jan. 19, 1851, and after attending a local school gained a scholarship at the newly founded Cornell University in 1869. There he graduated and began his active career as instructor in botany.

Jordan's first original papers, published in the *American Naturalist*, were on botanical subjects, but in 1873 he had the opportunity of attending the summer school of Louis Agassiz at Penikese, and henceforth his chief interest was in fishes. During the next few years he worked most industriously at systematic ichthyology, publishing several noteworthy papers, and in 1879 he was appointed professor of zoology in Indiana University. He was not only keen in research but also endowed with administrative ability, and in 1885 he became president of the University. There he remained until 1891, when he was elected first president of the Leland Stanford University in California, and rendered distinguished service to this new foundation until his retirement in 1916. As an acknowledgment of his work, he was eventually made chancellor emeritus of Leland Stanford University.

While occupied with academic duties, Jordan found time to take part in many other scientific and educational activities, and even in political discussions. From 1879 until 1890 he was closely associated with the United States Fish Commission, and in 1880 he was in charge of fishery investigations on the Pacific coast. In 1896–97 he was the American representative on the commission for studying the fur seals in the Bering Sea, and in 1898 he published (with the aid of George A. Clark) an official " Report of Fur Seal Investigations ". He was always active in organisations for the abolition of war. His varied reminiscences were published in 1922 in two volumes entitled "The Days of a Man ".

Jordan's researches on fishes were chiefly concerned with the naming of genera and species and their systematic arrangement. He made a special effort to examine personally the older collections, to determine precisely the meaning of many of the earlier names which had been given without adequate definition. Helped by his pupils, who were usually joint-authors of his papers, he then proceeded to describe and name some hundreds of new forms, not only from North America, but also from Japan, the Philippines, and Hawaii. In 1883, with C. H. Gilbert, he published a " Synopsis of the Fishes of North America ", and in 1896–1900, with B. W. Evermann, he prepared and published in four volumes a still more elaborate work on " The Fishes of North and Middle America ". In 1905 he issued a more general " Guide to the Study of Fishes ", in two volumes. Between 1917 and 1920 he aided systematic ichthyology by preparing a list of all the genera of fishes named between 1758 and 1920, with an indication of the type species of each—a work published in four parts by Leland Stanford University. In 1923 he supplemented this by " A Classification of Fishes " in the same University's publications. In his later years, Jordan was stimulated, by the discovery of numerous fishes in the Tertiary diatomaceous earth of California, to describe and name fossil fishes both from North America and from Brazil, but the results were not very satisfactory.

Throughout his career Jordan's influence on the systematic study of fishes in North America was indeed great, and he has left several devoted pupils to continue and extend his work. A. S. W.

WE regret to announce the following deaths:

Prof. James S. C. Douglas, Joseph Hunter professor of pathology in the University of Sheffield, on Oct. 30, aged fifty-two years.

The Rev. Dr. T. C. Fitzpatrick, president of Queens' College, Cambridge, and formerly a demonstrator in the Cavendish Laboratory, on Oct. 28, aged seventy years.

Dr. James W. Gidley, assistant curator of fossil mammals in the United States National Museum, on Sept. 26, aged sixty-five years.

Mr. Alfred J. Henry, senior meteorologist in the United States Weather Bureau, on Oct. 5, aged seventy-three years.

Prof. Guido Holzknecht, professor of medical radiology in the University of Vienna, and honorary member of the British Institute of Radiology, who was one of the pioneer workers in the application of X-rays to medicine, aged fifty-eight years.

News and Views.

IT is announced in the *Times* of Oct. 30 that the Nobel Prize for Medicine for 1931 has been awarded to Prof. Otto Warburg, of the Kaiser Wilhelm Institute for Biology, Berlin-Dahlem. Prof. Warburg is known for his work on the metabolism of tumour tissues, which is a development of his researches, commenced about twenty-five years ago, on the respiratory processes of cells and tissues. The earlier work was concerned mainly with the utilisation of oxygen by sea-urchin eggs and red blood cells; his later investigations have shown that tumour cells have a characteristic type of metabolism. In the presence of oxygen, lactic acid is produced, whereas the majority of normal tissues only produce the acid in the absence of oxygen; in its presence they oxidise it or resynthesise it to some more complex substance, such as glycogen. In other words, tumour cells appear to obtain the energy they require, or at any rate part of it, from the simple breakdown of sugar to lactic acid, whereas in normal tissues the further oxidation of the acid to carbon dioxide and water is required to supply the energy for their metabolic processes. The distinction between the two types of respiration, however, is not absolute: thus, tumour tissues also consume oxygen, whilst normal cells can be made to develop the abnormal type of metabolism by interfering with their respiration. Warburg's view of the origin of cancer is that it depends upon this abnormal development of aerobic glycolysis: in most cases this change in the type of metabolism leads to death of the cell; if the cell lives, however, a tumour results.

FURTHER information is now to hand regarding the discovery of element No. 87, to which reference was made in NATURE of Oct. 24, p. 696. Papish and Wainer, in the October number of the *Journal of the American Chemical Society*, describe some preliminary experiments in which samarskite was treated for the removal of elements before the alkali metal group, and the alkali metal fraction, in the form of the least soluble alum fraction, was examined in the X-ray spectograph. Five lines corresponding with the element 87 were obtained by excitation in a Siegbahn vacuum apparatus of high dispersion, the absence of tungsten, gold, and tin, which would have caused interference, being established by special experiments. Previous experiments by an optico-magnetic method made by Allison and Murphy in 1930 had led to the conclusion that element 87, which belongs to the alkali-metal group, was present in minerals rich in the rarer alkalis. Preparations from lepidolite and pollucite, which gave indications of the presence of comparatively large amounts of element 87 by the optico-magnetic method, were found, however, not to contain it by chemical and optical tests. The element 87 is regarded as non-radioactive or very feebly so, but it may be an inactive residue from the disintegration of radioactive elements of existing series or of a series long extinct. The samarskite used was rich in uranium and also contained rubidium and cæsium.

SIR CYRIL KIRKPATRICK's presidential address to the Institution of Civil Engineers, delivered at the opening meeting of the session on Nov. 3, was on "The Tidal Thames"—a subject full of historical and engineering interest. By a charter of Richard I. in 1197, the citizens of London became conservators of the river Thames from London Bridge to Colnie Ditch, now the river Colne, near Staines, where the boundary stone, dated 1280, is still in existence. By an Act of 1489 the river came under the direction of the Mayor and Corporation of London. In 1771 a Committee of the Corporation took over the duties. In 1857 a new Board, the Conservators of the River Thames, was created, and this Board was succeeded, on March 31, 1909, by the Port of London Authority; the upper section of the river above the landward limit (about 265 yards below Teddington Lock) remained under the Conservators, and the lower section under the Authority. The dredging of the river was taken over by the Port Authority in 1909, and the total quantity of material removed to the end of the year 1930 was 41,768,747 cubic yards, as measured in the hoppers. Reference was also made to dredging for ballast, which in the sixteenth century was a privilege of the Lord High Admiral of England and later of Trinity House. In 1861 there was shipped in the Port of London as ballast 202,915 tons of chalk and 565,700 tons of shingle. Owing to the introduction of water ballast during the nineteenth century, the dredging of ballast from the Thames for the use of vessels became no longer necessary.

DEALING next with the constructional works carried out in connexion with the Thames, Sir Cyril Kirkpatrick stated that in 1909 the area of dock water was about 641½ acres and the length of quays about 27½ miles. Since that date, the most noteworthy additions have been King George V. Dock and a new entrance lock and passenger landing-stage at Tilbury. The area of dock water is now about 723 acres, and the length of quays about 33 miles. The total capital expenditure incurred by the Authority on new works was over 14 million pounds. The total net register tonnage of vessels entering and leaving the port had increased from 38½ millions in 1909 to 57½ millions for the year 1930. Referring to the principal industries associated with banks of the Thames, Sir Cyril stated that shipbuilding practically disappeared with the substitution of iron for wood in shipbuilding and the introduction of steam propulsion. About 4½ million tons of coal are carbonised annually at the riverside gasworks for the production of gas, which is distributed by upwards of 7000 miles of mains. The coal is brought up the river by the companies' own steamers to their wharves, and the by-products amount to more than one million tons a year. Another very important industry is the generation of electricity for lighting and power. It is estimated that more than 650 million tons of water are borrowed from the river annually by electric power-stations for circulating water. It is expected that by 1935 the number of units will have increased to 3500 million, the consumption of coal to 2,200,000 tons, and the water required to more than 1000 million tons. A very important commercial undertaking is that of the Ford Motor Company at Dagenham, equipped with the first blast-furnace built on the Thames. Extensive depots for crude petroleum, motor-spirit, and lamp-oil have been established at Thames Haven in Sea Reach; more than three million tons were imported during 1930.

LIEUT.-COL. E. KITSON CLARK in his presidential address to the Institution of Mechanical Engineers, delivered on Oct. 23, forsook the usual path of a president who feels it his duty to deal with the particular branch of engineering he has been engaged on and thus give the members the benefit of his experience, and devoted his remarks entirely to hammers, hammering, and humanity. His title, indeed, was "Humanity under the Hammer". Claiming that mechanical history began with the hammer, he traced the evolution of hammers from palæolithic and neolithic man down to the present time, exhibiting and illustrating many types of both hand and power hammers, and we should not be surprised if his address comes to be regarded as a classic on the subject. Engineering knowledge, a love of antiquarian lore, a philosophic outlook, and a sense of humour were all brought to bear on the matter in hand. Whether it was the hammer of the flint knapper, the hammer of the coppersmith, the stone-mason, the gold-beater, each and every kind brought out some interesting and often unexpected point, and history, mythology, poetry, and religion were all called upon to contribute to the discussion. The plain story of the hammer, indeed, became a philosophy; and in the romance of the story there were to be found some essences of principles which are by no means settled, and even some reflections of the greatest issues of existence. Lieut.-Col. Clark said: "Let us reverence the unknown, determined, wherever we may find ourselves, to be ready to strike a blow *mente et malleo*, outside the routine of our allotted task, and try to carry even more than our part of that divine burden placed upon every nation, every family, on every kind and true heart, on every engineer, to leave the world a better place than we found it".

To the great suspension bridges of the United States has recently been added another of much greater span than has hitherto been attempted. The Manhattan Bridge has a span of 1470 ft., the span of the Brooklyn Bridge is 1595 ft., of the Williamsburg Bridge 1600 ft., of the Bear Mountain Bridge 1632 ft., and of the Delaware River Bridge 1750 ft. The George Washington Bridge over the Hudson River, between Upper Manhattan and Fort Lee, opened on Oct. 24, however, has a span of no less than 3500 ft. The main features of the bridge include the two supporting towers, 635 ft. high, in the construction of which about 40,000 tons of steel have been used, and the two pairs of supporting cables, 106 ft. apart. Each of these four cables is 36 in. in diameter and contains 26,474 parallel steel wires, each 0·196 in. in diameter. The wires are divided into sixty-one groups of 434 wires each, special spinning and compacting methods being employed. More than 28,370 tons of cable have been used. The roadway is 256 ft. above the river and has a designed capacity of 30,000,000 vehicles annually, while the addition of a second floor to the bridge will double this capacity. As the outcome of experience with this and other bridges, it is now proposed to construct a suspension bridge at Golden Gate, California, of 4200 ft. span, and another across New York Bay of 4500-5000 ft. span.

THE high cost of patent litigation was among the topics discussed in Section F (Economic Science and Statistics) of the British Association on Sept. 28. Two well-known authorities, Mr. W. H. Ballantyne and Mr. H. A. Gill, reiterated the complaint that has so often been voiced in NATURE—that the expense of patent actions precludes all but the wealthiest corporations from defending their patent rights, and largely defeats the aims of the patent system. The Departmental Committee under Sir Charles Sargant having failed to suggest any effective way of dealing with the difficulty, Mr. Ballantyne proposes a method analogous to that prescribed by the London Building Acts of 1894 and 1930 for the settlement of party-wall disputes. In the case of patents, the parties' patent agents having failed to reach agreement, would agree upon an arbitrator selected from the 'patent bar' or from among experienced expert witnesses, and would submit their cases in writing, with oral amplification if necessary. The parties would be bound by the arbitrator's decision. Mr. Gill referred to the British Science Guild's proposal to utilise the Comptroller of Patents for the settlement of small disputes, a proposal favoured by a minority of the Sargant Committee. He suggested that, failing adoption of that plan, an official referee of the High Court might be appointed for dealing with infringement and validity by a simplified procedure. The matter certainly cannot remain where the Sargant Committee left it.

MR. MAURICE DOBB, in a paper on "Current Economic Theory in Relation to the Five-Year Plan", read before Section F (Economic Science and Statistics) of the British Association on Sept. 29, said that Russia to-day presents to the economist a unique and important type of economic system in three ways. First, it presents a planned economy in which the conscious control of key factors which characterises the operations of a business trust in an individualist system is extended to the economic life of half a continent. Secondly, it presents an example of a socialist economy in the more fundamental social and institutional sense that the former propertied class has been expropriated and the receipt of personal income on property rights has ceased to be the controlling motive over the major part of the economic system. Thirdly, the aim of the Five-Year Plan is to effect an epoch-making industrial revolution of the whole country so that a backward agrarian economy may be transformed to one based on the most up-to-date American technique. Under the Five-Year Plan about thirty per cent of the national income is to be devoted to capital investment (or a proportion double that in pre-War Great Britain). Giant schemes are being undertaken, such as the half-million kilowatt Dnieper Dam scheme, the Stalingrad tractor plant (the largest of its kind in the world), the Nijni-Novgorod automobile plant with a capacity of 150,000 machines a year, and the State Farm, 70 miles by 30 miles in extent.

MR. J. F. SCHOFIELD, of Durban, writes to suggest that Great Zimbabwe may have been occupied at a much later date than is generally thought, and, in fact, may have been abandoned so recently as 1825, at the time of the Swazi invasion. The evidence upon which this conclusion is based is threefold. Wooden lintels would appear to have been used generally for the door openings in the girdle-wall of the 'Temple' and the west wall of the 'Acropolis'; but no one who has a practical acquaintance with the use of timber, especially in the form of logs retaining the outer sap-wood, in sub-tropical countries, would estimate its life at the five hundred years required by Miss Caton-Thompson's dating, still less the twelve centuries demanded by Frobenius. The date of the girdle wall and the wall of the Acropolis must be compatible with timber construction. In the second place, where the upper courses of the walls have been damaged by the branches of trees, the existing trees are the cause; but none of these is a hundred years old. Consequently the buildings must have been kept clear of vegetation up to a hundred years ago. In the third place, in view of the rapid change of ground level owing to the torrential rains of Rhodesia, it is improbable that the drain-hole through the wall noted by Bent would have been still overground in 1892 if it had been constructed more than a short time before Zimbabwe was abandoned. Mr. Schofield therefore concludes that, taking Miss Caton-Thompson's date of A.D. 800 as the earliest date of occupation, the latest and finest work was not completed until about A.D. 1775.

DECREASES in the number of samples examined during the year ended March 31, 1931, at the Government Laboratory and its branches reflect the present depressed state of industry. During the year the total number of samples was 517,462, compared with 545,422 in the preceding year. The report of the Government Chemist, Sir Robert Robertson, surveys the activities of the laboratories at Clement's Inn Passage, London, at the Custom House, London, at certain of the more important seaports, at the Geological Survey Museum, and at the War Office Supply Reserve Depot, Deptford. While most of the work is of a routine character, concerned with the protection of public health or State revenues, much investigation has to be continuously undertaken both to keep abreast of advances in manufacture and industry and to improve the processes of analysis. Moreover, the Government Chemist is frequently consulted by Crown Departments on such chemical problems as from time to time arise, and representation of the Laboratory on committees frequently necessitates experimental investigations. Among the subjects on which advice was sought was the protection, particularly from insects and the effects of moisture, of water-colour drawings in West Africa; the use, in frames, of hermetically sealed, glass-fronted metal cases was recommended. A sample of soot from burners using oil as fuel was found to contain free sulphuric acid; this explained its irritant action on a worker's mouth and throat. The causes of the deterioration of cinematograph films of national importance, and means for restoration and preservation, have been studied. The damage was traced to inefficient washing or to the use of weak or exhausted 'hypo'; improved methods of washing, together with final treatment with fresh 'hypo' and subsequent washing, were advocated.

AMONG the foodstuffs examined at the Government Laboratory was brown sugar which contained a considerable proportion of formic acid, either produced during the process of refining or added as a preservative. Three samples of tinned vegetables contained copper colouring matter. Although the abolition of the duty on tea has removed the necessity for the examination of tea denaturants or tea for export, all consignments are examined on importation to ensure that no tea other than that which is pure and fit for human food shall pass into the country. Sea-water samples are examined in connexion with a scheme of oceanic research carried out by the Fisheries Department of the Ministry of Agriculture and Fisheries and by the Fishery Board for Scotland, acting in concert with the International Council for the Exploration of the Sea. The objects of the investigations are "to determine the influence upon fish life of the salt concentration or salinity, and to trace the movements of the water, apart from tidal ebb and flow, from one part to another in the sea. The sea-water in the Atlantic is more salt than in the North Sea, and the drift of the water from place to place can be traced by making periodical measurements of the salinity at definite positions and charting the results." Imported cheese was found to vary considerably in water and fat content; less than half of the samples had been prepared from whole milk. Yet no exception could be taken, since there are no regulations relating to the marking of skimmed or partially skimmed milk cheese. Likewise, since there is no standard for cream in Great Britain, no action could be based on the fact that only seven per cent of the samples of cream contained 45-55 per cent of fat, the remainder containing only 19-35 per cent. Other important work has been concerned with the administration of the hydrocarbon oils duty, and with the accuracy of hydrometers.

IT has again proved worth while to provide a class at the Dairy Show at Islington for Muscovy ducks only—this species, after being neglected in England for a generation or so, and ignored or disparaged by most writers on poultry, having again come into prominence. Descended from the *Cairina moschata* of the warm regions of America, this duck is one of the few domestic-animal contributions of aboriginal American culture, the others being the llama, guinea-pig, and turkey; and, although less generally known, it has become more widely distributed than any of these, being kept even by savages in Africa and Polynesia. This is not surprising, as it is far more tolerant of unnatural conditions than the domestic ducks of mallard descent, and will rear its young with as much devotion as any hen. Curiously enough, though more sluggish than any other kind of poultry, it has not lost the power of flight, although its domestication, for all we know, may have been more ancient than that of the mallard. Another curious fact about it is that, although naturally black, it but rarely produces a slate-coloured or 'blue' variety, whereas 'blue' ducks of mallard descent are frequently to be seen; as blue-grey is supposed to be a dilute form of black, this is exactly the opposite of what might have been expected, the mallard having little black in its coloration.

THE Mongolian wild horses at the London Zoological Gardens are now assuming their thick winter coat, which, curiously enough, is bay, not dun, like the short summer pelage. The beasts are thus darker and brighter in colour in winter than in summer, showing the exact reverse of the change undergone by the northern race of the tiger. A more marked change in seasonal colour in the same direction is to be found in the chamois, which is brown in summer and becomes black in winter; but this is more easily understood as, in a winter world of snow, ice, and rock, black is obviously a colour better adapted to protective concealment than brown. The wild-horse foal born in mid-August this year is, however, growing a winter coat of dun, and as this was the case also with the last foal exhibited, it would appear that the dark rich winter coat is only worn by the older animals, which would be better able to look after themselves. The legs of the foal are beginning to blacken from the hoofs up, the wild-horse foal not being black-stockinged like its parents, and hence falling into line with other wild equines in leg-tint, which in these is either light or only barred with black.

NEARLY a hundred papers, contributed by scientific workers of fifteen nations, are listed in the preliminary programme of the Third International Conference on Bituminous Coal, to be held on Nov. 16-21 in Pittsburgh. The papers cover almost every phase of coal preparation and utilisation. The 'coal' man, it is hoped, will be furnished with an accurate picture of the coal industry throughout the world, and the mine-owner should be helped to predict the future demands for his product by major consumers. A section on the economics of the coal industry has been included because of the desperate condition of the industry throughout the world. The organisers felt that it would be impossible to hold any discussion on coal without considering this problem. Pulverised coal will come in for major discussion. Other sections of the conference will be concerned with gasification, hydrogenation and liquefaction, low and high temperature distillation, coal cleaning and preparation, smoke and dust, by-products, origin and classification, domestic heating, metallurgy, and competition of coal with other fuels.

DURING the last five years, the *Chemiker-Zeitung* has published from time to time reports upon developments of various branches of applied chemistry in the form of special supplements. In the issue of Oct. 14 will be found a twenty-five-page condensed summary by Prof. F. Mayer, of Frankfurt, of advances made throughout the world during the year 1930 in the dyestuff industry. An introductory section outlines the more important experimental lines of progress. This is followed by sections dealing with problems of theoretical interest, particularly those relating to colour and chemical constitution, new methods of obtaining intermediate products, and with the various types of artificial and natural dyestuffs and colours. The report presents, in a form useful for reference, a list of the principal publications and patent specifications relating to the subject, which should be helpful to those who are engaged upon dyestuffs research. The supplement also contains a brief report by Dr. Walter Herzog upon saccharin and its derivatives and on other synthetic sweetening compounds.

THE Report for 1930 of the Strangeways Research Laboratory, Cambridge, has been issued by the Trustees. The Laboratory has continued to make satisfactory progress under the direction of Miss H. B. Fell. The Medical Research Council has continued its financial support, but further endowment is required to extend the work. Experimental embryology and histology have been pursued by means of tissue cultures, and an extensive scheme for research into the effects of radiation upon normal and malignant cells has been organised and is in progress in association with various University departments and with the Addenbrooke's Hospital, Cambridge.

REFERENCE was made recently to an apparently new feature in the floor of the North Sea in the form of a deep trench about 100 miles east of Montrose. It was described by Prof. J. W. Gregory in the *Geographical Journal* for June. A note on the subject is published in the October issue, and it now appears that the Devil's Hole, as it was named, is not a new feature and so has no relation to recent earthquake activity. The feature appears in old fishermen's charts, with a depth of 142 fathoms, but was apparently not recorded on the Admiralty charts, since its exact position was not known. This has now been determined to be some ten miles north and twenty miles east of the position given on unofficial charts. The 'discovery' was thus due to a misunderstanding and recent survey has not recorded any changes on the floor of the North Sea.

THE Rockefeller Institute for Medical Research, New York, has issued a brief account of its foundation and organisation, with a description of the buildings and equipment and present scope of the scientific work. The Institute was founded in 1901 by Mr. John D. Rockefeller with a gift of 200,000 dollars to be expended on grants and fellowships for investigations into the nature and causes of disease and methods of prevention and treatment. With the aid of further gifts, a small laboratory building was rented in 1902, in 1906 a large modern laboratory was erected on a site in New York overlooking the East River, and to this a hospital of 60 beds was added in 1908. A department of animal pathology was created in 1914, located near Princeton University, and it was extended this year to include a division of plant pathology. The Institute is administered by a Board of Trustees and a Board of Scientific Directors, which together constitute the Corporation.

The latest arrangements for the polar year 1932–1933 were outlined in a paper communicated to Section A of the British Association by Dr. G. C. Simpson on Sept. 30. Thirty-five States have agreed to participate in the work, and of these the following are to establish new stations in high latitudes, chiefly within their own territory: Austria, Canada, Denmark, Finland, France, Germany, Great Britain, Holland, Iceland, Japan, Norway, Russia, Sweden, and the United States. The preliminary arrangements have been made to house the British party, which will leave England in May 1932, at Fort Rae, on the Great Slave Lake, where a party was stationed during the original polar year fifty years ago. The party will consist of five. The Government grant will cover the expenses of this station, but further funds will be required if a second station is to be established in Canada and the further project of reopening the Ben Nevis Observatory is to be undertaken. The programme of work arranged by the International Meteorological Committee was referred to in Nature for Oct. 31, p. 754.

Dr. Michael C. Grabham writes from Madeira recalling an incident in 1901 when Lord Kelvin gave him an advance copy of the paper "On the Clustering of Gravitational Matter in any Part of the Universe", which Kelvin read on Sept. 17 of that year at the meeting of the British Association at Glasgow. The incident to which Dr. Grabham refers took place on the eve of his departure for Madeira, and on the same day Crookes had given him a very active speck of radium bromide mounted in the spinthariscope which Crookes had recently invented. This inspired Kelvin to remark on the 'whimsical' objection of those who denied a rigid stellar ethereal medium, and on his own reluctance to accept radium as an element. In view of the theories at present being propounded on "a mathematical reconstruction of a Universe where planets are rare, while here and there in insignificant corners and at infrequent intervals a strange accident results in life stumbling into being", Dr. Grabham expresses a hope that Kelvin's "gravitational paper" may be still surviving. The paper in its entirety appears in Nature for Oct. 24, 1901, p. 626, and in the Report of the British Association, 1901. Lord Kelvin states his arguments still more fully in the *Philosophical Magazine* for August 1901, p. 169.

At the special general meeting of the Linnean Society of London held on Oct. 22, His Majesty the Emperor of Japan was elected an honorary member of the Society.

The seventh annual Norman Lockyer Lecture of the British Science Guild will be given by Dr. H. H. Dale, in the Goldsmiths' Hall, Foster Lane, London, E.C.2, on Tuesday, Nov. 24, at 4·30 p.m. The subject of the lecture will be "Biology and Civilisation".

At the annual statutory meeting of the Royal Society of Edinburgh held on Oct. 26, the following Council was elected: *President:* Sir E. A. Sharpey-Schafer; *Vice-Presidents:* Prof. F. G. Baily, Prof. T. J. Jehu, Prof. J. H. Ashworth, Dr. A. Logan Turner, Dr. J. B. Clark, Prof. James Ritchie; *General Secretary:* Prof. R. A. Sampson; *Secretaries to Ordinary Meetings:* Prof. C. G. Darwin and Prof. F. A. E. Crew; *Treasurer:* Dr. James Watt; *Curator of Library and Museum:* Prof. D'Arcy W. Thompson; *Councillors:* Prof. James Drever, Mr. A. H. R. Goldie, Dr. R. A. Houston, the Hon. Lord Sands, Dr. Murray Macgregor, Dr. A. Crichton Mitchell, Prof. P. T. Herring, Sir Thomas H. Holland, Prof. James Kendall, Prof. T. M. MacRobert, Prof. Godfrey H. Thomson, Dr. Malcolm Wilson.

A new part (pt. II.) of Sotheran's "Catalogue of Exact and Applied Science" (No. 828 of Sotheran's "Price Current of Literature") has just appeared. It deals with works on astronomy, dialling and horology, and physics, and contains, as is usual with the catalogues of Messrs. Sotheran, numerous valuable and interesting bibliographic comments upon the books listed.

Messrs. Dulau and Co., Ltd., 32 Old Bond Street, W.1, have just issued two new catalogues of second-hand books of science obtainable from them. No. 191 gives the titles of nearly a thousand works on botany, gardening, herbals, and allied subjects. No. 192 is devoted to books dealing with conchology, entomology, geology, ornithology, and zoology. Some 300 works are listed.

Applications are invited for the following appointments, on or before the dates mentioned:—A graduate assistant at the Plymouth Day Junior Technical School for Boys, in physics and mechanics—The Secretary for Education, Rowe Street, Plymouth (Nov. 11). A chief handicraft instructor at the Bath Technical College, etc.—The Director of Education, Education Office, Sawsclose, Bath (Nov. 14). A professor of medicine at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, S.W.7 (Nov. 26). A full-time lecturer and demonstrator in anatomy at the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Nov. 28). A professor of anatomy in the University of Lucknow—The Registrar, Lucknow University, Lucknow, India (Dec. 7). A Stevenson professor of international history at the London School of Economics—The Academic Registrar, University of London, S.W.7 (Jan. 8). A bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Director, Wellcome Tropical Research Laboratories, Khartoum, Sudan.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Branching of Lightning.

IT has long been known that the ordinary spark discharge between spherical electrodes exhibits numerous side-branches which are forked away from the positive pole. Similar branching, almost always directed downwards, is shown by lightning discharges between a thundercloud and the ground. For this reason it has been concluded that the direction of branching in a lightning flash is a criterion of the polarity of the discharge (Walter and Simpson). Simpson has examined some five hundred photographs of lightning and has concluded that at least 80 per cent of these pass from a positively charged cloud-base.

This conclusion can be tested from observations of the electric field change at the ground caused by the disappearance of the elevated charge. If the field change is negative, the cloud-pole must have been positive, and vice versa. The method is free from any ambiguity, provided care is taken to exclude multiple flashes which involve more than one charged region; such flashes can be distinguished both by the multiple nature of the field change recorded and by direct observations of the appearance of the lightning.

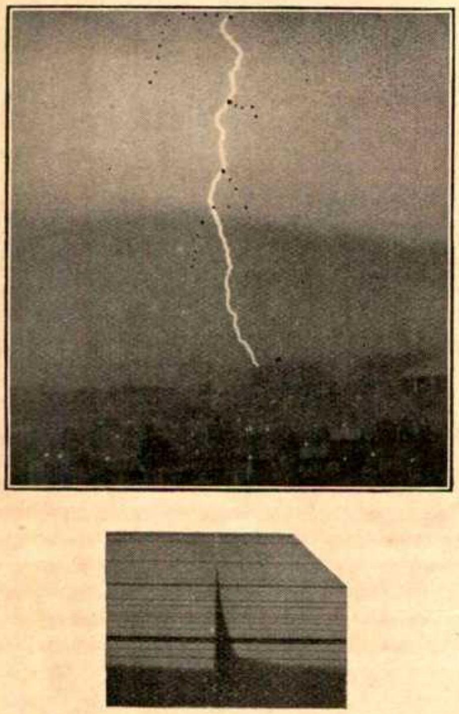

FIG. 1.

Observations of this kind have now been made on more than fifty South African thunderstorms, and indicate that in at least 95 per cent of the 404 flashes examined the cloud-pole was negative. The appearance of these flashes was observed by eye, and the field changes recorded by the capillary electrometer method of C. T. R. Wilson. Photographs of South African flashes to ground show a high preponderance of downward branching (21/24), and suggest, therefore, that in these flashes the branching was the reverse of that observed in laboratories.

Final evidence was obtained by correlating photographic records of the field changes with photographs and sketches of the flashes producing them. Ten such correlations have been made; eight showed that the branching was directed away from the negative pole, and the other two showed no branching and were possibly partly obscured by rain. One such correlation is shown in Fig. 1—this was a single flash to ground; the branches have been emphasised by dots placed above them.

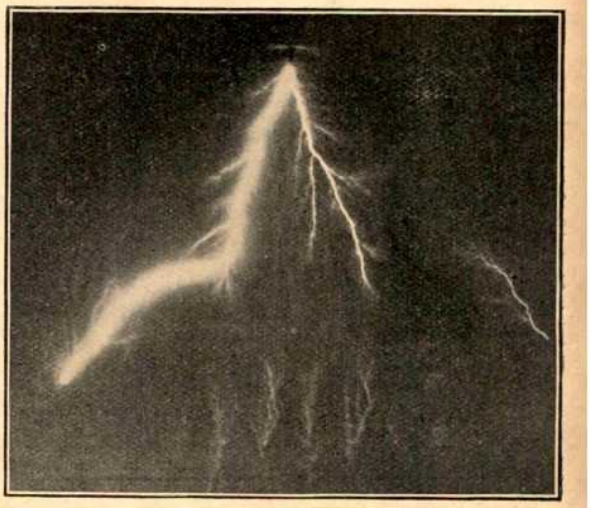

FIG. 2.

The conclusion that the branching criterion for cloud polarity is invalid seems unavoidable and is supported by the recent results of Lewis and Foust,[1] who have examined 100 cases in which lightning actually struck exposed conductors, and found that a negative charge was conveyed from cloud to ground in every case.

It is difficult to reconcile this negative branching with the common observations of positive and negative discharges. In addition to the observations on spark discharges mentioned above, the Lichtenberg figures taken between point and point or point and plane show that around the negative pole there extend straight radial streamers showing no branching, whereas around the positive pole the streamers are forked, and when a certain critical voltage is exceeded it is from the positive pole that heavy tree-like discharges extend far beyond the confined circle of brush discharge. What, then, are the conditions under which a positive discharge is suppressed and the negative enhanced so that in the macroscopic example of the lightning discharge the branching occurs from the negative pole?

One obvious difference between experiments in the laboratory and in the field is that in one case we are dealing with a symmetrical gap and in the other with an unsymmetrical gap. It is well known that the sparkover voltage of a point-plane gap is considerably less when the point is the positive pole than when it is the negative pole, whereas a sphere-sphere or point-point gap can show no such difference. But more important than this difference is the part played by the projections from the earth's surface—trees, buildings, etc.—which contribute their quota of space charge in the electric field between earth and cloud; these projections have not featured in experiments hitherto.

Some time ago, one of us had occasion to study the discharge of an impulse generator delivering 1,000,000 volts to a point-plane gap; it was noticed then that all positive impulses applied to the point—the plane being connected to earth—showed branching from the point; all negative impulses showed branching from the plane. Clearly asymmetry of the gap was insufficient to produce branching from the negative point. On raising a short projection out of the earthed plane, branching occurred from the high voltage point when positive, but in addition there was marked branching from the projection, that is, from the negative point. We have recently had further opportunity of continuing experiments on these lines; confining our attention to the case when the high voltage point was negative, we created a positive space charge above the plane by erecting from it a comb of short nails. From most of these proceeded short streamers branching upwards, whilst from the negative point the main discharge to ground was accompanied by many side branches forking downwards, as illustrated in Fig. 2. Negative corona is seen extending for a short distance from the electrode above the discharge, and positive branching is seen above the nails—St. Elmo's Fire. Thus, provided the conditions are correct, negative branching of a magnitude comparable with positive branching can be produced, and we have a ready explanation of the branched discharges from negative clouds. This throws fresh light on the mechanism of the discharge, and further investigations are proceeding.

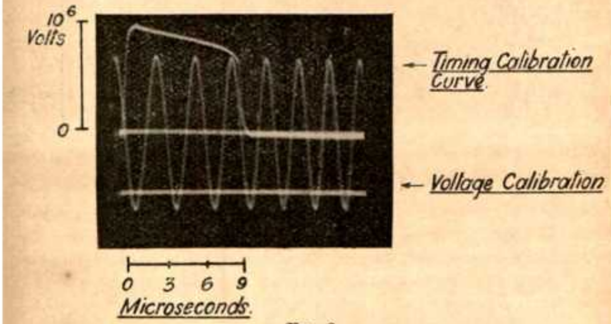

FIG. 3.

Fig. 3 is an oscillogram of the impulse applied to the point; the voltage applied reaches a maximum of 10^6 volts in ½ microsec., remains at that figure without oscillations for 9 microsec., and decays as the discharge passes to ground in ½ microsec. The polarity of the discharge is given by the oscillograms and also by a polarity indicator on the impulse generator. The current in the discharge is about 1000 amperes.

Some of the thunderstorm observations referred to are due to Mr. E. L. Halliday, of the University of the Witwatersrand, Johannesburg, whom we have to thank for permission to use them; our thanks are due to Mr. F. R. Perry and Mr. W. G. Hawley for assistance with the impulse generator, and to Mr. A. P. M. Fleming, for permission to publish.

B. F. J. Schonland.

University of Cape Town.

T. E. Allibone.

High Voltage Research Laboratory,
Metropolitan-Vickers Electrical Co., Ltd.,
Manchester, Oct. 10.

[1] *Gen. Elect. Rev.*, vol. 34, 8.

Atoms and Molecules as Fitzgerald Oscillators.

In his studies on the polarisation of scattered radiations, Bhagavantam,[1] besides recording numerous cases in which the displaced lines in the spectrum of the light transversely scattered by liquids exhibit complete depolarisation, also discovered in the case of sulphur trioxide liquid an anomalously polarised line. The depolarisation of this line exceeded unity; in other words, the horizontal component, instead of being weaker, as in normally polarised lines, was actually stronger than the vertical component. Critical and systematic investigations undertaken by S. Venkateswaran definitely confirm the existence of such anomalous polarisation in the spectra of light-scattering by various organic liquids, and indicate that it is by no means an unusual phenomenon.

The maximum depolarisation which a rotating electric dipole or Hertzian doublet can yield is 6/7 or 3/4 according as the incident light is common or plane polarised. It would seem, therefore, that we have to seek in some new direction for an explanation of the large depolarisations and anomalous polarisations so frequently encountered in light-scattering. It is proposed in this note to put forward, with all reserve, the suggestion that an atom or molecule scattering light may, in certain cases, function as a Fitzgerald oscillator or magnetic doublet. As electrons and nuclei in atoms and molecules are known to possess magnetic moments, there is nothing inherently improbable in this idea, and it offers an immediate explanation of 'anomalous polarisation' in light-scattering. For what is 'normal' polarisation for an electric oscillator is 'anomalous' for a magnetic oscillator, and vice versa.

A test of this idea is furnished by working with *polarised* incident light, and finding how a variation of its plane of polarisation affects the intensity of the given line in the spectrum. The conditions for maximum and minimum intensity for a Fitzgerald oscillator are the reverse of what they would be for a Hertzian doublet, the intensity of the line being a maximum when the magnetic force instead of the electric vector in the incident light is perpendicular to the direction of observation, and a minimum in the converse case. Venkateswaran has found liquid thiophene to be an excellent example of a substance which simultaneously gives 'normally polarised', 'unpolarised', and 'anomalously polarised' lines, and is, therefore, very suitable for the experiments. Polarising the incident light, and varying its plane of polarisation, he has discovered that 'normally' polarised lines show maximum intensity, while 'anomalously' polarised lines give minimum intensity, and vice versa.

The hypothesis that atoms and molecules may function as magnetic oscillators appears, therefore, to receive support from experiment. It should be remarked, however, that anomalous polarisation may also be explained as due to radiation from electric quadrupoles.

C. V. Raman.

210 Bowbazar Street, Calcutta,
Sept. 28.

[1] *Ind. Jour. Phys.*, 5, 59 and 603; 1930.

The Jumping Negative Glow.

I first observed the jumping negative glow in December 1929, in 'I' type Osglim tubes of special design supplied by the Research Department of the General Electric Company; the effect was demonstrated to the Physical Society on Dec. 13, 1929, and at the Royal Institution soirée on Jan. 24 of this year.

Afterwards it was found that Taylor had observed a similar effect in a Beehive Osglim lamp filled with air.[1]

Investigations designed to throw some light on the cause of the phenomenon have been carried on at intervals during the past two years. In the course of these, it was observed some time ago that the jumping effect was produced in an experimental tube with sealing-wax joints when the wax was heated. This suggested that the phenomenon might be caused by impurities in the filling gas. A further series of experiments led to the conclusion that the introduction of minute quantities of the vapours of certain hydrocarbons (toluene and hexane were both found effective) would produce jumps in neon-filled tubes in which the negative glow was previously quite steady.

I hope that a full account of the experiments (which showed other interesting effects of the introduction of traces of hydrocarbon vapour into neon discharge tubes) will be published in due course.

The jumping negative glow is probably related to the wavering positive column in discharge tubes containing hydrocarbons, as demonstrated recently by the General Electric Company. W. A. LEYSHON.

Physics Department,
London School of Medicine for Women,
Oct. 16.

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[1] NATURE, Sept. 13, 1924.

Raman Spectra of Benzene and Toluene.

I HAVE during the last summer, at Macdonald Physical Laboratory, McGill University, examined the Raman spectra of benzene and toluene under the fairly high dispersion of 4·5 A. per mm. This work has revealed that the line in the neighbourhood of 1000 cm.$^{-1}$, always characteristic of the benzene ring, is complex.

In benzene there are five components :

1005·3 cm.$^{-1}$
998·8
992·2
983·9
980·3

In toluene there are four frequencies in this region :

1027·7 cm.$^{-1}$
1001·9
992·2
968·3

Several other lines are observed to be complex. In addition, a number of entirely new lines are observed in toluene. A complete account of the work will appear shortly in the *Canadian Journal of Research*.

LESLIE E. HOWLETT.

National Research Laboratories,
Ottawa, Sept. 28.

A New and Peculiar Marine Nemertean from the Australian Coast.

THIS note is to record the discovery of a rather anomalous nemertean worm from the coastal waters of New South Wales. The creature is of outstanding interest because its proboscis, that organ highly characteristic of the phylum, is apparently different altogether from any previously described for this group. In fact, we are not aware of any approximately similar protrusible organ having been recorded in any animal class.

The proboscis of the nemerteans usually consists of an introverted tube in a proboscis sheath, and it is everted like a finger of a glove that has been pulled 'outside in'. This new nemertean has also a proboscis which is retractile within a proboscis sheath, but the proboscis is branched. The branching is of the dichotomous type. By the help of the illustration (Fig. 1) the extraordinary nature of this organ will be realised. During eversion, which takes place almost explosively, the short main trunk first appears, then this divides and the finer and finer branches appear, but since each one of these is the result of an evagination the effect is almost indescribable. It is as if a large number of lively, wriggling, minute worms had been shot out. The tip of the animal is like a gorgon's head. The final branches, all tubular but quite thread-like, are constantly in motion, becoming now longer, now shorter.

If the stimulus has been great, there is, apparently, no possibility of the retraction of the mass and it is thrown off. But it is most interesting to watch the slow retraction which takes place when complete introversion occurs. Each fine branch inverts itself from the tip—rolls inwards—the branches become shorter until their point of origin is reached, and then the junction follows suit, invaginates, and so on.

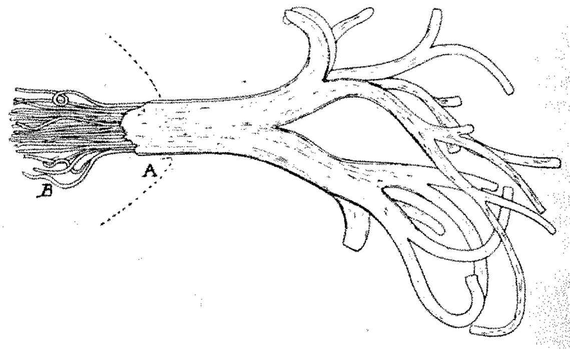

FIG. 1.—*Gorgonorhynchus repens* n.g. n.sp. Semi-extended proboscis torn away from the worm at A. At B can be seen the final branches of the proboscis not yet everted.

The illustration represents the result of tearing away from a worm the semi-extended proboscis. The primary and secondary branches have been everted but not the final ones, twenty or thereabouts in number, which lie within the former and still extend backwards. They have actually been exposed by the tearing away of the proboscis from the worm where its wall passes into that of the sheath.

A complete description of the anatomy of this interesting creature is being prepared. Many specimens have been found. The surprising thing is that such an anomalous form should fit in with one of the already known nemertean groups. From a study of its body wall it belongs to the *Heteronemertini*. We have created a new genus and species for it, *Gorgonorhynchus repens*, and the description here provided will serve to distinguish it from all other members of the group so far described.

WILLIAM JOHN DAKIN.

Zoology Dept.,
University of Sydney, Australia.

MAHALAH G. C. FORDHAM.

Zoology Dept.,
University of Liverpool, England.

Anisotropy Due to Flow in Cellulose Sols.

IT has been known for some years that certain liquids, and sols containing anisotropic colloidal particles, which in the normal state appear isotropic, will under the influence of external forces show some of the properties of anisotropic substances. The fact that an anisotropic state can be produced in certain fluids by means of the shearing forces caused by hydrodynamic flow, is due, at least in the case of sols, to the non-spherical particles contained in them.[1]

Cellulose gels have been shown to contain non-spherical colloidal particles or micelles,[2] and it is *a priori* almost certain that cellulose sols contain similar particles, which should be oriented by flow in just the same way as, for example, vanadium pentoxide sols are oriented. Further, since cellulose micelles show intrinsic optical anisotropy in the gel state, it should be possible to observe optical anisotropy in flowing cellulose sols.

In the case of cellulose nitrate sols in ether-alcohol, Kundt [3] has reported the generation of double refraction by shearing stresses, though he tried unsuccessfully to explain his observations as due to strains set up in the fluid. But since then an adequate explanation has been advanced, which ascribes the anisotropy to deformation and orientation of the particles.[4, 5] However, Faust [6] was not able to observe any anisotropy in flowing cellulose sols produced by the viscose process, and advanced the improbable theory that the anisotropy present in the fibres of artificial silk (generally regenerated cellulose gel) is due entirely to internal strains. Against this there is a large body of experimental evidence which indicates that this anisotropy is due to an oriented structure of the artificial silk fibres.[7, 8] Such an oriented structure must be originated in the sol from which the gel is produced, since it is not possible to produce permanent anisotropy in unoriented cellulose gels, by stressing them, of the same kind as that possessed by gels produced from rapidly flowing sols in the usual way.

On carrying out an investigation, I found that cellulose sols in cuprammonium hydroxide solution did show appreciable double refraction when flowing, thus indicating that they contain non-spherical particles which are capable of being oriented by flow.

Ageing in the case of vanadium pentoxide sols results in the growth of larger particles,[1, 5] which, other conditions remaining constant, are more easily oriented and thus give a greater double refraction. However, ageing of cellulose sols in the presence of air gave rise to lower double refraction, indicating a diminished particle size. This is to be expected, since the viscosity of such sols falls on exposure to air,[9] and this fall of viscosity is considered to be due to a decrease in micelle size.[10]

A fuller account of the anisotropy of cellulose sols when flowing, with particular reference to their behaviour during the spinning process in the manufacture of rayon, is to appear in the *Journal of the Society of Chemical Industry*. J. M. PRESTON.

College of Technology,
Manchester,
Oct. 5.

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[1] Zocher, *Koll. Zeit*, **37**, 347; 1925.
[2] Frey-Wyssling, *Zeit. fur. wiss. Mik.*, **47**, 1; 1930.
[3] Kundt, *Ann der Physik und Chem.*, Neue Folge **13**, 110; 1881.
[4] Schwedoff, *Jour. de Physique* (3), **1**, 49; 1892.
[5] Freundlich, Stapelfeldt, and Zocher, *Zeit. Phys. Chem.*, **114**, 161, 190; 1925.
[6] Faust, *Ber*, **59**, 2919; 1926: and *Cellulosechem.*, **8**, 40; 1927.
[7] Preston, *Jour. Soc. Chem Ind.*, **50**, 199 T; 1931.
[8] Preston, *Jour. Soc. Dyers Col.*, in the press.
[9] Gibson, Spencer, and McCall, *Jour. Chem. Soc.*, **117**, 486; 1920.
[10] Stamm, *Jour. Amer. Chem. Soc.*, **52**, 3047; 1930.

The Oldoway Human Skeleton.

THE announcement by Mr. Leakey and his colleagues [1] that, in their considered opinion, the Oldoway human skeleton found by Prof. Hans Reck in Tanganyika Territory, in 1913, appears to be of late Kenya Chellean or Kenya Acheulean age, is of outstanding interest. The Oldoway remains represent, unquestionably, an individual of the type of *Homo sapiens* who was buried in the ultra-contracted posture. Moreover, while there may be some doubt whether it is yet possible exactly to correlate the Chellean and Acheulean periods of Kenya with the corresponding prehistoric phases of Europe and of Great Britain, it does not seem probable that there is any great difference in antiquity between them.

It is therefore apparent that, if Mr. Leakey and his colleagues are correct in their opinion, there is now to hand evidence that in Chellean or Acheulean times in Africa there was in existence a race of people who were of 'modern' type and buried their dead in the contracted posture. Though this may seem incredible to some, it is not so to those who, in view of the evidence furnished by certain skeletons of *Homo sapiens* type found in various parts of the Continent and in England in pre-Mousterian deposits, and judging by the excellence and skill with which flint implements of the Acheulean period were made, have concluded that human beings of a high type were living at that epoch.

Further, if Mr. Leakey and his colleagues are right in their estimate of the age of the Oldoway skeleton, it is necessary to conclude that the origin of man must date back to a time much more remote than has been generally imagined, and this will also confirm the opinion of those who believe, from a study of his flint and bone implements and other cultural relics, that man was already well advanced in the Pliocene period. In view of these considerations, all those interested in man's antiquity will look forward to the publication of the detailed evidence upon which Mr. Leakey and his colleagues have based their momentous conclusion.

J. REID MOIR.

One House, Henley Road,
Ipswich.

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[1] NATURE, 128, 724, Oct. 24, 1931.

Priestley and Lavoisier.

I SHOULD like to make one correction (due to my friend Dr. Meldrum) of a statement in my discourse on Priestley before the Royal Institution. On p. 25 of the discourse, I say that "In his memoir of 1775 Lavoisier does not refer to Priestley". I ought to have said that Lavoisier "does not refer to his meeting with Priestley in October 1774". This was the meeting following Priestley's famous experiment of Aug. 1, 1774, generally described as the 'discovery of oxygen'. Lavoisier does, as a matter of fact, refer at the end of his paper to Priestley's views on fixed air as a compound of ordinary air and phlogiston, which he says, though not without plausibility (*non sans vraisemblance*) are contradicted by the facts. The correction does not affect my general argument. P. J. HARTOG.

Oct. 20.

A New Locality for *Gammarus chevreuxi* Sexton.

IN the autumn of 1929 the dominant animal in the fauna of Wyken Slough, near Coventry, was a *Gammarus*, the species of which was uncertain, but which I then recorded as *G. pulex* Linn. I have since sent specimens to Mrs. Sexton, who has identified them as *G. chevreuxi* Sexton. This organism has previously been found only in Chelston meadows, near Plymouth, and in view of its value in the study of genetics a new locality is worth recording.

Wyken Slough is a pond of about five acres in area, of brackish water (salinity 8·3 parts per thousand), at Alderman's Green, Foleshill, about three miles north-north-east of Coventry, Warwickshire.

F. T. K. PENTELOW.

Ministry of Agriculture and Fisheries,
The Tees Laboratory,
Barnard Castle, Co. Durham, Oct. 12.

Research Items.

Human Remains from Kish.—Dr. L. H. Dudley Buxton and Mr. D. Talbot Rice have published in the *Journal of the Royal Anthropological Institute*, vol. 61, Jan.-June 1931, a report on human crania and skeletal remains from Kish collected by the Field Museum and Oxford University Expedition in the three seasons 1923–26. The material was excavated in the old Sumerian palace at Ingharra (Eastern Kish) and Mound *W*, and belongs to the period immediately preceding the age of Sargon of Agade. It is contemporary with the fourth and last dynasty of Kish (2900–2800 B.C.), of which the names indicate the Semitic character. Owing to the defective condition of the material the number of specimens available for study is relatively small. In the majority of cases the height of the head cannot be measured, and the series comprises twenty-five specimens only. Examination of the crania suggests a dichotomous classification, corresponding to the linguistic and cultural division into 'Semitic' and 'Sumerian'. The majority of the skulls are distinctly long-headed and usually high, the extra height being due to a well-marked scaphocephaly. Yet the jaws are small instead of large and powerful as among most scaphocephalous races. This type of skull from Kish is strongly reminiscent of the Combe Capelle skull. The forehead is retreating and the eyebrow ridges prominent, cheek-bones and nose broad. It belongs to the type which has been described as Eurafrican, and is of considerable antiquity, lingering on in remote parts from western Europe to North Africa, and it may be very early in Egypt. The second type is also dolichocephalic. The main distinction is in the contour, which is rounded, not angular. The eyebrow ridges are mainly absent, and the occiput specially prominent. There is no scaphocephaly and the skull is well filled. It is assigned to Elliot Smith's 'brown race'. The third type is only sparingly represented. It is brachycephalic, with a well-marked eyebrow ridge and a stronger jaw. There is little doubt that it is 'Armenoid'. It did not penetrate to Ur. In a similar series from Ur the first two races from Kish are present, but not the 'Armenoid'.

Migrations of the Greenland Whale and Narwhal.—In the *Geographical Journal* for September is a paper by Dr. R. W. Gray on the colour of the Greenland Sea and the migrations of the Greenland whale and narwhal, founded mainly on log-books of the whaling vessels *Eclipse* and *Hope*, belonging to his father and uncle, in the former of which he himself has sailed. Both species of cetaceans, it appears, avoid the clear blue water and congregate in that which is turbid and olive-green in colour owing to the presence of diatoms, which supply food to the copepod *Calanus finmarchicus*, on which the whale feeds. The cuttle-fish (which feed the narwhal) also, it is suggested, ultimately depend on these. The 'banks', or areas of green water, appear to drift, like the ice, south-west, and are accompanied by the cetaceans for a varying distance according to circumstances, when they turn and migrate north-east, as they had done originally to meet the 'banks' early in the year. Whales are much dependent on ice for shelter, and the introduction of steam has increased this tendency. In summer there seems to have been some separation of the tribes in both cetaceans, the males of the whale following the food-banks south-west, while the females and young went north: while some of the narwhals also take a northerly route, independently of sex. Narwhals have been practically untouched by whalers, but it is suggested that whole tribes of the whales, with resorts and routes of their own, have been killed off, or nearly so.

Disappearance of Insect-borne Diseases from Britain.—Dr. Ll. Lloyd contributed a paper on this subject before Section D (Zoology) of the British Association on Sept. 20. In commenting upon the fact that Britain has suffered in the past from such insect-borne diseases as bubonic plague, typhus, relapsing fever, and malaria, Dr. Lloyd discussed the possible causes responsible for their more recent absence. There appears to be no evidence of any graded climatic change to account for the improved state of affairs. In so far as plague is concerned, this disease was dependent on insanitary habits in towns and fragile houses, which, respectively, afforded food and shelter to the black rat and allowed it to multiply greatly. With changes in these conditions, enforced by legislation, the black rats were reduced in numbers and plague ceased. Rapid reduction in numbers of the human flea is still in progress. Typhus and relapsing fevers, which are louse-borne diseases, had their foci especially in gaols and insanitary camps, and, when these were reformed, continuance of these diseases was due to the vagabond class. Outbreaks followed especially after famines, and the ability of the British people, in recent times, to make up any deficiency of food by importation has been an important cause of their cessation. Social measures which have tended to reduce the condition of utter vagabondage also contributed. Malaria was widespread in England and Scotland up to 1800, and since then, in several outbreaks, a tendency to restriction of its northerly range is noted. It is suggested that an old strain of malaria, capable of transmission at a somewhat lower temperature than present-day strains, has died out, probably owing to very cold years. Other factors which have, or may have, played a part in the reduction of malaria are—better treatment of the disease; increased drainage through improved farming; possibly also a change in the feeding habits of *Anopheles*, such as Hackett and Missiroli believe has abolished malaria from parts of Italy.

Atlantic Foraminifera.—In the eighth and concluding part of J. A. Cushman's "Foraminifera of the Atlantic Ocean", the author describes the species which have occurred in the waters adjacent to the United States, including the Caribbean Sea (*Bull.* 104, Smithsonian Inst., 1931). Nine families are included in this account. From the Rotaliidæ, a large family, the geological history of which begins with the genus *Spirillina*, recorded as early as the Cambrian, developed the Amphisteginidæ, the palæozoic records of which are stated to be erroneous. The pelagic habit of many species of the Globorotaliidæ and their association with the Globigerinidæ in both recent and fossil marls and oozes are held to indicate the close relationship of the two families—the Globigerinidæ have developed from the Rotaliidæ as a specialised group adapted to pelagic conditions. The Anomalinidæ, another family derived from the Rotaliidæ, gave rise to the attached forms placed in the Homotremidæ, and to the Planorbulinidæ, the species of which are mostly in the Indo-Pacific at the present time, but were more widely distributed in the tertiary period. The paper is illustrated by twenty-six plates.

Leaf Fall in the Tropics.—Mr. R. E. Holttum has recently put on record (*The Gardens' Bulletin*, Straits Settlements, vol. 5, Nos. 7 and 8, June 1931) the behaviour as regards leaf-fall and flowering of a number of trees in Singapore, thus rendering comparison possible with the behaviour of similar trees in the more seasonal tropical climates of Java and Ceylon, on which Coster and Wright have previously made similar observations. The climate of Singapore is very uniform throughout the year, but there is usually a definite change to drier conditions after the north-east monsoon in February, and also some tendency for July and August to be comparatively dry. It is therefore interesting to note that trees of a number of deciduous species change their leaves annually about February, whilst a few species change their leaves in August, and four species were observed to change their leaves twice a year, usually in February and August. A number of other species change their leaves at approximately constant intervals, which, however, have no reference to the faint seasonal cycle, so that, though the intervals are equal in time, they have no reference to the annual cycle and fall upon different months in successive years. These trees, especially, show variation from tree to tree within the same species, and Holtum's observations, since 1927, have been based upon weekly observations upon the same individuals. Detailed notes are given upon the different species, and interesting comparisons with Wright's and Coster's observations are made.

Liquid Drops in Electric Fields.—The October number of the *Proceedings of the Royal Society* contains a paper by Dr. W. A. Macky on the behaviour of water drops in electric fields which clears up several points in connexion with the mechanism of thunderstorms. It appears that the first effect of an increasing field is simply to elongate a drop. Then, at a field strength which varies inversely as the square root of the initial radius, instability sets in and filaments of liquid are drawn out from both ends, accompanied by characteristic electric discharges from the points so formed. The fields necessary to produce instability are independent of the air pressure, unless this is so small that the field is only a little greater than is required for a discharge in absence of the drops. Applied to storms, these results afford strong support for the view that the discharge current is carried by ordinary gaseous ions and not by charged droplets. They show also that the field will rise to some ten kilovolts per cm. immediately before a discharge passes, and that when this occurs the largest drops present are unlikely to be greater than about 0·15 cm. in radius, larger ones being automatically reduced by the formation of filaments. Dr. Macky's paper is illustrated by some interesting photographs of distorted drops and discharges.

Diffraction of Electrons.—Two papers on the diffraction of electrons in gases, which cover a large range of experimental conditions and serve as a check on the approximations which have to be made in the theoretical treatment of the phenomenon, are described by F. L. Arnot and by E. C. Bullard and H. S. W. Massey in the October number of the *Proceedings of the Royal Society*. The results provide, qualitatively at least, further convincing evidence that the interactions of electrons and atoms which have been studied are capable of description as a wave effect, but it is apparent that much still remains to be done in the necessarily complicated theoretical treatment of what occurs. The main features—the effect of the atomic fields, polarisation of the atoms in the interaction, and the exchange of electrons between the beam and the atoms—are probably recognised, but in the treatment of all three, difficult calculations and approximations are involved, the validity of which must be tested by reference to an extensive set of experiments such as the present ones, and even these are still evidently not completely adequate. At the moment, it looks rather as if the value of the diffraction patterns in the investigation of molecular structure consists chiefly in the comparison of the interaction of electrons with systems of known and of unknown internal arrangement respectively, and in the investigation of progressively deeper parts of a system by the use of electrons of increasing energy. There is, however, a natural tendency to look for unique analysis of structure from a theoretical treatment of the diffraction due to any particular substance, without reference to other substances, and future work is likely to be directed both on such lines and towards the accumulation of more complete experimental data.

Lightning Phenomena.—In a communication to Section A of the British Association on Sept. 25, Dr. B. F. J. Schonland gave an interesting account of observations he has made during more than eighty thunder-storms. It is well known that an electric spark branches away from the positive pole of the discharger. It has also been observed that lightning discharges between the base of a cloud and the ground generally fork downwards, away from the cloud base. It is therefore sometimes concluded that the base of the thunder-cloud involved in such a flash is positively charged. Dr. Schonland described experiments made on South African thunder-clouds, which make it very difficult to accept this argument from analogy with the ordinary spark discharge. An examination of the results obtained from some 500 flashes showed that the base of the cloud was negatively charged in 98 per cent of the cases, although the branching was generally downwards. He exhibited records which show downward branches proceeding from the negative pole of the cloud. He gave evidence to show that the conditions preceding the ordinary spark gap discharge require modification before they can be compared with those prevailing below a thunder-cloud. When these modifications are made, the branching is no longer from the positive but from the negative side. The chief modification lies in earthing the positive side of the spark gap (see also p. 795 of this issue of NATURE).

The Dissociation of Water.—An investigation of the dissociation of water in the glow discharge, described by E. G. Linder in the *Physical Review* of Aug. 15, breaks new ground in the application of electrical methods to chemical problems. A tube was set up through which a continuous stream of vapour could be pumped whilst a discharge at a few hundred volts passed through it. The products of dissociation were collected and analysed, and at the same time the potential throughout the discharge and the concentration and energy of the electrons were found, wherever possible, by the use of probe wires. Further information about the electrons near the cathode was obtained by calculations based upon the recent satisfactory theories of the cathode dark space due to K. T. Compton and P. M. Morse. From the collected chemical and electrical data it was then possible to show that about 11 electron-volts were expended for each water molecule which was split into hydrogen and oxygen in the discharge, although the minimum energy needed is only 2·5 electron-volts, and that each electron in the negative end of the tube dissociated about five molecules. Further, the probability of dissociation by an electron near the anode was shown to be of a reasonable order of magnitude. Little information is given about intermediate products in the dissociation, but it is of interest in this connexion that Prof. Bonhoeffer, who has recently discussed a similar problem with T. G. Pearson in the *Zeitschrift für physikalische Chemie*, has shown that it is unlikely that the hydroxyl radicle can ever be isolated from the discharge, in spite of the intensity of its band-spectrum.

Microscopic Examination of Metals by Polarised Light.—In *Metallurgia*, Oct. 1931, p. 180, is given an account of work by Dr. M. v. Schwarz on the application of polarised light to metallographic investigations. Although suffering in parts from the translation, the paper will be of great interest, particularly perhaps to those concerned with non-ferrous alloys. As an example of the utility of the method may be mentioned the clear differentiation between cuprous oxide and sulphide in copper. The former under crossed nicols appears deep red; the latter, as well as the corresponding selenide and telluride, blue. Crystalline orientation is also very clearly differentiated, to such an extent that etching may in some cases be dispensed with altogether. In the examination of worked materials this is a matter of considerable importance, and the existence of 'preferred orientations' may readily be observed. Structures are in some cases—such, for example, as the ternary eutectic which occurs in certain high phosphorus-bearing bronzes—much more clearly revealed than by ordinary etching methods; and for the determination of the existence of small amounts of insoluble impurities the method may be of great scientific and industrial importance. Stannic oxide, for example, in bronze or in the corrosion product of the alloy, is very clearly revealed, and the characteristic, needle-like, idiomorphic crystals are very evident. Although an account of the necessary technique is given, it will probably be better to refer to the original account given by Reichert (*Zeit. für Metallkunde*, 17, 299; 1925).

Origins of Power Engineering.—In a short paper contributed to Section H (Anthropology) of the British Association on Sept. 29, Mr. H. P. Vowles gave a sketch of the origins of power engineering. For half a million years or more, man has sought to augment his own bodily power, first with sticks and stones which gave him the mechanical advantage of the lever and the wedge; then after a vast lapse of time, by means of simple mechanisms operated by man and animal power; and, finally, by an ever-increasing control over the forces of Nature. It is only during the past 7000 years we find any evidence of man's attempt to harness external power. One very early invention was the wheel and axle, which is found depicted on a Sumerian plaque of 5000 or 6000 years ago. The wheel and axle led to the use of the wheel for irrigation and flour milling. Water-raising wheels are of great antiquity, but before water-wheels could be adapted for driving mill-stones the toothed wheel had to be invented. Toothed wheels are referred to by Heron, Papus, and Vitruvius. Three primitive types of water-mill exist to-day. One of these, seen in China, consists of a pivoted beam, one end holding a pestle, the other end being scooped out as a water receptacle. Water flowing into the receptacle tilts the beam, raises the pestle, but spills the water, leading to the fall of the pestle. Another primitive mill has a vertical shaft with a horizontal wheel at the bottom placed in the stream, and another consists of a water-wheel with a lengthened axle bearing pegs which act as cams and raise stamps. Wind-mills came after water-mills, and probably some of the earliest were those in Seistan, Persia, a particularly windy region. Mr. Vowles has consulted all the important early writers who have referred to these things, and his paper concludes with notes on the earliest use of steam and the observations by the ancients on magnetic and electrical properties of materials.

Astronomical Topics.

Calendar Reform.—The *Times* for Oct. 31 contains an article on the Conference of the League of Nations that has been considering this question. It appears that the Conference confined itself to recommending a fixed Easter, and postponed all other suggestions of reform. The question of the date of Easter is primarily an ecclesiastical one; other authorities can do no more than make recommendations. A consideration of some weight is brought out in the *Times* article: in one case the rules for Easter deliberately postpone it for a week after the Passover—this is when the fourteenth day after the tabular new moon falls on a Sunday; Easter is kept a week later. A fixed Easter would generally be within a fortnight of the Passover, and the difference between a week and a fortnight does not appear to be a vital one. There are two points in the present secular calendar that are inconvenient in astronomical calculations: the absence of system in the lengths of the months, and the insertion of the leap-day at the end of the second month instead of at the end of the year. Regret will be felt that the Conference did not come to any decision on these matters.

Determination of the Mass of Triton, Neptune's Satellite.—A note in NATURE for Sept. 5, p. 416, gave a summary of the research on this mass made by Dr. Nicholson and Messrs. van Maanen and Willis, using photographs of Neptune taken near its stationary point with the 60-inch reflector at Mt. Wilson. Further details of the research are given in *Pubs. Astr. Soc. Pacific* for August 1931. It appears that the result given in the former note was not quite correct; the mass that they find for Triton is 0·06 of the earth's mass, with a probable error of 0·024. If two rather poor plates are excluded, the higher value 0·09 of the earth is obtained. Even the smaller value 0·06 would make Triton by far the most massive satellite in the solar system; it would be more massive than Mercury, and nearly five times the mass of the moon.

The early notice of this work issued in the *Science Service Bulletin* implied that it was hoped that the research might throw some light on the mass of Pluto. Presumably the idea was that if Triton was found to have a higher mass than would be inferred from its light, the same was likely to be the case with Pluto.

The Numbering of Minor Planets.—The numbering of new planets is assigned to the Berlin Rechen-Institut. No planet receives a permanent number until five accurate observations, extending over several weeks, are available. A considerable number of planets that do not come up to this standard in the year of discovery have provisional orbits calculated; these sometimes enable the planet to be recovered in a subsequent year, and it can then receive a number. *Circular No. 472* of the Institut, issued on Sept. 28, assigns numbers to 31 new planets; the last of these has the number 1183. Seventeen of the 31 have been observed at more than one opposition. Planet 1930 *SQ* receives the number 1170; it had been hoped that this planet would prove to be identical with 330 Adalberta, which has been missing since 1892, the year of its discovery. The identity has presumably been found untenable.

Some hundreds of planets, in addition to the 1183 numbered ones, have had approximate orbits deduced, but await reobservation before being definitely enrolled. The work of following the records of these small planets keeps the Rechen-Institut very busy; two or three circulars are issued every week.

The South African Association.

GRAHAMSTOWN MEETING.

THE twenty-ninth annual meeting of the South African Association for the Advancement of Science was held in Grahamstown on July 6–11, 1931, under the presidency of Prof. J. W. Bews. The meeting was very well attended and 109 papers were read. The South Africa Medal and grant were presented to Prof. H. B. Fantham at the close of the presidential address. A popular illustrated lecture was delivered by Prof. R. H. Compton on "National Parks". There was a reception by the mayor and councillors, and a whole-day excursion to Port Alfred.

The presidential address to all sections was given by Prof. J. W. Bews on "The Ecological Viewpoint", the substance of which appeared in NATURE of Aug. 15, p. 245.

The year's progress in astronomy formed the subject of Dr. H. L. Alden's presidential address to Section A. The effect of the discovery of Pluto on astronomical science was discussed and the conclusions so far reached as to its mass, reflecting power, and eccentric orbit. The close approach of Eros to the earth has led to observations on its apparent double nature, variations in brightness, apparent elongation or duplicity, and rotation of the elongation. The discovery at the Union Observatory of a variable star with a period of only 100 minutes was noted, with its possible great consequences on evolutionary developments. The occurrence of diffuse matter in space, its concentration in the plane of the Milky Way and the possible use of infra-red photography in connexion with it, and the measurement of the velocity of a distant spiral nebula were also considered.

The aims and objects of soil science formed the subject of the presidential address to Section B, given by Prof. I. de V. Malherbe. A review was given of the rise of soil science since the work of Sprengel, and special reference was made to the work of Russian scientific workers who laid the foundations of the science of pedology, devised new methods for its investigation, departed from traditional methods of analysis, and stressed the importance of the whole soil profile. The developments arising from soil profiles and soil horizons were noted. The climatic basis of soil classification was extended to other European countries and further developed by Hilgard for American soils. International soil congresses have become a feature in work on soil science, and have grown in importance and scope. The work of the six Commissions of the International Society of Soil Science was outlined, these covering soil physics and mechanics, soil chemistry, soil biology and biochemistry, plant physiological methods, soil genesis, nomenclature and mapping, and applications to soil technology. The need for research in soil science and establishment of fundamental principles for applied science were stressed.

Prof. N. J. G. Smith in his presidential address to Section C dealt with the problem of making conditions unsuited to infectious diseases (mainly illustrated from plant diseases). Environmental conditions for diseases being extremely varied, co-operation between different branches of science is possible in combating them. The parasitic fungi, bacteria and virus diseases can be controlled by making conditions uncomfortable and unsuitable for them. Sensitivity to environment was illustrated by consideration of fungal cultures, for example, day and night growths of *Helminthosporium* on barley, temperature and growth rate, the sensitivity to which promotes or hinders the spread of plant parasites, the great sensitivity of fungi to the chemical nature of their environment, associated with which was the phenomenon of 'staling' of the parasite, which, by its own activity,' produces chemical substances that stop its own growth. The possible application of these chemical substances by inoculation into plant tissues and of soil inoculation was indicated. The problem of keeping parasites at a distance was among the other topics discussed.

Dr. C. von Bonde discussed the correlation between marine biology and the problems of the fishing industry in his presidential address to Section D. The history of the Marine Biological Survey of South Africa was traced from its inception in 1895. In 1929 a new specially constructed survey ship was commissioned. In addition to investigation of the effect of trawling on the Agulhas Bank, further prolific trawlable areas have been found. Many other lines of work are in progress. These include intensive continuous study of the plankton and its fluctuations, seasonal variations in migration of fish, with their dependence on currents, salinity, phosphate and nitrate content of water, tagging experiments by special means for study of migration, scientific legislation with the view of conservation of supply. The fisheries survey work demands a complete biological and physical survey of every hydrographic basin and the whole coast of the Union, determination of life-histories of all animals and plants of economic importance and their associations, the physical and biological problems connected with artificial culture, an effective code of laws, schools for training fishery investigators and administrators, and the survey working in co-operation with the universities.

The presidential address to Section E, delivered by Mr. A. J. H. Goodwin, dealt with problems of association and chronology in prehistory. Speculation on prehistoric man's habits from man's physical and cultural remains was deplored. Association, chronology, and technology were stressed, also correlation with related branches of science. Simplicity is an ideal. Terminology and lax use of it has caused misunderstanding, and the use of such terms as culture and industry were therefore discussed. Cultural development, phases, and variations in South Africa are of some difficulty not experienced elsewhere. Phase is considered a change in fashion, variation a major cultural development brought about by a major force. The importance of association and some of its pitfalls were noted, also the difficulties due to muddled use of racial and cultural terms. The vexed question of patination and dating was discussed in general and with special reference to dating of petroglyphs. The desirability of correlation of chronological series from individual sites to provide generalised series for zones was emphasised.

"Intelligence, Environment, and Heredity" was the subject of Prof. R. W. Wilcocks's presidential address to Section F. The question of interaction of environment on heredity and vice versa was discussed in relation to intellectual efficiency. The many types of researches in connexion with the problem were outlined, such as correlations between blood relatives, estimate of intelligence of pupils by teachers, concomitant variations, correlation between intelligence of siblings and that found between various physical characters. The results of work on twins were considered. The literature relating to attempts to get correlations between environmental factors and intellectual efficiency was reviewed, the conclusion being that apparently marked changes and differences of environment do not affect intelligence quotients of children to any great extent. A brief mention of the South African Group Intelligence Tests results was made. The average I.Q. of 3281 'poor white' children of ages 120 to 155 months showed a definite tendency to sink with increase in chronological age, which is ascribed to unfavourable environmental conditions under which the 'poor white' child lives.

In Section A astronomers dealt with the cause of a nova outburst, second order terms in differential refraction in the measurement of photographic plates, comparison between observations on a comet and an ephemeris and the expanding universe. Meteorological papers were concerned with Rhodesian rainfall and the meteorite at M'Bozi, Tanganyika. Soil reclamation and water provision in arid countries were of much interest and the goodness of fit of Dieterici's equation was discussed. Engineers were interested in papers on induction heaters, electric current and the human body, and road construction and maintenance problems in South Africa. An interesting paper was contributed on the historic determinations of the longitude of the Cape.

In Section B papers of chemical interest dealt with the sugar-acid relationship in oranges, the essential oils of *Empleurum serrulatum*, the recent results of plant poison work, the value of valve potentiometers in physico-chemical work, and electrically heated vacuum desiccators. Accounts were given of the mineral springs of South Africa and of the register of medicinal waters of the country. Natural products of the Union such as Iceland spar and the clay responsible for the ceramic industry at Grahamstown were of interest, as was the paper on the products of native iron smelting. The nature and significance of the soil colloidal complex interested geologists and agriculturalists alike.

In Section C important papers on germination of wattle seeds, the germinating capacity of certain native South African seeds, on the vegetation of Natal, and on the siccation process were contributed. In systematic botany there were revisions of the genera *Lopholæna* and *Sutherlandia*, the evolutionary tendencies of the Labiatæ, new species of *Juncus*, and the parasitism of *Harveya*. Mycological papers dealt with new species of South African fungi, bacterial diseases of grain, physiological forms of *Puccinia graminis*, anthracnose of almonds, and new diseases of potatoes. Agricultural problems included studies in pasture management, grass or bush in the Karroid areas, physical properties of wattle soils, soil depletion, experiments on the control of *Selago*, and the fertility factor in turf production.

In Section D a number of interesting new parasitic Protozoa and the Protozoa from Kalahari soils were described. A series of papers dealt with various Amphibia from the points of view of morphology, osteology, and economics. The mammalian basicranial axis and the descent of the mammalian vomer from the reptilian parasphenoid were discussed. The embryological development of the beetle, *Euryope terminalis*, was described and beautifully illustrated. Methods of marking insects taken at regular intervals in quantitative samples, the therapeutic uses of detoxicated snake venom, and fish mortality were of interest. The native beliefs concerning pregnancy and child-birth, with their effects on public health administration, formed a useful practical contribution. A series of papers dealing with sheep and wool research, density and staple length, variation in the merino fibre, correlation between crimp and diameter of wool, and the blowfly menace were taken in a special sheep and wool subsection. Fine exhibits of small mammals from south-west Africa, of deep-sea fishes, of extinct mammals associated with the Taungs skull, and of curious letter-like markings on the mouth of a snoek were displayed.

In Section E an account was given of Bushman paintings at Quthing, Basutoland, and of the present-day Basuto copies of them, the skeletal remains of cave dwellers of the Outeniqua Mountains were described, and also skeletal material from early graves in the Riet River valley. The traces of Bushman occupation in Tanganyika Territory were detailed, and an interesting historical and philological investigation of the lost tribes of the Cape was given. Artefacts from Melkhoutboom and implements from Healdtown were described, also rock engravings and suggestions as to their significance and age. Superstitions of coloured people in Knysna and traditions connecting the Bantu and Zimbabwe were discussed, and a paper on native music dealt with the mystery of the Grand Gom-gom.

In Section F papers of much economic interest dealt with provincial councils from the point of view of political science, with indirect rule in Tanganyika, and with an analysis of the contributions to family support of women workers on the Witwatersrand. The quantitative valuation in ethics and the question of the retention of the distinction between sensation and perception were considered. Educationists were interested in investigations into intelligence tests in South Africa and in experiments in vocational guidance. Two papers of much historic interest dealt with the making of a Cape governor, Sir Benjamin D'Urban, and with early revenue and taxation in South Africa. Another most interesting paper dealt with the new cosmology in its historical aspect, Plato, Newton, and Whitehead being considered. An account of the International Institute of Intellectual Co-operation was given at a meeting of all sections.

The next annual meeting of the Association will be held at Durban in July 1932, under the presidency of Prof. P. J. du Toit. H. B. F.

Metallurgical Spectrum Analysis.

TWO papers on metallurgical spectrum analysis, presented at the recent meeting of the Institute of Metals at Zurich, "Application of the Spectrograph to the Analysis of Non-Ferrous Metals and Alloys", by H. W. Brownsdon and E. H. S. van Someren, and "The Spectrographic Assay of some Alloys of Lead", by D. M. Smith, represent the latest developments of a method of metallurgical analysis which appears to have been first suggested and used by W. A. Miller, assayer to the Mint, in 1863. The theory and technique of metallurgical spectrum analysis were elaborated by physicists having academic interests, but it is noteworthy that the present papers, and others recently published, emanate from the research departments of industrial concerns—Imperial Chemical Industries, Ltd. (Metals), and the British Non-Ferrous Metals Research Association; moreover, these papers indicate that spectrographic methods have been adopted for particular routine assays. Now that the importance of the presence of small quantities of foreign metals in alloys is appreciated, though in individual cases the quantitative relations may be quite unknown, it is customary for specifications to set rigorous limits for the content of these foreign metals permissible; limits which, in the absence of precise knowledge, are often very low. It is in the works control of the production of such alloys that the methods described in these papers are particularly valuable.

The method most favoured by these writers is the simplest available, and it is the one most capable of general works use, since the instrumental routine does not require a high degree of technical training in the operator: reading and interpreting the spectrograms requires more training. Direct visual comparison is made of the spectrogram of a standard alloy with the spectrogram of the alloy to be assayed. For the examination of brasses, the authors of the first paper use a pair of electrodes, the positive being pure copper, the negative being the sample to be assayed. Spectra of arcs of all the standard alloys are run in this way and photographed with the standardised routine, and from an examination of the spectrograms, tables are prepared showing the relation between the intensities of the lines of the metal being determined and neighbouring copper lines. An example is shown in the accompanying table.

MANGANESE IN BRASS.

Manganese Line.	2949.	4236.
Manganese, per cent		
0·01	*b.v.* < Cu 2858	
0·02	= Cu 2858	
0·04	> Cu 2858	
0·1	< Cu 2997	
0·2	< Cu 2883 = Cu 2997	
0·3	= Cu 2883 > Cu 2997	< Cu 4249
0·4	> Cu 2883	= Cu 4249
0·8	< Cu 2961	> Cu 4249
1·6	= Cu 2961	

b.v. signifies barely visible.

The spectrogram of the sample to be assayed is taken with the same routine, and by a comparison of the intensities of the manganese line 2949 with the copper lines 2858, 2883, 2961, and 2997, and of 4236 manganese with 4249 copper, the manganese content of the brass is determined.

For the examination of lead alloys, a high tension spark discharge was used, both electrodes being of the metal examined. Relative intensity tables were prepared, in which the pairs of lines to be compared consisted of one line of the metal to be determined and a neighbouring lead line, but were otherwise similar to Table 1.

Preliminary experiment must be made to determine whether arc or spark excitation shall be used, what the arc or spark gap shall be, whether a condensing lens is to be used, and to standardise carefully the electrical conditions of the excitation and the photographic technique. It is evident from the papers under review and others recently published that different workers evolve different routines to suit their particular problems and equipment. Such papers as the present ones are valuable in that they give complete working details for the determinations of which they treat, as shown in the following table.

Alloy.	Metal determined.	Percentage range for which data are available.	
Brass . .	Lead	0·005	5·0
	Tin	0·005	1·3
	Iron	0·005	1·2
	Nickel	0·01	15·0
	Aluminium	0·01	2·0
	Manganese	0·01	1·6
Lead alloys	Tin	0·002	9·0
	Antimony	0·03	15·0
	Cadmium	0·0001	1·0
	Arsenic	0·03	1·5
	Bismuth	0·0003	0·15
	Copper	0·0002	0·06
	Zinc	0·001	0·06
	Silver	0·0006	0·002
	Thallium	Data for	0·001
	Mercury	Data for	0·005

In some cases these figures do not represent the extreme limits over which the methods can be used, but those which the writers have used in practice. When most of the observations will involve very small quantities, a modified procedure with longer exposure and development will be used; while for determinations which are mostly more than one per cent, it will often be advantageous to use the logarithmic wedge sector referred to later.

D. M. Smith deals, further, with the preparation of standard alloys, an important preliminary to putting a spectrographic routine into works operation; and with a more refined method of making the intensity comparisons. A simple spectro-photometer, the logarithmic wedge sector of Scheibe and Neuhäusser, is used: its use gives not so much an increased accuracy as an extension upwards of the range over which the equipment may be used for making determinations.

The accuracy to be obtained from both these methods is about ten per cent of the amount of the constituent present, over the range for which the method is applicable. Thus 0·1 per cent would be returned as between 0·09 and 0·11 per cent; 10 per cent would be returned as between 9 and 11 per cent.

A. A. FITCH.

Work of the Radium Commission.

THE first Annual Report of the work of the Radium Commission, published this time last year, gave an outline of the policy of the Commission, and stated that the radium was to be used primarily for the treatment of malignant disease. In the first instance, the faculties of medicine at universities throughout Great Britain, excluding Oxford and Cambridge, were approached, and negotiations with centres in London were made irrespective of the University.

The second Annual Report, just published,* shows that the year has been largely occupied in developing the work at the national radium centres. Since the Commission's scheme was launched, a number of medically qualified men have taken up radium therapy and by courses of study in England and abroad have prepared themselves for the position of radium officers. The wisdom of the policy of concentration of radium therapy at centres where the work can be properly organised can scarcely be doubted, for it is becoming generally recognised that this is a highly specialised kind of treatment, and to carry it out satisfactorily there has to be a certain amount of co-ordination; pure medicine, surgery, radiology, pathology, and physics all play their parts. In these circumstances, it is obvious that the best treatment can only be procured where there is a real appreciation of the many factors that should decide and control the exact methods to be adopted.

It has been necessary to enlarge on the original scope of this radium service, for owing to the uneven geographical distribution of the universities with medical schools where the twelve national radium centres had been established, it became obvious that there were considerable areas in England which could not be adequately covered by them. It is likely, in the near future, that regional radium centres will be established to serve these areas, the main policy of concentration at centres adequately staffed and equipped still being preserved.

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* Second Annual Report of the Radium Commission. Pp. 32. (London: H.M. Stationery Office, 1931.) 6*d*.

The chief aim of the Commission for the first five years of its existence is not only to get the best facilities for radium treatment at these recognised centres, but also to be able to assess quantitatively at the end of this time exactly what the value of the radium has been in the treatment of cancer. All the centres keep their clinical records on forms which have been devised and issued by the Commission, and the information from these forms is to be collected yearly and assembled on statistical cards, the general form of which has been agreed upon in consultation with Prof. Major Greenwood. In this way it should be possible year by year to obtain information of the number of people treated, the various sites of cancer which have been treated, all technical details of the treatment, and progress of the patients.

Reference is made in the Report to the work at the Westminster Hospital with what is known as the 'four gramme bomb'. The trial with this appliance was limited in the first instance to cases of malignant disease originating in the breast, stomach, and prostate, and after a period of more than a year the conclusion has been reached that, under present conditions, this form of therapy cannot be recommended for the treatment of cancer in these regions. The Commission takes the view that surface treatment with radium may be better developed by dividing the bomb into smaller units.

Under the terms of its charter, the Commission has two main obligations imposed upon it in administering the national radium; and whilst it has considered that its most pressing duty is to "promote the treatment of the sick throughout Great Britain", it has also taken steps to forward the "advancement of knowledge of the best methods of rendering such treatment". With this latter object in view, it has allocated 1 gm. of radium element to the Medical Research Council and 0·18 gm. to the National Physical Laboratory. The policy of making such allocations to large corporate bodies in touch with individuals specially qualified to conduct the kinds of research work involved obviously has many advantages. As stated in the present Report, it is an encouraging sign of the activity of experimental research in radium that within a few months of completing the arrangements with the Medical Research Council ninety-five per cent of the loaned radium had been allocated to research groups.

Human Embryology.

OCCASIONALLY children are born with the terminal part of an arm or leg represented by a mere rudiment, or a whole segment may be missing as if an amputation had been performed within the uterus. Dr. George Streeter, director of the Carnegie Laboratory of Embryology, has made an important addition to our knowledge of such abnormalities (*Contributions to Embryology*, 1930, vol. 22, pp. 3-46). Having numerous examples of such abnormalities at his disposal, he has been able to throw light on many points which have hitherto been obscure.

It has usually been supposed that fibrous bands—known as amniotic bands—formed round the growing limb of the fœtus, causing a constriction, ultimately led to the death and shedding of the distal part of the limb. Dr. Streeter's investigations throw a new light on these encircling bands. They are not formed from the amnion but are developed as fibrous rings from the tissues of the necrosing limb. A survey of the evidence collected and tabulated by Dr. Streeter leaves no doubt in the medical mind that intra-uterine amputations are the result of a partial failure of the placental circulation, which leads to gangrene of the fœtal limbs—just as a partial failure of circulation in the adult may lead to gangrene of the extremities.

Fœtal tissues react to lack of blood quite differently from adult tissues. At the zone where separation is to take place between the living and dead parts of the fœtal limb, the lymph thrown out becomes organised and forms the constricting rings of tissue, known as 'amniotic bands'. The unnourished segment of the limb, being bathed in amniotic fluid, undergoes only partial death, parts of it surviving to form an irregularly shaped hand or foot.

Curiously enough, liability to intra-uterine amputation has been shown to be inherited in a few instances.

In the same volume, Dr. R. H. Hunter clears up certain obscurities relating to the development of the human vagina and hymen. In the sixth week of development the vagina is represented by a canal formed out of the fused lower ends of the Mullerian ducts. Thereafter the canal becomes represented by a cord of epithelial cells, this cord, which represents the vagina, continuing to elongate until the end of the fourth month. In the fifth month of development, the solid core of vaginal epithelium begins to proliferate rapidly on all sides, distending the canal round the corner of the uterus at the upper end and pressing against the wall of the vulva (urogenital sinus) at the lower end. The central cells degenerate and the lumen of the vagina is thus formed. The hymen, which represents part of the wall of the urogenital sinus, is formed out of the vagina-vulvar junction by the expansion of the lower end of the vaginal cord. The phylogenetic significance of these vaginal changes is still unexplained.

University and Educational Intelligence.

BELFAST.—Dr. J. S. Young, lecturer in experimental pathology and assistant director of cancer research in the University of Leeds, has been appointed Musgrave professor of pathology.

CAMBRIDGE.—Mr. A. G. Brighton (Christ's College) has been appointed curator of the Sedgwick Museum of Geology.

The Council of the Senate recommends that the Goldsmiths' readership in metallurgy be discontinued, and that a Goldsmiths' professorship in metallurgy be established, with a stipend of £1200 a year. The General Board recommends that a new faculty of geography and geology be instituted in the University. This faculty would include the Departments of Geology, Mineralogy and Petrology, Geography, Geodesy, and Geophysics.

At Emmanuel College, Prof. C. E. Tilley, professor of mineralogy and petrology, has been elected to a professorial fellowship.

V. V. Narlikar (Fitzwilliam House) has been elected to an Isaac Newton studentship, and H. R. Hulme (Gonville and Caius College) has been elected to an additional Isaac Newton studentship.

LONDON.—Dr. F. C. Benham, Sir Ernest Cassel lecturer in commerce at the London School of Economics, has been appointed University reader in commerce, and Mr. R. J. V. Pulvertaft, pathologist at St. Thomas's Hospital, has been appointed University reader in pathology (Westminster Hospital Medical School). The title of reader has been conferred on Dr. Nora Edkins, lecturer in physiology at Bedford College.

Applications are invited by the Royal Society for the Moseley research studentship, value £350, for the furtherance of experimental research in pathology, physics, and chemistry, and other branches of science, but not in pure mathematics or astronomy. Applications must be made by Dec. 15, upon a special form, to the Assistant Secretary, Royal Society, Burlington House, W.1.

At the recent general parliamentary election, besides those members for university constituencies who were returned unopposed, as announced in Nature for Oct. 24, p. 732, the following candidates have been elected: University of London, Sir Ernest Graham-Little; Combined English Universities, Miss E. Rathbone and Sir Reginald H. Craddock; University of Wales, Mr. Ernest Evans.

The award of the John Gray Jubilee Scholarship has just been made to Mr. G. Alan Thompson, a research student of the Gas Engineering Department of the University of Leeds. This scholarship was endowed by Mr. John Gray, a past-president of the Society of Chemical Industry, on the occasion of the celebration of the jubilee of the Society this year. It is tenable at such place of learning as the council or president may prescribe, and preference will be given to students who have already graduated in a university and are sons of members of the Society of ten years' standing.

Birthdays and Research Centres.

Nov. 10, 1861.—Dr. Robert T. A. Innes, Union Astronomer emeritus, Johannesburg.

At present I am working on the motion of the 12-year periodical comet 1927 *f*. I am also trying to find further grounds for the hypothesis that changes in the earth's climate are in the main due to impacts with the comæ of comets, and am examining and making further applications of Cowell's process to the motions of the major planets.

Nov. 12, 1863.—Prof. Alfred W. Porter, F.R.S., emeritus professor of physics in the University of London.

The work on which I have expended most effort during the last few years is divisible into several parts. (1) The calculation of surface tensions from experimental measurements on the ascent of liquids in tubes and by the bubble method. The part played by the angle of contact in the latter method is still a subject for discussion, though something has been done to clear the ground. For the tube method, I have given diagrams enabling the effect of the contact-angle to be allowed for (when it does not exceed 35°) with an accuracy surpassing that required in practice. (2) The interpretation of the Joule-Thomson effect, especially in regard to steam and to refrigerating materials. (3) The vapour pressures of binary and ternary mixtures. (4) The variation of the viscosity of colloids with shear. (5) The resolving power of optical instruments. Some work has been published on all these problems; further work is being more or less slowly elaborated, especially in regard to the Joule-Thomson effect.

Societies and Academies.

London.

Royal Society, Nov. 5.—Sir F. Gowland Hopkins and K. A. C. Elliott: The relation of glutathione to cell respiration with special reference to hepatic tissue. The relative capacity of various mammalian tissues to reduce the disulphide form of glutathione under anaerobic conditions has been determined. The course of the oxidation of the thiol group during the survival respiration of the hepatic tissue of various animals has been followed. That the concentration of certain metabolites in the liver is wholly, or in part, responsible for the maintenance and amount of reduction is shown by the effects of administering or withholding food. In general the initial marked delay in the disappearance of the $-SH$ group during aeration is observed only in the liver of well-fed animals; after relatively brief periods of fasting it is much lessened and may not be observed. If extra glutathione in the disulphide form be added to the freshly excised tissue before aeration, the existence of residual active hydrogen is revealed. In spite of vigorous aeration the concentration of $-SH$ then rises during the earlier periods of survival, though ultimately the whole is oxidised. The amount of this extra pressure-head of hydrogen consistently differs in the livers of different species. The origin of the active hydrogen which reduces the disulphide grouping is at present unknown. The transport of hydrogen to molecular oxygen by the path in question, though representing but a small part of the total respiration, may, therefore, prove to represent a specialised and significant aspect of tissue oxidations.—**Lord Rutherford and C. D. Ellis:** The origin of γ-rays. Calculations are made of the probability of escape of the α-particles from radium C' and of the average time of transition of the α-particle for different energies of the γ-ray. The strongest α-ray group, which corresponds to the emission of a β- or γ-ray of energy $1 \cdot 426 \times 10^6$ volts, represents an abnormal mode of transition compared with other groups. The time of transition is very long, and it may be, as suggested by R. H. Fowler, that the transition is radiationless, the surplus energy being directly transferred to one or more of the outer electrons of the atom. Many of the lines in the β-ray spectrum may be a result of similar radiationless transitions. In explanation of the complicated γ-ray spectrum of radium C' it is suggested that more than one α-particle in the nucleus may occupy the same energy level.—**A. V. Hill:** Myothermic experiments on the frog's gastrocnemius. An arrangement is described by which the 'initial' heat set free in the contraction of a frog's gastrocnemius can be measured in absolute units. A single fine thermocouple of constantan-iron is employed, the 'hot' junction lying inside the muscle. It may be applied to single twitches, to groups of twitches, or to tetani up to 25 seconds in duration. The mean value of Tl/H, the isometric heat coefficient in a twitch, is 13·4. This is twice the mean value found in sartorii. The difference is due to the fact that in gastrocnemii the fibres, or parallel fibre bundles, run, on the average, only half the length of the muscle. A modification is described of the method recently suggested by Bozler of 'calibrating' by condenser discharges. This is far simpler and more accurate than the old method employing an alternating current. The specific heats of muscle and blood have been determined. For a given water content they are the same. The density of a tissue depends upon the amount of solid it contains. This provides a simple and accurate method of measuring, without the labour of drying and weighing, the percentage of solid in a muscle.

Paris.

Academy of Sciences.—Sept. 28.—**Ernest Esclangon**: The observation of the eclipse of the moon of Sept. 26, 1931, made in Haute-Provence. The atmospheric conditions were exceptionally favourable. The most striking feature of the eclipse was the marked difference in the coloration and intensity of the earth's shadow, as a function of the distance from the centre of the shadow.—**E. Mathias** and **G. Grenet**: The electric field at the summit of the Puy de Dôme. A Benndorf recording electrometer has been set up in the dwelling-house, and the coefficient for converting these readings into those given at the summit (1440 metres) determined. A table showing the diurnal variation is given.—**Lucien Daniel**: The hybrids of the annual sunflower grafted on the Jerusalem artichoke. Grafting, in certain cases, is a factor capable of producing new variations.—**M. Ghermanesco**: The n-metaharmonic functions.—**Walter Saxer**: Families of meromorph functions of several variables.—**Henri Poncin**: The movement of a fluid round a cavitation.—**H. Mémery**: Some remarks on the duration of the solar period.—**L. Goldstein**: The intensity distribution in the continuous bands of the spectrum of hydrogen.—**W. Swietoslawski**: A new boiling-point method for studying ternary heteroazeotropes.—**E. Carrière** and **Janssens**: The determination of fluorine as calcium fluoride. Reply to a criticism of P. Maugnaud. Experiments on the magnitude of the possible error in the results caused by the co-precipitation of calcium carbonate with the calcium fluoride. It is shown that the error due to this cause is negligible.—**Georges Bohn** and **Mme. Anna Drzewina**: The influence of metallic silver on the calcification of the larvæ of the sea-urchin. If into water containing young sea-urchin gastrulæ a very thin sheet of silver is inserted for a time less than one minute, the pluteus has no skeleton and the calcification is prevented as long as the water remains unchanged. But if a trace of amino-acid is added along with the silver, the calcification proceeds normally.—**Paul Wintrebert**: The contractility of embryo cells, producing shape, a necessary factor in development, in amphibians.

Rome.

Royal National Academy of the Lincei, April 26.—**S. Pincherle**: A special linear operator.—**F. Conforto**: Mathematical formalism in a continuous functional space ruled by a linear element of the second species.—**R. Caccioppoli**: A method of summation in the calculation of infinite matrices.—**M. Villa**: The singularity of the Jacobian of $(r+1)$ hyper-surfaces of space of r dimensions.—**N. Cioranescu**: The summation of trigonometric series.—**P. Mentré**: The differential forms of a complex of straight lines.—**A. de Mira Fernandes**: Concurrent directions.—**Luca Teodoriu**: The zeros of the derivatives of a holomorph function.—**D. Bonvicini**: Certain fundamental theorems of electrodynamics and of the statics of elastic solids (2). Thermodynamical theorems corresponding with Castigliano's theorem, with Volterra's theorem of reciprocity, and with Colonnetti's second principle of reciprocity are enunciated.—**G. Valle**: Experimental investigations on the flash discharge. In experiments on the passage of electricity through rarefied gases, the course of the static characteristics in the various types of stationary régime of the flash discharge and the maximum value reached by the current intensity at the beginning of the discharge have been investigated.—**B. Rossi**: Absorption and diffusion of the penetrating corpuscular radiation in lead and iron. This radiation is diminished in intensity by 23·2 ± 1·6 per cent on passage through a screen of lead 9 cm. in thickness, and by 21·7 ± 1·6 per cent by a screen of iron 11 cm. thick, which contains an equal number of electrons per square centimetre. Diffusion is found to be of secondary importance and incapable of affecting appreciably the form of the absorption curve. Both the above values are distinctly lower than those obtained by Steinke (1930), the former being in good agreement with the value, 24·6 per cent, given by Bothe and Kolhorster (1929) for the absorption by a layer of gold 4·1 cm. thick.—**Algeri Marino**: Conditions of equilibrium in a Wheatstone bridge for measuring audio and radio frequency.—**L. Sanzo** and **F. Pirrone**: Irradiation of sea water by ultra-violet rays and its action on the velocity of alcoholic fermentation of glucose solutions. Further experiments show that the irradiated sea water activates alcoholic fermentation only if the period during which the water is exposed to the rays does not exceed a certain value, this being three hours under the conditions employed. The activity is due partly to the sea water considered as a solution of certain salts in certain proportions, and partly to an undetermined factor, which loses its effect if the sea water is either boiled for twenty minutes or evaporated to dryness and made up to the original volume with sterile distilled water.—**S. Sorrentino**: Mount La Queglia in Abruzzo. The geological formation of this mountain is described.—**V. Rivera**: Factors exciting increase of vegetal neoplasms by *B. tumefaciens*. In the experiments described, pelargoniums inoculated with the bacterium were completely encased in either hermetically sealed leaden sheaths or wooden sheaths lined with black paper. The plants enclosed in wood developed slight neoplastic formations at the zone of inoculation, whereas those in lead developed such formations to a greatly enhanced extent and formed also a number of aerial roots with positively geotropic development. The difference in behaviour in the two cases is ascribed mainly to the different humidity of the air. The phenomena are influenced also by the absence of light and by the ionisation of the air.—**R. Perotti**: Mycobacteriosis.—**C. Gaureschi**: The otocysts of urodele amphibia form a mosaic system (experimental demonstration).

Sydney.

Royal Society of New South Wales, Aug. 5.—**R. T. Baker**: On a fossil timber from the Sydney Harbour Colliery. The fossil was 20 ft. long and was taken from a depth of 2225 feet. The anatomical structure was very well preserved, which enabled it to be placed systematically as a conifer, resembling the genus *Callitris*. Its greatest affinity was with *Antarcticonyton Priestleyi*, Seward, found by the second Scott expedition, and so was named *A. Raei*. Calcium carbonate was thickly deposited on the cold-weather side of the tree, and also in numerous channels throughout the wood structure.—**W. R. Browne**: Notes on bathyliths and some of their implications. The division into synchronous and subsequent bathyliths is emphasised, the main contrasting characters of the two types are enumerated, and examples from Australia are described. The underground extensions and the probable shapes of bathyliths are discussed, and explanations are suggested for the association of synchronous bathyliths with strongly-folded and with subsequent moderately folded strata. Some stratigraphical and palæogeographical implications of bathyliths are pointed out. Since it was injected in connexion with the collapse of a geosyncline, the existence of an outcropping bathylith of determinable geological age implies the former existence, above and around it, of sediments belonging to a certain geological period. The use of this principle is exemplified in its application to a few Australian palæogeographical problems.

Official Publications Received.

BRITISH.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1355 (Ae 486—T. 2606, T. 3011): Experiments on Models of a Compressed Air Wind Tunnel. Compiled by Dr. R. Jones and A. H. Bell. Pp. 22+14 plates. 1s. 3*d*. net. No. 1372 (Ae. 499—T. 3096): Ventilation of 24 ft. Wind Tunnel. By B. Lockspeiser. Pp. 10+4 plates. 9*d*. net. No. 1394 (Ae. 515—T. 3078): A Study of Slots, Rings and Jet Control of the Boundary Layer. By H. C. H. Townend. Pp. 31+16 plates. 1s. 9*d*. net. No. 1395 (Ae. 516—T. 3038 and 'a'): Interference of a Streamline Nacelle on a Monoplane Wing. By E. Ower and C. T. Hutton. Pp. 17+7 plates. 1*s*. net. (London: H.M. Stationery Office.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 47: Radio Research Board, Report No. 1. 1: Corrections to Field Strength Measurements with Loop Antennae, by W. G. Baker and O. O Pulley; 2: A Radio Field Strength Survey within 100 Miles of Sydney, by W. G. Baker and O. O. Pulley. Pp. 32. Bulletin No. 48: The Experimental Error of the Yield from Small Plots of 'Natural' Pasture. By Dr. J. Griffiths Davies. Pp. 22. Bulletin No. 49: Factors affecting the Mineral Content of Pastures, with Particular Reference to the Environmental Conditions incidental to Southern Australia. By Dr. A. E. V. Richardson, H. C. Trumble and R. E. Shapter. Pp. 47. Pamphlet No. 19: Black Disease; a Short Description of its Nature and Means of Prevention. By A. W. Turner. Pp. 12. (Melbourne: H. J. Green.)

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 2: Studies on the Inheritance of Corolla Colour and Petal Size in Asiatic Cottons. By J. B. Hutchinson. Pp. 29+1 plate. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*.

The Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), No. 10: Report of the Irish Radium Committee for the Year 1930; including Reports by Oliver Chance, Andrew Charles, John A. Gerachty, P. MacCarvill, Oswald J. Murphy, C. Conor O'Malley. Pp. 99-117. 1*s*. Vol. 20 (N.S.), No. 11: On a Method of Distinguishing the Seedlings of Swedish Turnip (*Brassica napus* L. var. *Napobrassica* (L.) Reichb.) from those of Rape (*Brassica napus* L. var. *Biennis* (Schubl. et Mart.) Reichb.). By M. J. Gorman and H. A. Lafferty. Pp. 119-124+1 plate. 1*s*. Vol. 20 (N.S.), No 12: The Influence of the Work of Sir William Rowan Hamilton on Modern Mathematical Thought. By Prof. A. W. Conway. Pp. 125-128. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

The Changing World: a Broadcast Symposium. 1: Industry and Trade. By Prof. Henry Clay. Pp. 48. 4*d*. 2: The New Spirit in Literature. By Harold Nicolson. Pp. 40. 4*d*. 3: Science in Perspective. By Prof H. Levy. Pp. 48. 4*d*. 4: The Modern State By John A. Hobson. Pp 44. 4*d* 5: Learning to Live. By John Macmurray. Pp 48. 4*d*. (London: British Broadcasting Corporation.)

FOREIGN.

Journal of the Federated Malay States Museums. Vol. 15, Part 2, August. Pp. 43-78+plates 9-21. (Kuala Lumpur.)

Federated Malay States. Annual Report of the Department of Agriculture, S S. and F.M.S., for the Year 1930. By Dr. H. A. Tempany. Pp. ii+31. (Kuala Lumpur.)

Japanese Journal of Botany. Transactions and Abstracts, Vol. 5, No. 4. Pp v+371-456+89-119. (Tokyo: National Research Council of Japan)

Journal of the Faculty of Science, Hokkaido Imperial University. Series 1: Mathematics. Vol. 1, No. 2, August. Pp. 47-155+267-273. (Sapporo.)

U S. Department of Agriculture. Technical Bulletin No. 255: Life History of the Codling Moth in the Rogue River Valley of Oregon. By M. A. Yothers and E R Van Leeuwen. Pp. 35. (Washington, D.C.: Government Printing Office.) 10 cents.

Det Kgl. Danske Videnskabernes Selskab: Mathematisk-fysiske Meddelelser. Bind 11, Nr. 2: Manomètre à contact optique et son emploi pour la détermination du triple point de l'eau. Par K. Prytz. Pp. 46. (København: Andr. Fred. Høst et fils.) 2.00 kr.

Svenska Hydrografisk-Biologiska Kommissionens Skrifter. Ny serie, Hydrografi 10: Svenska Strommatningar i Kattegatt 1930. Av T. Gustafson och B. Otterstedt. Pp. 43. (Goteborg: Wald. Zachrissons Boktryckeri A.-B.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 32, Part 1: Studies on the Japanese Saprolegniaceae. By Masaji Nagai. Pp. 43+7 plates. (Tokyo: Maruzen Co., Ltd.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 316-324. Über die Polymerisierung der Methylester hoherer ungesättigter Fettsauren, 8: Polymerisation der Methylester der Linolen- und Linolsaure, von Kichiro Kino, Über die Polymerisierung der Methylester hoherer ungesattigter Fettsauren, 9: Hydrierung der angenommenen intrapolymerisierten Methylester, von Kichiro Kino; Zur Kenntnis der Ligninbildung ion Pflanzenkorper bei der Verholzung, von Keiti Sisido; On the Stress Distribution of an Angle Plate, by Zirô Tuzi; On the Prevention of Explosion Danger in Oil Tanker—Optical Analysis of very weak Mixture of Petroleum Vapour, by Zirô Tuzi and Oosi Kadita; On Cracks and Fissures, their Physical Natures and Significance, by Torahiko Terada; Experimental Studies on Form and Growth of Cracks in Glass Plate, by Morisô Hirata, On the Micro Method for Determination of Nitro Groups in Aromatic Compounds (Abridgment), by Suttekiti Maruyama; On the Mechanism of Mutarotation of *d*-Methylen-Camphor of the Primary Amine (Abridgment), by Taro Hayashi. Pp. 127-203. (Tōkyō: Iwanami Shoten.) 1.00 yen.

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1930. By William Henry Fox. Pp. 78+5 plates. (Brooklyn, N.Y.)

The Rockefeller Institute for Medical Research. History, Organization, Present Scope of the Scientific Work, Buildings and Equipment, Publications. Pp. 36+2 plates. (New York City.)

CATALOGUES.

The Best Books on Nature Study. (Foyle's Guides to Literature) Pp. 40. (London: W. and G. Foyle, Ltd.)

Botany, Gardening, Herbals, etc. (No. 191.) Pp 44. Conchology, Entomology, Geology, Ornithology, Zoology (Vertebrate and Invertebrate). (No. 192.) Pp. 12. (London. Dulau and Co., Ltd.)

W. Junk. 1: Verlag, Publications, Livres de fonds, 2: Antiquariat, Second-hand Books, Livres d'occasion. Pp. ii+142+vi+143-296+8 Tafeln. Berlin: W. Junk.)

Diary of Societies.

FRIDAY, NOVEMBER 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—N. Patterson: The Training of an Oto-laryngologist (Presidential Address).—E. W. Williams: Treatment of Suppurative Meningitis.—Dr. D. McKenzie: Some Graphs Illustrating Otosclerosis.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Sir Arthur Eddington: The Expanding Universe (Presidential Address).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Pathology of Hydrocephaly.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Ll. B. Atkinson: The Mechanical Aspects of Electricity (Thomas Hawksley Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Manchester Sections of Society of Dyers and Colourists, Institute of Chemistry, and Chemical Section of Manchester Literary and Philosophical Society) (at College of Technology, Manchester), at 7.—Prof. H. Mark: The Significance of the New Cellulose Models (Molecular Structure) for the Technical and Dyeing Properties of the Fibre.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—F. C. Knowles: Inaugural Address.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle-upon-Tyne Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Prof. G. T. Morgan: Chemistry of Low-Temperature Tars (Jubilee Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with South Wales Institute of Chemistry) (at Thomas' Cafe, Swansea), at 7.30.—Dr. Sladden: Chemistry in the Service of the Doctor.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. P. Quarrell: The Cooling of the Crude Oil Engine.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Royal Institution, Liverpool), at 7.30.—N. Heaton: Modern Developments of Inorganic Pigments.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. H. W. Featherstone, J. D. Morgan, and others: Discussion on Anæsthesia for Diathermy and Endoscopy.

SATURDAY, NOVEMBER 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. E. Yerbury: Present-Day Architecture on the Continent (1): Modern Buildings in Holland.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square. W.C.1), at 3.—W. B. Gourlay: Plant and Animal Collecting in Chili (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section—London) (Informal Meeting), at 6.45.—Debate on: That a College Education is Desirable in the Training of a Mechanical Engineer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Tees-Side Branch—Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—J. Lang: Chairman's Address.

MONDAY, NOVEMBER 9.

ROYAL GEOGRAPHICAL SOCIETY, at 5—Brig. H. L. L. Winterbotham: The Small-scale Maps of the Ordnance Survey.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—R. Davies-Colley: Demonstration on The Border-line Tumours of Bone.

INSTITUTE OF TRANSPORT (Annual General Meeting) (at Institution of Electrical Engineers), at 5.30.—J. Paterson: The Influence of Transport on Regional Planning.

ROYAL AERONAUTICAL SOCIETY (at Film House, Wardour Street, W.1), at 6.30—Capt. W. J. McDonough: Aeroplanes as an Aid to Mineral Exploration and the Operation of Aircraft in Sub-zero Temperatures.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. F. Shipley and others: Discussion on Lightning Protection, especially in Tropical Countries.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. Grierson: The Electrical Heating of Buildings.

CERAMIC SOCIETY (Pottery Section) (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—T. Sheppard: Roman Pottery Kilns at Throlum.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7 30—W. L. Govier: Experiences with Some Electric Furnaces for Melting Copper and Copper Alloys.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 8.45.—J. Gray: Animal Movements (Illustrated by Cinematograph Films).

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Technical College, Gloucester).—E. W. Dickinson and H. W. Grimmitt The Design of a Distribution System in a Rural Area.

TUESDAY, NOVEMBER 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. G. I. Finch: The Combustion of Gases in Electric Discharges (2).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—I. A. J. Duff: The Dilution Theory of Detonation.

Institute of Marine Engineers, at 6.—J. L. Adam: Effects of Propelling Machinery on Hull Structures.

Institute of Metals (Swansea Local Section) (at Y.M.C.A., Swansea), at 6 15.—Prof. D. Hanson: Some Causes of Unsoundness in Non-Ferrous Alloys.

Textile Institute (London Section) (at Clothworkers' Hall), at 6 30.—Dr. J. B. Speakman: Recent Developments in the Study of Wool Finishing Processes.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—R. Grierson: The Electrical Heating of Buildings.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—R. M. Charley: Recent Progress in Large Transformers.—W. E. M. Ayres: The Application of the Induction Voltage Regulator.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—Dr. A. F. Burstall: Electric Welding.

Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Section—London and District Branch) (at Borough Polytechnic), at 7.—T. G. Noble: Notes on Ventilation.

Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Section—Manchester and District Branch) (at Engineers' Club, Manchester), at 7.—W. P. Ollett: A Summary of Modern Heating Systems.

Institution of Electrical Engineers (Scottish Centre) (at 39 Elmbank Crescent, Glasgow), at 7.30.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

Institution of Automobile Engineers (Coventry Centre) (at King's Head Hotel, Coventry), at 7.30.—B. G. Robbins: The Training of Young Automobile Engineers.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—A. H. Mundey: Die-Casting.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.30.—Dr. Isabella Gordon. Reversal of Sex in Crustacea.

Institution of Welding Engineers (North-Western Branch) (at College of Technology, Manchester), at 7.30.—A. Y. Stirrat: Carbon Arc Welding.

Royal Society of Medicine (Psychiatry Section), at 8 30.—Dr. Bernard Hart: Psychology and Psychiatry (Presidential Address).

Pharmaceutical Society of Great Britain, at 8.30.—Sir William Willcox: The Practical Relationship of Bacteriology to Pharmacy and its Influence on the Curriculum.

Royal Anthropological Institute, at 8.30.—C. W. M. Hart: Grave Posts of Melville Island.

Royal Photographic Society.—Dr. D. A. Spencer: Modern Developments in Colour Photography.

WEDNESDAY, November 11.

Royal Society of Medicine (Surgery: Sub-Section of Proctology), at 5.—W. S. Perrin: Some Landmarks in the History of Rectal Surgery (Presidential Address).

Institution of Engineering Inspection (at Royal Society of Arts), at 5.30.—Dr. G. H. Gulliver: Mechanical Testing of Materials.

Institution of Electrical Engineers (Hampshire Sub-Centre) (at University College, Southampton), at 7.30.—R. M. Charley: Recent Progress in Large Transformers.

THURSDAY, November 12.

Royal Society, at 4.30.—*Papers to be probably read*:—Prof. A. Fowler and Dr. J. S. Badami: Spectrum of the Hydrogen–Nitrous Oxide Flame.—S. H. Bastow and F. P. Bowden: On the Contact of Smooth Surfaces.—W. B. Mann and B. G. Dickins: The Thermal Conductivities of Saturated Hydrocarbons in the Gaseous State.—*Papers to be read in title only*:—L. C. Bailey: The Thermal Conductivities of Certain Approximately Pure Metals and Alloys at High Temperatures.—W. A. Macky: Some Investigations on the Deformation and Breaking of Water Drops in Strong Electric Fields.—M. L. Smith and B. Topley: The Experimental Study of the Rate of Dissociation of Salt Hydrates.

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. S. Chapman: Tides in the Atmosphere (Presidential Address).

Child-Study Society (at Royal Sanitary Institute), at 6.—Miss Thyra Smith: The Psychology of the Junior School Child.

Institute of Metals (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.—W. A. Benton and others: Discussion on Mechanical Testing.

Society of Chemical Industry (Nottingham Section) (at University College, Nottingham), at 7.30.—Lord Trent: Chairman's Address

Institution of Electrical Engineers (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—J. E. Luckhurst: The Receiving Station at Cupar for Transatlantic Telephony.

North-East Coast Institution of Engineers and Shipbuilders (Tees-Side Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—S. Burns: Electric Grid Change-over.

Oil and Colour Chemists' Association (London Section) (at 30 Russell Square, W.C.1), at 7.30.—R. G. Daniels: Paint Industry in the Future.

Optical Society (at Imperial College of Science and Technology), at 7.30.

Institute of Metals (London Local Section) (at Royal School of Mines), at 8.—Dr. W. J. P. Rohn: Some Recent Advances in Rolling Plant.

FRIDAY, November 13.

Biochemical Society (at Imperial College of Science and Technology), at 3.—T. Moore: High Potency Vitamin A Concentrates.—S. H. Piper: X-Ray Analysis of Certain Long Chain Paraffins, Ketones, and Alcohols.—A. C. Chibnall: The Metabolism of Plant Waxes.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.—J. A. B. Smith: The Glyceride Fatty Acids of Certain Forage Grasses.—C. R. Harington and S. S. Randall: Synthesis and Properties of *i*-*β*-Hydroxyglutamic Acid.—W. L. Davies: The Inactivation of Lipase in Dairy Products by Traces of Heavy Metal Salts.—J. Pryde and R. T. Williams: The Structure of Borneol Glucuronic Acid Synthesised *in vivo*.—T. S. G. Jones and E. T. Waters: A Note on the Sugar of the Nucleic Acid of *Bacillus Tuberculosis*.—H. J. Phelps: The Influence of Hydrogen-ion Concentration on the Response of Tissues to Histamine.—P. V. McKie: The Nitrogen Metabolism of the Lupin Seedling.—A. C. Chibnall and R. G. Westall: The Estimation of Glutamine in the Presence of Asparagine.—J. M. Gulland and W. H. Newton: Observations on the Purification of the Oxytocic Principle of the Posterior Lobe of the Pituitary Gland.—*Demonstrations*:—S. H. Piper and A. C. Chibnall: Apparatus for Distillation in High Vacuo of Substances with a High Melting Point.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.

Royal Society of Arts (Indian Meeting), at 4.30.—Lt.-Col. M. L. Ferrar: The New Penal System in the Andamans.

Malacological Society of London (at Linnean Society), at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.—J. W. Hobson: The Care and Maintenance of the Industrial Steam Locomotive.

Institution of Electrical Engineers (London Students' Section), at 6.15.—W. A. Bishop: Short Wave Transmission.

Institution of Welding Engineers (at Chamber of Commerce, Birmingham), at 7.—E. W. Thompson and A. Jeavons: Some Details of the Progress reached in Forge and other Welding in Boiler Works Practice.

Junior Institution of Engineers, at 7.30.—Annual General Meeting.

Institute of Metals (Sheffield Local Section) (at University, Sheffield), at 7.30.—E. A. Smith: Engineering Silver Solders

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—D. McDonald: Platinum.

SATURDAY, November 14.

Royal Institution of Great Britain, at 3.—F. E. Yerbury: Present-Day Architecture on the Continent: Modern Buildings in Scandinavia.

PUBLIC LECTURES.

SATURDAY, November 7.

Mathematical Association (London Branch) (at Bedford College for Women), at 3.—A. W. Siddons: The First Two Years of Geometry in a Secondary or Preparatory School.

Horniman Museum (Forest Hill), at 3.30.—D. Martin Roberts: London in the Age of Dr. Johnson.

TUESDAY, November 10.

University College Hospital Medical School, at 5.15.—Dr. Harriette Chick: Vitamins and Disease. (Succeeding Lecture on Nov. 17.)

WEDNESDAY, November 11.

Royal Institute of Public Health, at 4.—Prof. Winifred Cullis: The Health of the Woman Citizen.

THURSDAY, November 12.

Science Museum, South Kensington (in connexion with Exhibition of Modern Glasses), at 4.45.—R. F. Taylor: Sheet and Plate Glass.

FRIDAY, November 13.

King's College, London, at 5.30.—J. Benda: L'exploitation de la Science par la Littérature au 19e Siècle.

Bedson Club (at Armstrong College, Newcastle-upon-Tyne), at 6.30.—Prof. J. Read: Some Researches on Essential Oils.

Chadwick Trust Lecture (at Gateshead).—Sir Robert Philip: The Outlook on Tuberculosis—Now and Then

SATURDAY, November 14.

Horniman Museum (Forest Hill), at 3.30.—M. A. Phillips: Nature at Home.

DISCUSSION.

Thursday, November 12.

Faraday Society (at Chemical Society), at 8.—Discussion on the following papers by Dr. E. W. J. Mardles:—

- (*a*) The Oxidation in Air of (*a*) Carbon Disulphide, and (*b*) Carbon Monoxide.
- (*b*) The Oxidation of (*a*) Hydrogen, (*b*) Methane, and (*c*) Coal Gas in Air.
- (*c*) Comparative Study of the Vapour Phase Oxidation in Air of (*a*) Ethane and Ethylene, (*b*) Pentanes and Amylenes, (*c*) Ethyl Alcohol and Amyl Alcohol, (*d*) Acetaldehyde and Valeraldehyde.
- (*d*) The Oxidation of Fuel Vapours in Air: Experiments with (*a*) Aromatic Hydrocarbons, (*b*) Cyclohexane, and (*c*) Cyclohexene.
- (*e*) The Oxidation of Acetylene in Air.

CONGRESS.

November 7 to 11.

Allgemeine Mitgliederversammlung der Aeroarctic (at Berlin).

Saturday, Nov. 7.—Prof. Weickmann: Die Wetterlage vor und während der Forschungsfahrt des "Graf Zeppelin" und ihr Einfluss auf den Kurs der Expedition.

Prof R. Samoilowitsch: Die geographischen Beobachtungsergebnisse.

Dr. Ljungdahl: Die erdmagnetische Ausrustung und die Beobachtungsergebnisse.

Lt. Comdr. Smith u. Dr. Kohl-Larsen: Über die Eisbeobachtungen.

Prof. Moltschanoff und Prof. Weickmann: Die aerologischen Instrumente und Beobachtungsergebnisse.

Sunday, Nov. 8.—Prof. v. Gruber und Dr. Aschenbrenner: Über die photogrammetrische Ausrustung, die Arbeits- und die Auswertungsmethoden des auf der Expedition gewonnenen photogrammetischen Beobachtungsmaterials.

NATURE

SATURDAY, NOVEMBER 14, 1931.

CONTENTS.

PAGE
National Needs. By H. E. A. 809
A Doctrine of University Functions. By T. P. N. . 811
Laboratory Technique in Physical Chemistry. By J. R. P. 814
Physiological Perception of Position 815
Short Reviews 815
The Jungfraujoch Scientific Station 817
Faraday as a Botanist. By Dr. R. W. Butcher . 820
News and Views 821
Letters to the Editor:
  Viscosity of Liquids.—Prof. E. N. da C. Andrade 835
  Anomalous Variation of the Electrical Conductivity of Quartz with Temperature at the Transformation Point.—Prof. H. Saegusa and S. Shimizu 835
  Control of Prickly-Pear by the Cochineal Insect.—T. V. Ramakrishna Ayyar 837
  Control of Humidity of Air Currents.—Dr. P. A. Buxton; Dr. W. H. J. Vernon and L. Whitby . 837
  Short Wave Reception and Ultra-Radiation.—Dr. W. M. H. Schulze 837
  Rhythmic Breaking of Ship-waves.—Prof. Kerr Grant 838
  Constitution of the White Dwarf Stars.—Seitarô Suzuki 838
  Dehydration of Salts.—Dr. Maurice Copisarow . 838
Research Items 839
Astronomical Topics 841
Recent Excavations at Vinča 842
Chemistry of the Vitamins 842
Phosphorescence of the Sea 843
Acoustical Problems of Broadcasting Studios . . 844
University and Educational Intelligence . . . 844
Societies and Academies 845
Official Publications Received 847
Diary of Societies 847
SUPPLEMENT.
  Beyond the Milky Way. By Sir James Jeans, F.R.S. 825

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National Needs.

> "*The great trouble is that the civilisation of to-day is still of a very low degree. We talk big and think small. Only a few of us even know how to read . . . we need a long initiation in almost any subject before our reading about it is likely to be of any value.*"—ELLWOOD HENDRICK: "Percolator Papers".

THE present sore trouble of the world, which has long been surely coming upon us owing to the inconsidered action of all nations, will not be without its compensations, if we be led to probe into the causes and to reorganise our operations upon considered lines.

The call is upon us all to turn our attention to affairs of State. Scientific workers especially have to recognise that they have been selfish in their too exclusive devotion to experimental study and the immediate development of their discoveries; that they have soared entirely above the heads of the community and in no way prepared the masses to understand the profound changes brought about in our life by the scientific forces at work in industry. Brains and brawn were never so far apart as now. Although this is the case, it was never so clear that a wise socialism is foreshadowed as the only possible way of avoiding the downfall of our civilisation. In some way or other, the nations must come to work together. Competitive industry, as we have known it in the past, is ceasing to be possible: it pays no one and is but a disguised civil war. Mechanisation is bringing about its own defeat: the cost of displacing human labour is becoming prohibitive. Man is ever there; capital will not long be, at present rates of taxation: we shall soon be forced to return to *manu*factures.

The chief duty before us clearly is—to make all men work: a machine which is idle has no right to be. Nature herself ever works and necessarily dies if she cannot. Man alone of her works is ceasing to be natural and fast becoming a mere parasite.

The country is now in the hands of a Government elected upon a National ticket; the popular expectation is, that it will be Rational and rise superior to party. There is, however, an ominous preponderance of men of rigid outlook bearing political labels; few are known to profess a belief in government by scientific methods. Probably the Prime Minister alone can attach any real meaning to the term 'scientific'. He was long an attendant at Royal Institution lectures and grew up in a scientific atmosphere. Very remarkable, at the recent Faraday celebration in Queen's Hall, was the entirely sympathetic way in which he entered into the spirit of the occasion, outshining all other speakers in clearness of perception of the service rendered to the world by Faraday, especially the moral value of the example set by this great experimentalist. His father-in-law, we know, was the most sympathetic of Faraday's biographers. Probably Sir John Simon comes next to Mr. MacDonald. He at least has breadth of outlook and a severely logical mind.

It is much to be feared that the men who have taken upon themselves to govern us cannot possibly fathom the depth of present-day world activities: the overwhelming complexity of the issues; the subtle problems they present; the hopeless difficulty of meeting the naturally selfish dictates of human nature. Earl Grey being all but out of action, there is no prophet in the field of politics. We need a Disraeli, a man of imagination, able to grasp our modern problems and be a constructive leader. If the recent election have shown one thing more than another, it is that the country is prepared to follow a clear lead. In this particular, Mr. MacDonald and his small band of devoted followers have set a noble example.

Nothing could be more definitely painted upon the wall than the failure of our public schools to train the ruling classes in any proper way. The 'science' introduced into them has been to no purpose—no effective teaching has been given in the logic of method. Consequently, the calculated practice of scientific argument—the habit of sound scientific thought—plays no part in our affairs; it has no considered place in our Civil Service. This is one of the matters of urgency, calling for fullest consideration, at the present moment. Unless and until our universities and schools are brought into harmony with the times, no real progress can well be made. Oxford most needs reformation: the present neglect of a broad culture by the University is a national danger. As to the schools, it should be deemed a criminal act to bring up a boy or girl upon literary study alone, without training in the judicial method.

Our schools still teach little more than the worship of words and those largely words of the past. The men in charge of them, with few exceptions, have no feeling for the wide issues of practice and scientific leadership. We are a strange people: intensely practical in our general outlook, we place ourselves in the hands of those who cannot possibly become masters of the intricate situation which confronts us. Teachers as a class in no way grasp the responsibilities of their position, let alone the dangers of the times. They are too much of one school and, with rare exceptions, of an unadventurous type. Complaint of the inflexible nature of the material they produce is rampant everywhere.

Lafcadio Hearn, writing from Japan, in August 1893, in an outspoken letter to Ellwood Hendrick, after remarking how terribly tragic modern life is becoming, directs attention to its hopeless contradictions. These, he says,

> "can only be recognised and reconciled through a profound knowledge of social conditions, not in the abstract only but in the most complex operations. This is the theoretical recognition. The practical recognition requires special hereditary gifts—intuitions—instincts—powers. Mere education in business alone won't do. That only makes servants. Masters must be natural masters of men. Life is an intellectual battle but not a battle to be fought out by mere chess-combinations. It is also a battle of characters. . . . I do not see much likelihood of moral development . . . morals have been at a standstill since the beginning of history: we have made no apparent progress in that. Then comes the question, Are we not developing immorally?"

There can be little doubt as to the answer. The Hollywood atmosphere in which the masses now live—the scorching, motor habit, developed as a mere means of escaping from the boredom of mental vacuity—the condition of the Press, which for the most part has no soul beyond sexuality and sport: all these things are proof sufficient that there is no real intellectual progress to be recorded. The masses have learnt to read—but "the hungry sheep look up and are not fed". The body scientific—those who hold the keys of knowledge—makes no calculated effort to provide them with food. The literary class, as a body, has no message; brought up upon words alone, with myopic uncultivated vision, it can only use words to describe the obvious.

Not so long ago, starting from Huxley and Herbert Spencer, a body of men representative of natural science, in its various branches, made a determined effort to galvanise the schools into practical scientific activity and make education an introduction to life: the attempt has been a failure. Scarce any of the band remain. Modern scientific workers—the professional researchers—no longer take interest in such matters. Occasionally someone kicks: Prof. Irvine Masson is the latest example. The bookmen hold the field: what public conscience there may be is stilled by free education and scholarship grants. We have little right to complain of politicians, so long as we make no effort to train them to their office by bringing about the revolution which every thinking man knows to be long overdue in our school system.

Meanwhile the industrial shoe pinches terribly. There isn't enough leather to make it a comfortable fit. We are so pampered into the belief that we can live on industrialism, that no real thought is given to the problem as a whole. The fetish of what is supposed to be cheapness is worshipped without any consideration of its consequences. No sense of the meaning and value of agriculture has been bred into the community.

The mathematicians can discuss the Unseen Universe with great popular effect. Yet they make no attempt to stem the ignorance of the money-changers or help them to devise a rational system of banking which will enable us to do without the gold we cannot have, wherewith to back the counters issued as money—so that commerce may be controlled and its operations made facile, not the sport of speculators. The multitude obviously does not understand the meaning of the term *standard*: the professed economists have not the wide equipment that is needed for their task.

Men now need to be so trained that they learn to work together—without losing their souls. No trade to-day is free; some combine is at work which prevents each one from being fair. So long ago as 1894, Hearn could write to Hendrick prophetically:

> "The tyranny of the future must be that of Organization: the monopoly, the trust, the combination, the associated company . . . much more powerful than the robber-baron . . . these are infinitely less human—having no souls."

Hearn spoke as an artist, of course. Still, his plaint is justified in a tyranny such as is being exercised over milk production, by the great combines now coming into action as universal purveyors. Water has long since passed into public control: milk someday perhaps will be seen to be of even greater consequence and cared for properly.

We have no food sense worth calling a sense: biology to this end is not taught in the schools; women decline to cook and are deluding themselves into a belief in canned foods. Our ignorance of all essential things is monstrous. Scared by a few bacteria, we systematically spoil our milk. We are even threatened with synthetic food. Machinery, using the sunshine of past ages, is to put the nose of our present sun out of joint and make the farmer a back number. Our only salvation is the natural horse sense that is in us. Meanwhile, proof is being quietly accumulated that if we but choose to cultivate our land with considered care and knowledge, we can make not two but many blades of grass to grow where one is now starved—and largely feed ourselves, with food of a quality unprocurable from elsewhere. These are the things to be considered in framing our national, rational policy. Fair trade in food should be the first demand satisfied, however tentatively we may proceed. To this end, we need to develop a great scientific organisation. The farmer's chief protection should be—our determination to help ourselves!

In future, the scientific worker, to be worthy of the name, must justify himself through social service in the first instance. Our situation is so grave that he must be militant without delay and in every quarter. H. E. A.

A Doctrine of University Functions.

Universities: American, English, German. By Abraham Flexner. Pp. ix+381. (New York, London and Toronto: Oxford University Press, 1930.) 16*s*. net.

THIS volume is an expansion of three lectures, given at Oxford in 1928, which excited a considerable amount of journalistic comment by reason of the author's severe animadversions upon the University of London. Apart from sensational attractions of that kind, any study of the functions and organisations of universities written by so well-informed and acute an inquirer as Dr. Flexner is bound to be worth careful attention; and a dispassionate reader of the present book must admit that it is a weighty and timely work, in which the author has set down, with the utmost directness and clarity, criticisms and positive views that demand the anxious consideration of all who are concerned with university policy.

In the courageous performance of his task, Dr. Flexner has felt obliged to dwell long and to fall heavily upon the errors and follies of certain universities. No one could accuse him here of patriotic partiality; for if he has chastised the University of London with whips, he has chastised some of the greatest of American universities with scorpions. Indeed, the reviewer felt that it was indecent for him, a foreigner, to be present at the merciless castigation of these famous institutions; and, in his embarrassment, turned over quickly the more deeply ensanguined leaves. Doubtless it is salutary for an institution to have its sins shown up without fear or favour, but in doing the thing so thoroughly Dr. Flexner has incurred certain risks. Human nature being what it is, there is the possibility that the institutions which might have profited most from his admonitions will harden their hearts against him and seek to defend their ways; it is also possible that the great achievements of the universities which fall most under the author's scourge may be forgotten, notwithstanding his generous praise; and above all, there is the danger that the reader's attention may be distracted from the main purpose of the book—which is to develop a positive doctrine of university functions and to use criticism of activities which the author regards as misguided simply to throw into clear relief those which he deems to constitute the proper work of a modern university.

Dr. Flexner's idea of a university (he borrows the phrase, of course, from Cardinal Newman) is expounded in the first chapter. Universities, being highly representative organs of national consciousness, must differ, sometimes in important features, in different countries; but in the ideal university "we should see to it that in appropriate ways scholars and scientists would be conscious of four major concerns: the conservation of knowledge and ideas; the interpretation of knowledge and ideas; the search for truth; the training of students who will practise and 'carry on'" (p. 6). Here, in brief, is the theory which, expanded in an illuminating manner in subsequent pages and from time to time throughout the book, is the basis of his criticism of what is, and of his hopes with regard to what may be. In the author's view—constantly reiterated—universities should resolutely concentrate upon the 'concerns' he has laid down for them, leaving other educational functions, however important they may be, to be carried out elsewhere.

This does not mean that universities are to be cloistered institutions, remote from the world and its practical problems. On the contrary, a main charge in Dr. Flexner's indictment of existing universities is that they fail to recognise fully their obligation to give intellectual guidance to the community; that they suffer too wide a 'social lag' to exist between their interests and activities and the urgent problems of the day; and that they confine their study of those problems within far too narrow a field. His point is that while a university should care greatly about the important problems that arise in the practice of any of the major professions, such as engineering, medicine, or teaching, or in the practice of government, or in the sphere of economic relations, its attitude towards them must be strictly theoretical: that is, it must seek to solve the problems but has no concern with exploiting the solutions. Having solved one problem, the university research worker must pass on to another, leaving developments and practical applications to those concerned with them.

One can scarcely fail to recognise the nobility of Dr. Flexner's concept of universities as places where thought and disinterested inquiry are pursued upon the highest levels, and where the best minds of each generation are trained for intellectual achievement. It is perhaps realised most closely at the moment in the Hebrew University of Jerusalem, an institution finely directed and inspired, and as yet uncorrupted by age or prosperity. Among the universities which Dr. Flexner reviews, none rises so near to his ideal as this shining example; but Oxford and Cambridge and the German universities come nearest. It is a relief to an Englishman's fears to find our ancient universities placed so high, and it is also interesting in view of the serious discrepancy between their practices and the author's canons of university behaviour.

Judged by those canons, Oxford and Cambridge give far too much attention to what is in effect secondary education, and have been misled (Jowett's work at Balliol is the capital instance) by the notion that training for service is a proper function of a university. Nevertheless, there is in them something, a little difficult to explain, which makes them great institutions of learning. They have their honours schools, and they permit—though it can scarcely be said that they help—men of outstanding force to become centres of really advanced work and thought. Above all, their traditions make it impossible for them to degrade their dignity and to waste their spiritual resources by pandering to the demands which have drawn American universities so far from the true path. There remains, however, very much to be done if they are to play the part that modern universities should play in the affairs of a great nation and in the interests of civilisation as a whole; and many pages are given by Dr. Flexner to the detailed exposition of his ideas as to the directions which the required developments should take.

Dr. Flexner cannot understand in what sense the University of London is a university at all. The institutions which it comprises are too heterogeneous in quality and purpose, and the control exercised by the central machinery over policies is too limited and indirect to secure the unity essential to a real university. Moreover, he finds much to criticise in the constitutions and powers of the two highest organs, the Court and the Senate. Incidentally, in stating (p. 237) that the Court "contains no professors", the author makes an error which could so easily have been avoided that one is led to wonder whether his statements of fact elsewhere may not be vitiated by mistakes which tend, as in this instance, to give improper support to important inferences. It may be further noted, in this connexion, that Dr. Flexner does not mention that the statutes ensure in the Court a clear majority of persons who are also members of the Senate—a provision which makes very remote some of the evil possibilities he foresees.

The greatest weaknesses of the University of London as Dr. Flexner sees it are, first, that, regarded as the body governing its constituent institutions, it is almost entirely external to them all, and next, that some of the constituent institutions and much of the work done in most of them have no proper place in a university. To some extent the provincial universities fail in the same way; but their unity saves them, and, on the whole, they represent—as do the American State universities—" an amazing achievement within a brief period ".

It is not possible to summarise here Dr. Flexner's interesting and sympathetic account of the German universities. It is well known that there are several respects in which their position and methods contrast almost violently with those of the English universities. Most conspicuous is their dependence upon the State and the way in which, notwithstanding that dependence and the evils it has recently brought about, they have, on the whole, conserved their *Lehrfreiheit* and *Lernfreiheit*. Equally characteristic and different from English practice is the responsibility they cast upon the student, who " is treated as a man from the day he matriculates ".

It would also take too long to consider Dr. Flexner's treatment of important specific problems of university work and organisation—such as the organisation of medical research and training, upon which he writes with admitted authority. On the other hand, the reviewer cannot resist making an attempt to set down some of the doubts with regard to Dr. Flexner's theory of universities which his admiration of the author's largeness and loftiness of view has not prevented from rising.

One of the greatest of American teachers once voiced a distrust of all " rational, clear-cut, temple-like " systems of thought. William James's epithets together with the feeling they expressed come into one's mind in contemplating Dr. Flexner's conception of the educational institutions of a country with the universities, Olympian in their elevation and their detachment, at the top. One questions whether the universities can perform with full efficiency the high, abstract functions he rightly allocates to them, if their activities are restricted to those functions with the rigour which he would enforce. Granted that a university may (for the sake of the fees) give too much attention to ' secondary ' teaching, and may be tempted (for the same reason or better ones) to interpret too widely its duty in the matter of ' service ', is it not true, nevertheless, that some contact with these things, in their higher, more definitely intellectual forms, is necessary to preserve in the loftier regions of the institution a proper balance and sense of reality ?

The argument is put here from the point of view of the university. From the point of view of professional or ' service ' institutions, it seems obvious that direct contact with the spirit of exact inquiry which lives in a university, and with the atmosphere of intellectual adventure which should prevail in it, is the best if not, indeed, the only means of maintaining a high level of professional teaching and study. Dr. Flexner's opinions here (we respectfully suggest) are influenced by a view of the " training of the mind " which any psychologist (if he believed in psychologists) would assure him is sadly out of date. This is illustrated by his story of the professor's wife whose " powers trained elsewhere " enabled her to produce " an excellent loaf ", and of the " astonished Bridget's " comment : " That's what education means—to be able to do what you've never done before ". In brief, Dr. Flexner's censure of the ' service ' activities of universities—where they are not plainly justified by the low intellectual level of the institutions condemned—is based upon an uncritical acceptance and a far too sweeping application of Bridget's theory of education.

Lastly, it seems possible that the same tendency to take an abstract and too simplified view has prevented Dr. Flexner from doing justice to the University of London. One would gather from his pages that the good work done in the more important institutions is done in spite of the constitution rather than with its aid ; yet that is by no means the view held, as a rule, in the institutions themselves. For example, Prof. Hearnshaw's centenary history of King's College shows how that institution was rejuvenated—one might almost say recreated—by entering into the new teaching university; and Sir William Beveridge recently gave impressive evidence of how the peculiar combination of autonomy with central control, which Dr. Flexner finds so illogical, serves to foster the individuality of the colleges, while tending to maintain common standards of efficiency—to say nothing of a common university consciousness—in all. But to offer these critical remarks is not to deny the outstanding importance of a book the value of which will become more clear the more thoroughly it is studied.

T. P. N.

Laboratory Technique in Physical Chemistry.

Ostwald-Luther Hand- und Hilfsbuch zur Ausführung physiko-chemischer Messungen. Unter Mitwirkung von W. Bothe, W. Gerlach, R. Gross, H. v. Halban, R. Luther, F. Paneth, F. Weigert. Herausgegeben von C. Drucker. Fünfte, neubearbeitete Auflage. Pp. xix + 979. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1930.) 52 gold marks.

"OSTWALD-LUTHER", the preface to the first edition of which is dated 1893, is a work which is known in every laboratory of physical chemistry in the world. It has, in its successive editions, proved a reliable guide to experimenters, and many of the methods which, in the early editions, were perhaps not very well known even in physical chemical laboratories specialising in this type of work, are now commonplaces in technical laboratories. The book has never professed to give a course of experiments suitable for the use of students, but seeks to explain the principles of methods which are used, or are likely to be used, in research work, and the great progress which has been made in the development of such methods has called for a considerable extension in the scope of the book.

It is clear that, even in a book of nearly a thousand clearly printed pages, it is impossible to enter into detail regarding all the experimental technique which the modern physical chemist must have at his disposal. What may reasonably be expected is that the book shall deal with the broad fundamental parts of the subject in some detail, and that it shall provide indications where fuller information on special points can be found. In the last respect, it may reasonably be anticipated that in a book of this size and price an international outlook shall be maintained, and it must be said at once that, in spite of the obvious distaste towards a criticism of a previous edition that it fell short in this respect, a distaste expressed in the preface, much more could usefully have been done in taking account of the contributions of British and American workers. There would be no useful purpose served in entering into detail on this point, but in many parts of the book there is no mention of important work which should have found a place. In some cases this work is merely mentioned by references to German abstracts, a practice which has nothing to recommend it, since the English-speaking chemists have long possessed reliable abstracts in their own language, and will not welcome a journey to a large public library in order to turn up, in a collection of German abstracts, the reference to a paper which is on their own shelves in the original. It is essential that the authors of such a work as this shall not only have read the paper in the original, but that they shall also provide their readers with a reference to the latter.

It is clearly impossible within the limits of space imposed on a reviewer to enter into a detailed discussion of the whole of such a comprehensive work. What has been done, therefore, has been to select a few representative sections at random, and to see how far these cover the more recent work which they profess to describe.

The section on transport numbers gives a fairly comprehensive account of the Hittorf method, with a useful example of calculation, but it is much too brief in connexion with the direct method. Although references are given to some papers by McInnes, no attempt is made to describe in any way the apparatus used. It may be said that space did not allow of this. If this is so, it may be suggested that the by no means negligible space used in giving the names and addresses of German firms supplying squared paper, slide rules, logarithm tables, glass, etc., could have been better utilised, since no user of the book will be likely to trouble himself with such matters.

In the section on surface tension, the methods described are somewhat old-fashioned, and the corrections to be used in the capillary tube method are not given. The section on the viscosities of gases is poor, and the rule for the ratio of length to diameter of the tube, given at the top of p. 313 (from a very old paper by Meyer), is misleading, since the real factor is the nature of the flow in the tube, about which nothing is said. No account is given of measurements at high temperatures. The section on the specific heats of gases is also far from satisfactory, and recent collective accounts of the subject are not mentioned. Not even a reference is given to more recent experimental methods used for the determination of the ratio of specific heats, or to measurements by the explosion method, except those of German authors. The whole section on this subject occupies only about two pages. In the section on dielectric constants there are only five references, all to German authors, the whole of the recent American work being unmentioned. Spectrometry in the infra-red is represented by three lines of type, no reference being made to recent important English work.

It is possible that the sections chosen for notice were unfortunate. To them, at least, the criticism to which the authors take exception applies completely. English and American readers will not feel satisfied, after the purchase of large and expensive German books, if information which they might reasonably expect to find in them is missing.

Although the present edition of "Ostwald-Luther" is far from being up to date in some sections, and is overburdened with too much irrelevant matter, the classical parts of the work, if they may be so called, remain, and those who have no edition of the book in their possession will find it of the greatest value in the physical chemistry laboratory. The information on the more recent advances will also serve a useful purpose, provided that the reader remembers that there is much good work, some even fundamental, to which no reference whatever is made. The printing and paper are of the best quality. J. R. P.

Physiological Perception of Position.

The Physiology of the Vestibular Apparatus. By Mario Camis. Translated and annotated by R. S. Creed. Pp. xiv + 310 + 27 plates. (Oxford: Clarendon Press; London; Oxford University Press, 1930.) 21*s.* net.

PROF. CAMIS deserves the thanks of all physiologists for bringing together into one book the mass of knowledge—very largely of modern growth—concerning the vestibular apparatus of animals. The gap thus filled, and the extent of his service, is amply shown by the long and complete bibliography given in the book—where, save for de Cyon's polemical book of 1908, the last treatise devoted *entirely* to this field is Ewald's "Nervus Octavus", which appeared so long ago as 1892.

The author commences with an interesting account of Marey's cinematographic demonstration in 1894 of the righting movement by which a falling cat drops upon its paws—a demonstration not only of interest because of the dynamical problem it set, but also as one of the first results of the cinematographic method developed, and largely originated, by Marey himself. The dynamical problem is discussed and solved, and the subject of the dropping cat—which at one time or another has fascinated most young people, and Clerk Maxwell amongst them, if we are not mistaken—is then itself dropped, to give place to an account of the older work on the physiology of the labyrinth. This brief historical survey deals chiefly with the theoretical conclusions of Flourens; of Goltz; of Crum Brown, Breuer, and Mach; of de Cyon; and finally of Ewald. Next follow chapters on the anatomy of the vestibular apparatus and of its central nervous connexions, and on the operative methods used in experiments.

A chapter upon the effects of experimental lesions of the labyrinth is followed by a complemental one upon the effects of stimulation, and that by an interesting and valuable discussion upon the labyrinth as the organ of the sense of space. The theories and speculations of de Cyon are ably summarised here in their bearing on the philosophical teaching of Kant; and there follows an account of other views with regard to the functions of the labyrinth. This closes the story of the older work and views on the function of the labyrinth. The remaining half of the volume under review deals with the modern investigations and conclusions.

Modern investigation has been directed, chiefly by Magnus and his pupils, to the function of the vestibular apparatus and its connexions in the *reflex* activities of the animal; and Prof. Camis prefaces his description of this work with a brief account of Sherrington's development of the reflex theory. This is followed by an excellent summary of the work on non-labyrinthine postural and righting reflexes; and that by a description of the labyrinthine reflexes and their influence on the tone of limb muscles. A following chapter is given to the description of the relations of the labyrinth to the eyes; then comes an analysis of labyrinthine reflexes, and an interesting appendix on the terminology and classification of reflexes. Later chapters are devoted to the adequate stimulus for the receptive end-organs of the labyrinth, and to the nervous connexions of the vestibular apparatus.

Prof. Camis presents this complex subject in a most clear and readable manner. Our debt to him is great; but we have another debt to acknowledge. Not only is Dr. Creed's translation so good that we forget that the original was written in Italian, but he has also added many notes which increase the value of the book.

Short Reviews.

Brain, Mind and the External Signs of Intelligence. By Dr. Bernard Hollander. Pp. 288. (London: George Allen and Unwin, Ltd., 1931.) 12*s.* 6*d.* net.

THE book opens with an introduction in four parts: the nature of the mind, the ascent from unconsciousness to self-consciousness, the development of the human mind, and the development of the human brain. Into these twenty-five pages is compressed a great deal of important matter lucidly treated.

Chapter ii. is devoted to a critical account of the results of the experimental physiology of the cortex cerebri. To follow this admirable historical résumé, a considerable amount of previous knowledge of cerebral physiology is needed, so that the layman may be somewhat puzzled by the contradictory accounts of the results of experiments upon the cerebral cortex. The omission of the name of Gall from this discussion is curious, since Gall undoubtedly held views far in advance of those of his contemporaries. Indeed, for locating ' moral sentiments ' in ' mere matter ', he was expelled from Vienna

Dr. Hollander, of course, believes in the localisation of cerebral function, and in particular inveighs against the notion that the brain ' acts as a whole ' —a vague statement to which no qualified neurologist would to-day subscribe. The work of Head and Gordon Holmes on the localisation of ' emotive reaction ' in the thalamus is duly referred to, and the James-Lange theory of the peripheral origin of emotion is promptly dismissed. The chapter on the histology of the cerebral neurons is excellent, though here again the unfortunate lay reader—for we presume Dr. Hollander writes also for him—must crave for an illustration or two, to render visible to him such things as ' arborisations ', ' axons ', and ' dendrites '. It is curious not to find ' synapsis ' in the index.

It should, however, be said that the diagrams, illustrations, and portraits provided are excellent; indeed, the book is quite valuable for these alone.

The author gives expression to a number of much-needed cautions on the subject of the correlation of intellect and size or weight of the brain. A large portion of the work is occupied with a detailed study of the functional importance of the human frontal lobes, and here, as elsewhere, there are full references to original sources in clinical and other literature. D. F. F.-H.

Gmelins Handbuch der anorganischen Chemie. Achte vollig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. System-Nummer 26: *Beryllium.* Pp. viii+180. 30 gold marks. System-Nummer 58: *Kobalt.* Teil B: *Die Ammine des Kobalts.* Pp. xxv + 376. 58 gold marks. (Berlin: Verlag Chemie G.m.b.H., 1930.)

THE new volume on beryllium will be welcomed on account of the interest which is being taken in the commercial production of the metal and of its alloys, known to have valuable properties. The literature has been reviewed up to May 1930 and the result is a very useful compendium of information. It must, of course, be borne in mind that this is a work of reference, in which results are recorded so far as possible in chronological order, rather than a textbook to guide the reader in his choice. Thus, many methods are described of obtaining beryllium from its chief ore, including the separation of the metal from aluminium by means of the different solubilities of their fluorides, although no preference is indicated. Again, there is no hint to show that electrolytic methods of reduction are to be preferred to purely chemical methods. While the volume contains a list of references to researches on the alloys of beryllium, the detailed account of the alloys must be sought in other volumes of the work.

The immense group of the cobalt ammines has grown not only in extent but also in importance since the well-known researches of A. Werner gave the clue to modern developments of the theory of molecular structure and of valency. Thus, a separate volume is now devoted to this subject, which includes between two and three thousand derivatives, practically all of which fall into the scheme of classification, which is carefully explained in the opening chapter. This is followed by the systematic treatment of the ammines of bivalent and of tervalent cobalt, the latter occupying the greater part of the volume. The literature is reviewed to the end of 1929.

Geologie der Steinkohlenlager. Von A. Dannenberg. Band 2, Teil 2. Pp. 125-270. (Berlin: Gebrüder Borntraeger, 1930.) 14 gold marks.

THE part of this work under notice deals with some of the coalfields in eastern North America. Among those in the United States it describes the fields of West Virginia and those of the Appalachians—both the northern basins in Kentucky and Tennessee around the famous Cumberland Gap, and the southern basins in Alabama and Georgia, including the Birmingham fields and the Cahaba and Coosa basins. The part also describes the Michigan coal basins and those of the series grouped as the Western Interior Basin, which ranges from Iowa southward across western Missouri, Kansas, Arkansas, and Oklahoma, and is continued to the south of the Arbuckle Mountains into Texas. A brief reference is given to the coal of Alaska. The rest of the part is devoted to the coalfields of the maritime provinces of Canada and Newfoundland.

In reference to each field, the author describes the succession of the sediments and coal seams and the tectonic structure of the field and gives reference to the literature. The summary of the southern part of the western interior field is of special interest owing to the extensive recent literature upon it.

Chemische Bindung als elektrostatische Erscheinung. Von A. E. van Arkel und J. H. de Boer. Deutsche, von den Verfassern autorisierte Ausgabe von Li Klemm und Wilhelm Klemm. Pp. xx+320. (Leipzig: S. Hirzel, 1931.) 15 gold marks.

THIS monograph deals with the study of compounds from the point of view of Kossel's theory and the method of calculation of Born, in which Coulomb forces and a force of repulsion varying inversely as a higher power of the distance are assumed. It carries the theory as far as is possible in this direction and gives a useful and suggestive picture of many important properties of compounds which are amenable to this treatment. The applications of the newer quantum theory, including wave mechanics, find only a subordinate place, and the theory of covalent compounds is necessarily very restricted. Within the limits imposed by the method of treatment, the book provides a useful summary of recent investigations and also includes many numerical results of value.

The Jungfraujoch Scientific Station.

PHYSICISTS and meteorologists who are interested in the upper atmosphere, and biologists who wish to study the effects of different altitudes on living organisms, have hitherto been severely handicapped in Europe for lack of adequate facilities for their investigations, yet in spite of this much valuable work has been done in the past. But such places as the observatory on Mont Blanc, the Capanna Margherita on the summit of Monte Rosa, and various Alpine huts which have at different times served as laboratories for scientific work, are difficult of access. Situated as they are amid the higher peaks of the mountains of central Europe, and accessible only after crossing glaciers and snowfields where human transport alone is available, the problem of provisioning and maintaining a scientific expedition and arranging the carriage of its equipment is a very serious one and has imposed a limit on the duration and the scope of the investigations which have been undertaken. Moreover, the available accommodation has been but scanty and protection from storm and frost inadequate, while the risk has to be run that communications may be severed by a change in weather. The outlook has, however, been completely altered by the establishment on the Jungfraujoch of a properly built and well-equipped laboratory, which was formally opened at the beginning of July. The illustrations accompanying the present article are from a *Festschrift* published to commemorate the occasion.

The idea of building such a laboratory is no new one, for it dates back to the days when the Jungfrau railway was first planned. The scheme received the ardent support of the late Prof. A. de Quervain and was fostered by the Swiss Naturforschende Gesellschaft; but lack of funds for long prevented its realisation. Recently, however, the co-operation of Switzerland, Germany, France, Great Britain, Austria, and Belgium, with further financial assistance from the Rockefeller Foundation and from other benefactors and the invaluable aid of the Jungfrau Railway Company, has made possible the foundation of an international research station.

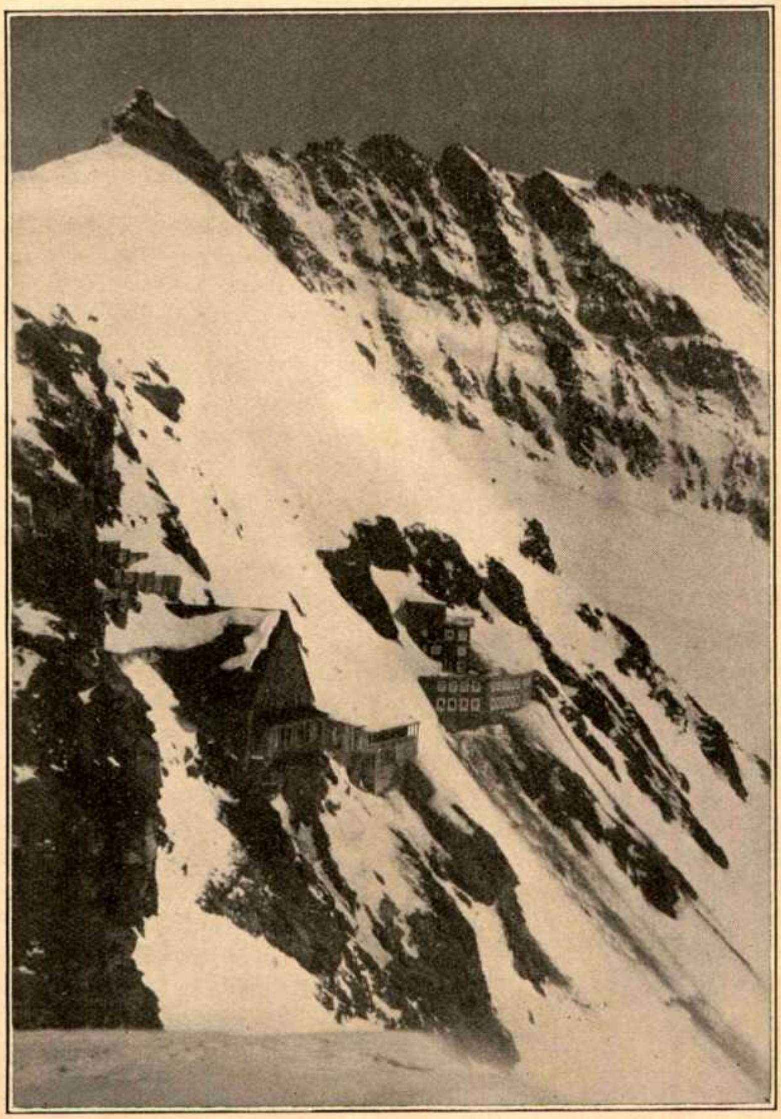

Photo.] [R. Schudel, Grindelwald.

FIG. 1.—General view of the Jungfraujoch Scientific Station.

The Jungfraujoch Scientific Station has been built at an altitude of 3457 metres (11,340 ft.), on a shelf formed by blasting in the rock face which falls steeply towards the snowfields from which the Great Aletsch glacier takes its origin. The laboratory faces south, with the panorama of the Bernese Oberland before it, and a short ascent to the summit of the Jungfraujoch gives an uninterrupted view towards the north. Its general position is shown in Fig. 1.

The building in the foreground is the Hotel Berghaus at the terminus of the railway: beyond this is the new scientific station, access to which is gained through a tunnel in the rock connected with the railway station. Fig. 2 shows a closer view of the laboratory and gives a good idea of its construction.

The laboratory is substantially built of stone to the designs of Messrs. Pfister, of Zurich, and the roof is specially strengthened to withstand falls of stone or snow from the mountain slope above. The walls are cork-lined to ensure warmth, and the living-room and bedrooms are, in addition, panelled with wood. The main block is of two stories, and is surmounted at one end by a tower of three additional stories.

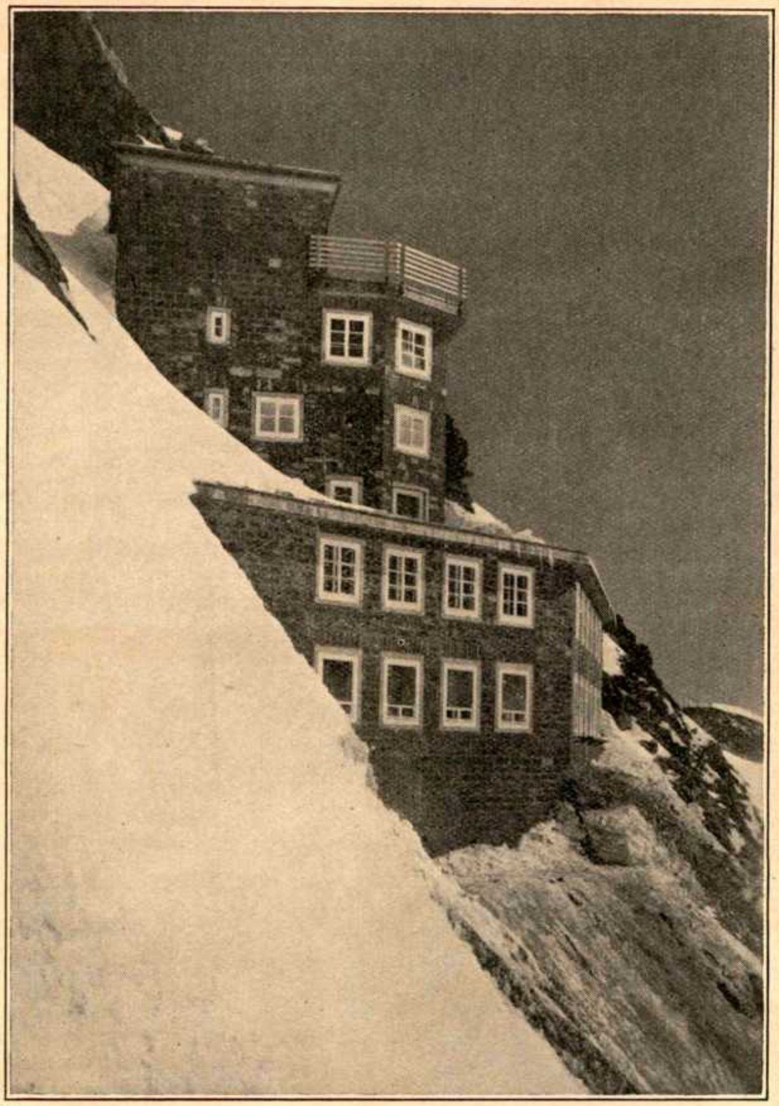

Photo.] [*R. Schudel, Grindelwald.*

FIG. 2.—Jungfraujoch Scientific Station from the west.

On the ground floor (Fig. 3) are an entrance lobby, cloakroom, six research-rooms (two of which each afford room for two working places), a workshop, a dark-room, store-rooms, a stable for animals, an electric power switch-room, and a fresh-water reservoir. On the first floor (Fig. 4) are situated a living-room, administrative bureau, nine single bedrooms, one four-bedded room, a bathroom, kitchen, and dark-room. In the tower, the lower floor is designed as a botanical laboratory and gives access to the flat roof of the main building; the middle floor affords quarters for the attendants, and the upper floor is devoted to the library, in which there is an optical projection apparatus. Above the library is an open-air terrace, which is partly roofed over as a protection against falling stones.

Electric power for heating, lighting, and cooking is obtained from the railway, and as a precaution against temporary failure of this supply an emergency lighting circuit is installed which is supplied with current from accumulators. Every research-room is supplied with running water and is fitted with a switchboard from which electric power may be obtained for experimental purposes at both high and low voltages. Valuable gifts of scientific apparatus have already been received from industrial firms.

The laboratory has been built with the view of encouraging research in both the physical and biological sciences; and it is certainly well adapted for the purpose. The benches in the research-rooms are ample and so arranged as to leave plenty of floor space available for the erection of special apparatus. The windows, which are double-glazed, are not very large; but in spite of this the general lighting of the rooms is extremely good: indeed, the glare from the snow-fields around renders the provision of sun-blinds essential. The research-rooms themselves are of good size, and it would be a mistake to suppose that only one research worker can be accommodated in each. Each is large enough to permit of work involving the co-operation of two or three persons. The building as a whole is, indeed, larger than might be anticipated, when the great difficulties that had to be faced in its construction are borne in mind.

The scientific station is designed to be complete in itself. Not only does it afford working space and sleeping quarters, but the kitchen also is adequate for the provision of meals for the occupants. The Hotel Berghaus is close to the laboratory, and at first sight it would possibly seem easier to take meals there. But it must be remembered that the number of tourists who are brought by the railway to the Jungfraujoch is very large, and that at the height of the season the hotel accommodation is liable to be taxed to the utmost.

It will be seen from Fig. 1 that the laboratory is quite separate from the hotel. It can only be entered from behind through a tunnel; and though this is connected with other galleries in the rock through which tourists can pass freely, it should not be difficult to keep out the inquisitive intruder: the research workers are therefore not likely to be inconvenienced materially by the tourist traffic.

For the purpose of meteorological observations the laboratory itself is not altogether ideal, since the rock face rises steeply above it and it only affords a free view in one direction. The snowfield on the summit of the Joch does not suffer from this disadvantage, as it commands an all-round view. For the meteorologist an even better site is to be found on the rocky peak, the 'Sphinx', the top of which is 400 feet above the laboratory. This can be reached from the Joch, and it is being rendered even more accessible for tourists by the Jungfrau Railway Co. It is hoped before long to establish a small meteorological station on this point.

The new research station is readily accessible from Interlaken by the Scheidegg and Jungfrau railways, and there will be no difficulty in carrying up both delicate and bulky apparatus. So short are the communications and so frequent the train service that little delay should occur if additional apparatus has to be procured during the course of a research, while telephonic communication with the Swiss universities and laboratories will be easy. The laboratory will be available for work all the year round, summer and winter alike. It may fairly be claimed that the disadvantages under which so many of the earlier high altitude expeditions laboured have now been overcome, and with the full laboratory facilities at their disposal research workers at the new station should be the better able to attack with success many problems which are as yet unsolved.

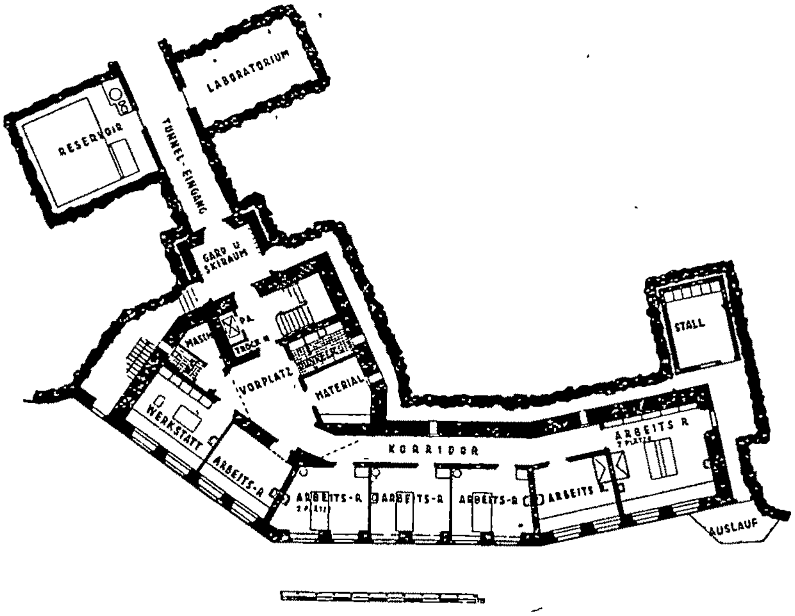

FIG. 3.—Plan of ground floor with research-rooms.

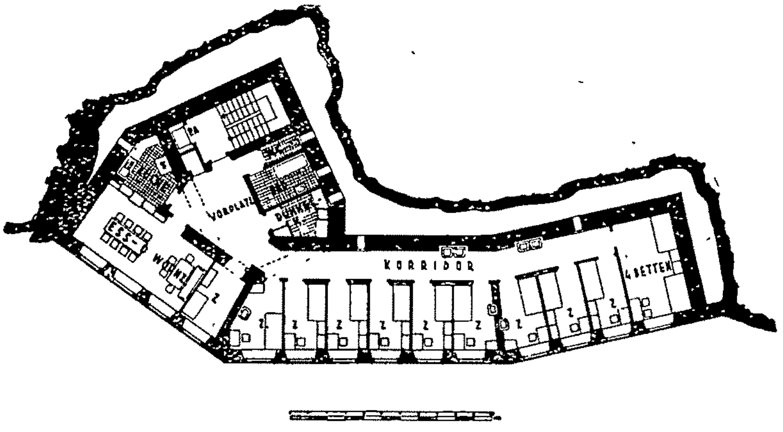

FIG. 4.—Plan of first floor with living-room and bedrooms.

It would, no doubt, have been an advantage if the laboratory could have been built at a still higher altitude; but no other point in the Alps so high as the Jungfraujoch can be reached with such ease; the Gorner Grat, for example, which can be reached by train from Zermatt, is more than 1000 feet lower. Though the altitude of the new scientific station may seem but moderate in comparison with the heights reached by mountaineers in recent years, it is a point of some interest to physiologists that genuine mountain sickness is by no means unknown amongst those who ascend to the Jungfraujoch from the lowlands and have had no time to become acclimatised. After all, the barometric pressure is only about 500 mm. of mercury at the laboratory.

The direction of the Jungfraujoch Scientific Station is vested in a council, consisting of a president, Prof. W. R. Hess, of the University of Zurich, and two representatives of each of the following bodies: the Swiss Naturforschende Gesellschaft, the Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften of Berlin, the University of Paris, the Royal Society of London, the Akademie der Wissenschaften of Vienna, the Fonds National de la Recherche Scientifique of Brussels, and the Jungfrau Railway Company. There is in addition an executive committee, of which the officers are Prof. W. R. Hess, president; Prof. A. Kölliker, of Zurich, treasurer; and Prof. L. W. Collet, of Geneva, secretary.

Faraday as a Botanist.

By Dr. R. W. Butcher.

AMONG the Faraday relics at the Royal Institution is a small quarto book containing a collection of pressed flowers collected between 1850 and 1853, when Faraday was about sixty years of age. Apparently this book is very little known, and this seems an opportune time to describe it, as it shows that the great scientific investigator had no mean knowledge of his native plants, a fact not noted elsewhere.

The book is inscribed: "Michael Faraday to Joan Barnard" (his niece), and probably the collections were made when they were on holiday together. Each page is numbered; on the left-hand pages the specimens are mounted with gum, and on the right-hand pages quotations are sometimes written. Most of the plants are named both with the English and scientific names. The writing appears, for the most part, to be that of Mrs. Faraday, though whether all was written by her is doubtful. Mr. Evelyn Barnard thinks that the flowers were collected and named and the verses chosen by Michael Faraday and written in the book by Mrs. Faraday.

The collection falls into four periods. In July 1850, thirty-one specimens were collected at Norwood. In September 1850, fourteen were collected at Kingswood, Surrey; and probably at the same time, the box from Box Hill. Then follow ten plants unnamed and unlocated; these are spring woodland plants such as *Arum maculatum* and *Orchis mascula*. The last lot, six in number, were collected at Hastings in 1853. A full list will best illustrate Faraday's collecting activities. The names in square brackets have been added by me.

1. From Norwood, July 1850.

1. *Lathyrus pratensis*.
2. "*Anthyllis vulneraria*" [this is *Lotus uliginosus*].
3. *Lotus corniculatus*.
*4. *Lonicera periclymenum*.
*5. *Rosa canina* [*Rosa arvensis* also on same page].
*6. "*Rosa rubiginosa*" [this is *Rosa micrantha*].
*7. "*Hypericum perforatum*" [this is *Hypericum pulchrum*].
8. *Hypericum* [*humifusum*].
9. *Hypericum Androsæmum*.
*10. *Chrysanthemum leucanthemum*.
11. *Ranunculus flammula*.
*12. *Papaver rhœas*.
13. *Vicia Cracca*.
14. "*Fumaria*" [this is *Vicia hirsuta*].
15. *Potentilla Tormentilla*.
16. *Juncus* [*communis*].
17. *Digitalis purpurea*.
18. *Polygala vulgaris*.
19. [*Lathyrus montanus*].
20. *Lysimachia nemorum*.
21. *Lysimachia nummularia*.
22. *Scutellaria galericulata* (no specimen).
23. *Tamus communis* (no specimen).
24. *Chelidonium majus*.
*25. *Veronica Chamædrys*.
26. *Veronica officinalis* (no specimen).
*27. "*Veronica serpyllifolia*" [this is *Veronica montana*].
28. *Erythræa Centaurium*.
*29. *Anagallis arvensis*.
*30. *Campanula rotundifolia*.
31. *Asperula odorata*.

2. From Kingswood, September 1850.

*32. *Erica cinerea*.
33. *Erica tetralix* (no specimen).
34. *Calluna vulgaris*.
35. *Linaria spuria*.
36. *Bartsia Odontites*.
37. "*Senecio*" [this is *Solidago virgaurea*].
38. *Polygonum Persicaria*.
39. *Centaurea scabiosa*.
40. *Helianthemum vulgare*.
41. *Anagallis cærulea* [this is a dwarf *Veronica Buxbaumii*].
42. *Scabiosa arvensis*.
43. *Clematis Vitalba*.
44. *Achillea Millefolium*.
45. *Buxus sempervirens* (from Box Hill).
46. *Agrimonia Eupatoria*.
47. *Trifolium procumbens*.

3. Unnamed and Unlocated.

48. [*Orchis mascula*].
49. [*Arum maculatum*].
50. [*Anemone nemorosa*].
51. [*Allium ursinum*].
52. [*Lastrea Filix-Mas*].
53. [*Ornithogalum nutans*].
54. [*Hedera helix*].
55. [*Primula vulgaris*].
56. [*Anthriscus sylvestris*].
57. [*Hypnum molluscum*].

4. Hastings, 1853.

58. *Statice Armeria* (from Castle Hill).
59. *Ornithopus perpusillus*.
60. *Rumex acetosella*.
61. *Sedum anglicum*.
62. *Trifolium subterraneum*.
63. [*Erodium cicutarium*].

* With quotation.

There are several points of interest in this list. From Norwood there is a collection of plants from a district now covered with houses. Of the Surrey plants, the most interesting are *Hypericum Androsæmum* and *Veronica Buxbaumii*; the former because it is by no means a common plant, and the latter because it indicates how common this plant, introduced about 1835, had become. The other Surrey plants are recorded by Brewer in the "Flora of Surrey" as common. Apparently, Faraday also noted the difference between *Lotus corniculatus* and *Lotus uliginosus*, though he did not name the latter correctly. Of the Hastings plants, *Sedum anglicum* may be considered a first county record, as in the "Flora of Sussex" the earliest record is 1878.

Considering the literature available at that time, the naming of the plants is remarkably accurate; the mistakes are shown in the list and illustrate the collector's difficulties—difficulties with which some who remember their first attempts to name wild-flowers will sympathise.

The order of the plants in the book is probably the order in which they were collected, closely allied plants being put together when collected at the same time.

Quotations are written by the side of eleven of the plants and these are indicated in the list with an asterisk. Some quotations are assigned to their author, but most are anonymous.

My best thanks are due to Sir Robert Robertson (hon. treasurer) and to Mr. Cory (librarian) of the Royal Institution, for enabling me to examine the book, and to Mr. Evelyn Barnard, donor of the book to the Royal Institution, for information.

News and Views.

HIS MAJESTY THE KING has approved the following awards this year by the president and council of the Royal Society in respect of the two Royal Medals: Royal Medal to Sir Richard Glazebrook for his distinguished work in experimental physics; Royal Medal to Prof. W. H. Lang for his work on the anatomy and morphology of the fern-like fossils of the Old Red Sandstone. The following awards of medals have also been made by the president and council: Copley Medal to Sir Arthur Schuster for his distinguished researches in optics and terrestrial magnetism; Davy Medal to Prof. A. Lapworth for his researches in organic chemistry, particularly those connected with tautomerism and the mechanism of organic reactions; Sylvester Medal to Prof. E. T. Whittaker for his original contributions to both pure and applied mathematics; Hughes Medal to Prof. W. L. Bragg for his pioneer work on the elucidation of crystal structure by X-ray analysis.

WE print as a Supplement to this week's issue the evening discourse entitled "Beyond the Milky Way", delivered by Sir James Jeans on Sept. 29 during the centenary celebrations of the British Association. Starting with the star system of which we are a part, Sir James takes us outside it into the realms of interstellar spaces and the extra-galactic nebulæ, and in his characteristic and lucid manner leads us to a consideration of the hypothesis of the expanding universe. The extra-galactic nebulæ known to astronomers present a bewildering variety of size, shape and brightness, but after eliminating those which are not seen edge on, the remainder may be arranged in a single continuous sequence, beginning with spheres and ending with flat discs. This sequence is interpreted as showing evolutionary development from a mass of rotating and shrinking gas. The nebulæ are distributed fairly uniformly through space, and are regarded as condensations of a universal primeval gas. Recent observations have shown that the nebulæ are receding from the galaxy and from each other at speeds approximately proportional to their distances; the universe appears to be expanding like a balloon during inflation. This is in accord with relativity considerations, but it makes the ages of the stars considerably less than we have hitherto believed. The hypothesis of an expanding universe was dealt with in the British Association discussion which we printed as a supplement to NATURE of Oct. 24, and it also formed the subject of Sir Arthur Eddington's presidential address to the Physical Society delivered on Nov. 6. Sir Arthur pointed out that the theory of the 'expanding universe' can also be regarded as the theory of the 'shrinking atom', and he envisaged a cosmic being, whose body kept pace with the expanding intergalactic spaces, looking down on the atomic drama and watching the actors growing smaller and smaller and the action faster and faster until "One last microscopic blur of intense agitation. And then nothing."

SIR ARTHUR EDDINGTON'S presidential address to the Physical Society was entitled "The Expanding Universe". After a brief sketch of the system of spiral nebulæ, he described the necessity of introducing the cosmical constant 'lambda', and went on to show that the ideal universe postulated by Einstein some years ago is unstable. If initial expansion is set up, it will continually increase. From a study of the wave equation of the electron, Sir Arthur has recently found a theoretical value of the cosmical constant, and from this he deduces the following values. The equilibrium radius of the universe is 1068 million light-years, the number of electrons in it is $1 \cdot 29 \times 10^{79}$. Its total mass is $1 \cdot 08 \times 10^{22}$ times that of the sun. The recession due to the 'lambda' term is 528 km./sec. per megaparsec, in excellent agreement with the round number 500 km./sec. which has been adopted from observation. He concludes that the recession of the spiral nebulæ, indicated by the spectroscope, is a real one; others have suggested that the reddening of the light may arise in some other way. The universe doubles its radius in 1300 years, a space included within the limits usually assigned to geological time.

SIR ARTHUR EDDINGTON pointed out that this favours the intermediate scale of stellar life (of the order of ten thousand million years, rather than many millions of millions), a conclusion which he reached in another manner last year by considering the motion of the interstellar gas in our galaxy; it was found that this motion was unlikely to persist for the periods required by the longer scale. The intermediate scale permits the theory that stellar energy is derived from the transmutation of hydrogen into other elements, though the theory of the annihilation of atoms is still tenable. He made an interesting suggestion about the cosmic penetrating radiation. The only source which can be considered to be arranged symmetrically about the earth is the whole universe. These radiations go back to the early days of the universe, and have probably circuited it several times. Their wave-length is probably some four times as great as its primitive value, so that a correcting factor should be applied before making deductions from it as to the origin of the rays.

JOHANNES BOSSCHA, the centenary of whose birth falls on Nov. 18, was regarded as the leader of Dutch physicists. Born at Breda, he was initiated into physics by van der Willigen. In 1850 he entered the University of Leyden, and two years later took his degree with a dissertation on the differential galvanometer, his work being done in the physical laboratory at Leyden, then under the direction of Rijke. After a short stay at Berlin he became an assistant in the laboratory, where he did much work in connexion with the law of the conservation of energy, the e.m.f. of the Daniell cell and multiplex telegraphy. Ten years of his life were devoted to secondary and technical education in Holland and the provision of facilities for scientific studies. In 1873 he became a professor and in 1878 the director of the Polytechnic at Delft; in 1885 he was made secretary of the Dutch Society of Science at Haarlem. He also reorganised the Dutch Meteorological Service. He made original researches on the velocity of sound and on heat. Much of his later life was devoted to the study and editing of the correspondence of Huygens. He died in the spring of 1911 and an appreciation of his work by Kamerlingh Onnes was published in NATURE for May 25, 1911.

MANY of our readers must have seen with regret the announcement in the daily Press that a serious outbreak of fire occurred at the University of St. Andrews in the early morning of Nov. 3. We learn that considerable damage has been done to the new building which contains the chemical and physical laboratories of the United College of St. Salvator and St. Leonard. The entire roof of the physical laboratory and part of that of the chemical laboratory have been destroyed. Two large Hilger spectroscopes and other instruments used in physical research have been badly injured. A large amount of valuable apparatus has been completely destroyed as well as many chemical specimens illustrating Prof. J. Read's researches. It is remarkable that many specimens of the products obtained by the late Prof. Purdie and Principal Sir James Irvine have escaped. An unofficial estimate places the amount of damage, which is covered by insurance, at £10,000. Fortunately, the fire did not reach the chemical research laboratory at the north end of the block or the adjoining building, which houses the natural philosophy lecture rooms and museum, where much interesting historical apparatus is preserved.

THE Royal Photographic Society has arranged a series of annual exhibitions illustrating photography in the service of man. The third of the series was opened on Nov. 9 at the Society's house at 35 Russell Square, London, W.C.1. It is devoted to colour photography, and will remain open on each weekday from 10 A.M. to 5 P.M. until Nov. 28. Demonstrations of modern colour processes will be given at 7 P.M. on Nov. 18 and 25, on which days the exhibition will remain open until 9 P.M. In its historical section, the exhibition honours a host of scientific workers and inventors too numerous to mention individually. Overshadowing all the rest are the names of Clerk Maxwell and Ducos du Hauron, whose discoveries form the foundation of most of the practicable methods of colour photography. The most brilliantly colourful section of the exhibition represents the four main photomechanical processes: collotype, half-tone photogravure, and photolithography. Great progress, has been made in simplifying colour printing during the last thirty years. Coloured prints of great beauty were produced many years ago, but they were very costly owing to the large number of printings necessary for each; twelve, sixteen, or even more different printings being often made. To-day, exquisite replicas of paintings often take no more than seven printings, and even this is deemed a very complicated process. Most modern colour reproductions are made with three or four printings.

THERE is in one of the showcases at the exhibition a specimen page of a popular daily picture paper printed in colour. This seems like prophecy. How long will it be before our great daily papers print their pictures in colour? Photolithographic reproduction in colour by offset printing is now capable of yielding an enormous output, and can be employed on comparatively rough paper. The methods of colour photography which may be used by the amateur are also very well represented. Mosaic screens of all kinds and transparencies obtained with many of them are shown. Then there are examples of various apparatus employed for making three colour-separated negatives, including cameras in which the three exposures are made simultaneously, and 'repeating backs' which allow negatives to be made consecutively. The automatic repeating back is said to make three consecutive exposures in a total time of about one second. This apparatus is now employed for recording in clinical medicine. There is a great deal more: two-colour photography, Lippmann photography, colour reproduction by diazo processes, colour cinematography, all of great interest. The exhibition is probably one of the finest of its kind which has ever been produced in Great Britain.

IN a paper read to the Illuminating Engineering Society on Oct. 30, Mr. P. Good discussed the lessons to be learnt from the recent flood-lighting display. He considers that the cost of flood-lighting was not an extravagance. He pointed out that a sum of £50,000 would equip and endow in perpetuity the proper lighting of the façade of the National Gallery. Another way of considering the matter is this: one per cent of the expenditure of the B.B.C. on music and entertaining would maintain the flood-lighting carried out in London for the International Illumination Congress this year for a whole year, and provide illuminated fountains in Trafalgar Square as well. Mr. Good made two useful suggestions for utilising the advertising value of flood-lighting. He advocated that buildings, some hospitals, for example, which are at present defaced by advertisements for the purpose of raising money, should instead invite the advertiser to paint and flood-light their building so that it makes an attractive picture. The advertiser might be permitted to have a very small notice invisible to everyone except those close by, and be left to advertise in the Press what he had done. Mr. Good's second suggestion was that as there are many streets in London and its suburbs with bare plots of land utterly disfigured with advertisement hoardings, these should be removed and the advertisers could turn the waste-land into little gardens with small notices stating who had provided them. Mr. Good is certain that the lighting engineer, with the illimitable possibilities of flood-lighting, now has an opportunity for developing a new technique of advertising to replace the present blatantly self-assertive methods.

ACCORDING to a dispatch from the Peking correspondent of the *Times* in the issue for Nov. 4, it has now been established to the satisfaction of the members of the Geological Society of China that Peking man was capable of fashioning and using stone implements with considerable skill. At an early stage in the investigation of the cave of Chou Kou Tien, the discovery of a piece of quartz not of immediately local origin was considered by Dr. Andersson to be evidence of the possibility that the early inhabitants of the cave used stone for implements; but a search prosecuted continuously for four years failed to produce further support of this view. It would appear, however, that artefacts in considerable number have now been found in the cave, as well as evidence of the use of fire. These artefacts have been submitted to a close examination, with the result already mentioned; they have also been accepted by the Abbé Breuil, who is now on a visit to China. He is said to regard them as indicating that life was intelligently organised at the time of Peking man, who must have had a much more primitive predecessor. This can only mean that the implements are relatively advanced in type. This is confirmed by Prof. Elliot Smith's letter to the *Times* for Nov. 5. He says that he is informed that the implements are well-shaped and not unlike the Chellean type of Europe. Prof. Elliot Smith adds that the new discoveries are due to Mr. W. C. Pei, the young Chinese palæontologist to whom we owe the discovery of the skull in December 1929. Further details and a more precise indication of the character of the implements will be awaited with interest. The close associations of a specific type of implement with this early type of man, in conditions which admit of more or less precise geological dating, still further enhances the significance of Peking man.

DR. MARGARET MEAD, of the American Museum of Natural History, sailed in the middle of August from New York for New Guinea, where she will spend two years in ethnographical field work. Dr. Mead is accompanied by her husband, Dr. Reo Fortune, who will investigate the religious and social organisation of certain tribes, on lines parallel to those to be followed by Dr. Mead in her study of the women and children and the attitude of the sexes respectively to certain matters of cultural and biological import. Dr. Mead will also be engaged in the collection of notes and specimens to be used in the preparation of models for installation in the South Sea Hall of the American Museum. These models will be similar to those of the inhabitants of the Admiralty Islands which have been set up as a result of Dr. Mead's recent expedition to Melanesia and are described in *Natural History*, vol. 31, pt. 5. In the same issue, Dr. George C. Vaillant, assistant curator of Mexican archæology, describes four very remarkable and instructive models of temples in Central America which have been presented to the Museum, two through the good offices of the secretary of the Trustees, Mr. Clarence L. Hay, one by the Carnegie Institution of Washington, and one by the Government of Mexico. The temples are representative of the characteristic cultures of Central American archæology, one being a model of Uaxactun E-vii-sub., the oldest Mayan temple yet discovered, the others, models of the Toltec pyramid of the sun of Teotihuacan, the Aztec temple of Teopanzalca, and the Totonac temple of Tajin, Vera Cruz. The advantage of these models in revealing the qualities and beauties of Central American architecture and art to the untrained eye is immediately apparent from an inspection of the photographs with which Dr. Vaillant's article is illustrated.

DR. RICHARD WOLFRAM, of Vienna, gave a lecture, illustrated by lantern-slides, on the sword dances of Austria to the English Folk Dance Society at Cecil Sharp House on Nov. 4. Dr. Wolfram dealt with these dances with special reference to their origin and meaning. As generally understood, the dances are regarded as survivals of a ritual dance, related to the fertility cult, in which is represented the sacrifice of the principal performer. Dr. Wolfram, however, maintains that they are to be attributed rather to the tendency of young men to form secret societies. Hence he relates them to the ceremonial of the secret initiatory rite. In this connexion, he directed attention to the morris dance, which means the dance with blackened faces, the dancers with blackened faces representing the army of the dead, just as the troops of children who beg at festival times are also to be regarded as representing the army of the dead. Dr. Wolfram laid considerable stress on the similarity which he finds underlies the English dances and those found throughout the Germanic peoples.

ONE of the most interesting exhibits at the Faraday Centenary Exhibition at the Albert Hall was a huge new valve manufactured by the Metropolitan-Vickers Electrical Co., Ltd. It stands ten feet high, is fourteen inches in diameter, and weighs more than a ton. Its water-cooled steel anode weighs 3 cwt., and hydraulic jacks are required to facilitate demounting and accurate assembly. Its filament current is approximately 500 amperes, and, according to the *Metropolitan-Vickers Gazette* for November, its filament emission of 160 amperes represents the almost inconceivable electron flow of three hundred thousand billions of electrons per second. It was built for operating the main transmitter at the Rugby G.P.O. radio station, where it will replace a bank of fifty high-power valves. No glass is used in its construction, only steel, copper, and porcelain. The possibility of making such a huge valve was first suggested by the discovery in the research laboratory of the company that oil distillates had remarkable properties. They can be boiled at a fairly high temperature without decomposition, and yet at room temperature their rate of evaporation is so small that they can be placed inside a radio valve without impairing the vacuum. Its low volatility proved that an oil distillate is an ideal liquid to replace the mercury of the vapour pump. Using this liquid, an exceedingly high vacuum is obtained even at the highest power input. In the event of repairs being necessary the valve is completely demountable. Only ordinary engineering tools are used to make repairs. The manufacture of valves of 500 kilowatts, the largest in the world, has now been demonstrated and the possibility of constructing even larger valves has been proved. In fact we may say that the transmission of power on a large scale by radio has been shown to be practicable. These large radio valves mark the beginning of a new era in engineering practice.

IN a leading article in the *Engineer* for Oct. 30 a strong appeal is made for increased support from the shipping and shipbuilding industries for the Froude Laboratory and National Experimental Tank at the National Physical Laboratory, Teddington. The annual cost of the Laboratory and Tank is about £12,000, of which £7000 is earned in fees, while, up to now, the Department of Scientific and Industrial Research has given pound for pound to all sums contributed by the industry for research. With this assistance, the sum required from shipbuilders and shipowners is £2500. In the course of the article, figures are given as to the number of designs submitted and the numbers in which improvements were made. Out of thirty tests made in 1930, no fewer than five brought about an increase in efficiency of 20-30 per cent. Moreover, there are no signs of slackening in the efforts of other nations. Improvements have been made in the tanks at Hamburg, Berlin, and Spezia, while new tanks have been built at Rome, and in Holland and the United States. The new tank in America is 1920 ft. long. It is true that shipping and shipbuilding are both suffering severely from the decrease in the trade of the world, but Great Britain and Northern Ireland still own twenty million tons of shipping, against the four million tons of Germany, and the 9,500,000 tons owned by France, Holland, and Italy collectively. Where so much is at stake it does not seem an unreasonable hope that so small a sum as £2500 will be forthcoming.

THE Lord Mayor's Show is an annual civic event in London of popular interest. This year it had an added interest in that, at the request of the new Lord Mayor, Sir Maurice Jenks, the pageant illustrated the progress of industry aided by science. The leading car was from the National Institute of Industrial Psychology and bore at its foot a large oil-can, "Industrial Psychology oils the wheels of Industry". Then came three cars illustrating the radio industry and showing a modern 'radio' home, the earth girdled by radio, and a symbolic tableau including the arms of the Radio Manufacturers' Association. The cinematograph industry was represented by cars portraying by tableaux the sciences which have contributed to its development, early apparatus, a modern film studio, and modern picture and sound production. The transport industry was illustrated by early and modern forms of bicycle and motor-car, including *Bluebird*, the motor-car in which Sir Malcolm Campbell made the land speed record, and *Miss England II.*, the motor-boat in which Mr. Kaye Don made the present water speed record. The Gas Light and Coke Company had cars showing the scientific application of gas in industry and in the home; one car carried a gas-heated annealing furnace in operation. The British Electrical Development Association, Inc., was mainly responsible for a car representing symbolically light, heat, and power, the three principal applications of electrical energy. Modern electrical communications were represented on a car by Imperial and International Communications, Ltd., designed to demonstrate the cable and wireless links maintained by this company, which owns more than half the world's submarine cables and a widespread system of wireless services. The Lord Mayor's Show this year was a useful piece of propaganda on behalf of science in industry.

IN a pamphlet entitled "The Social Function of Science", Prof. C. H. Desch directs attention to the need for greater effort to make the influence of science felt in the world of citizenship and to bring home to the public the value of the services which science, rightly interpreted, can render to the community. The continuous subdivision of science both in research and in teaching not only results in excessive specialisation, but also widens the gap between the physical and the biological sciences. Prof. Desch, asserting the importance of developing real social sciences, points out that the evolution of these sciences will assist in a synthesis or union of the sciences which will remove the isolation of the specialist in different fields and promote contact with life. As illustrating the need for science in national life, Prof. Desch refers to the growing recognition of social well-being as the true object of industry and the need for scientific minds, free from party prejudices, to bring into the political field the ideas of international co-operation which in industry and economics have already made rapid progress where scientific principles have control. Similarly, scientific methods of thought might well be applied to questions of finance, particularly to distinguishing between positive and negative values in regard to wealth, etc., and there is still great disproportion in Great Britain between the control of industry exercised by technical as compared with purely financial or commercial interests. Scientific men cannot disclaim responsibility for the purposes to which the knowledge they acquire is applied, and the application of scientific method to the study of social facts is urgently needed if society is to be preserved from anarchy. The problem is chiefly a matter of education and of research. Scientific workers are called upon to co-operate in an attempt to interpret to

(*Continued on p.* 833.)

Supplement to NATURE

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Beyond the Milky Way.*

By Sir JAMES JEANS, F.R.S.

OUR earth is one of a system of nine planets which, with millions of smaller bodies—asteroids, comets, and meteors—circle round the sun; our sun is one of a system of millions of stars which circle about one another; this star-system is one of millions of star-systems—and here, so far as we know, the sequence ends abruptly. These star-systems are the biggest objects known to science; there is nothing beyond them except the great universe itself. They form the largest subdivision of the universe, and it is from this circumstance that they derive their special importance to science.

THE GALACTIC SYSTEM.

Our own special system of stars—the system of which our sun is a member—is called the galactic system, because it is bounded by the Milky Way. In shape it is known to be somewhat like a disc or a coin or a cart-wheel. Perhaps the last of these three comparisons is the best, because it has recently been found that the whole system is rotating. Early investigators, Sir William Herschel in particular, believed, for inadequate reasons, that the hub of this wheel must be somewhere near the sun; we now know that it is so remote that even the brightest stars near the hub are invisible to our unaided eyes. Indeed, we can see no stars which are more than about 3000 light-years away, while the hub of this great wheel of stars is probably something like 40,000 light-years away. We still do not know the size of the wheel with any approach to accuracy, but its diameter is probably of the order of 200,000 light-years.

This great wheel is held together by the gravitational attractions of the different stars of which it is composed. As a consequence the outermost stars move most slowly and take the most time to perform a complete revolution, just as in the solar system the outermost planets move most slowly and take longest to describe their orbits round the sun. The sun probably moves round the hub at about 200 miles per second, and requires something over 200 million years to perform a complete revolution.

We can estimate the mass of the wheel by calculating the gravitational pull it exerts on the sun to keep this from flying off into space. It is found that this mass is certainly more than that of 100,000 million suns, and may quite possibly be twice, or even four times, this. Probably the greater part of it represents matter in the form of stars. If so, as the average star has less mass than the sun, the galactic system must contain well over 100,000 million stars. Actual star-counts confirm this estimate.

EXTRA-GALACTIC SYSTEMS.

In the early days of astronomy the galactic system was assumed to be the only system of stars in the sky. Then it began to be conjectured by Kant and Herschel that it was only one of innumerable systems. Recent research has confirmed this conjecture very fully. If you look to the north of the star Beta in the constellation of Andromeda you will, if your eyesight is good, see a faint, hazy patch—the Great Nebula in Andromeda. It looks at first like diffused starlight—as though a bit of the Milky Way had broken loose and wandered off to the south. The astronomer Marius described it as looking like candle-light seen through a horn. When this vague patch of light is viewed through a powerful telescope a certain amount of detail begins to appear. But to study it properly we must photograph it, with an exposure of many hours. We then find that the nebula is far larger than it appears either to the unaided eye or on looking at it through a telescope; roughly speaking, it covers twenty times as much sky as the full moon. The part we can see with the unaided eye is only a small central region—a comparatively bright fuzzy mass. Coiled round this is a detailed structure which lies completely hidden until it is brought to light by a long exposure photograph (see Fig. 1). Just as, in 1609, Galileo's tiny telescope broke up the Milky Way into separate points of light which he at once identified as stars, so modern high-power telescopes break up the outermost regions of this nebula into separate points of light, which we can identify as stars (see Fig. 2). We may be sure they are stars, because many of them show the same peculiarities and characteristics as the stars of our own system; among them we recognise variable stars of regular Cepheid type, irregular variables, helium stars, and novæ. Many of these special types of stars are so peculiar, so uniform in their behaviour, and so similar to one another, that we can estimate the distance of the nebula from the apparent faintness of the examples we find in the nebula. According to Dr. Hubble's most recent estimate, its distance is such that its light takes just over 800,000 years to reach us.

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* Evening discourse delivered before members of the British Association in the Central Hall, Westminster, on Sept. 29.

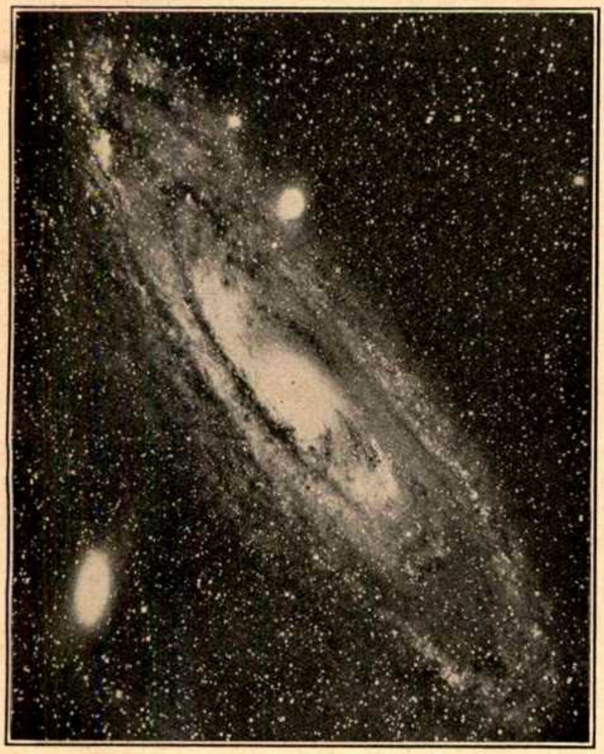


FIG. 1.—The Great Nebula (M 31) in Andromeda.

We can no longer doubt that, in its outer parts at least, this great nebula is a system of stars essentially similar to our own galactic system. We recognise the cart-wheel shape at once, the brighter fuzzy centre, the only part we can see without high telescopic power, forming the hub. The spectroscope shows that this cart-wheel too is in rotation—again like our galactic system. But it is spinning much faster; while our system requires about 200 million years for a complete revolution, this nebula gets round once every 17 million years or so. Its greater agility is due in part to its smaller size; it has only about a quarter of the diameter of the galactic system—50,000 light-years as against perhaps 200,000 light-years.

Again, this structure can be weighed by calculating the force which the system as a whole must exert on its outermost members to restrain them from running off at a tangent into space. We find that the weight of the whole nebula is quite small compared with that of our galactic system—about 5,000 million suns, as against perhaps 200,000 million suns for the galaxy.

These two cart-wheels are not the only such systems in the sky; millions of others can be observed. They are the objects we commonly describe as extra-galactic nebulæ.

A random collection of such nebulæ may seem at first to exhibit a bewildering variety of size, shape, brightness, and constitution, but a scientific study soon reduces them to law and order. Size and brightness are found to go together, and variations in both originate mainly in differences of distance. The nebula which appears small also appears faint, and does both merely because it is far away. If we could put all the extra-galactic nebulæ in a row at the same distance from us we should see that they were all of about the same size and the same brightness. Here and there in the sky Nature performs this experiment for us. An example is shown in the upper half of Fig. 3, where we find a cluster of nebulæ which we believe to be physically related, because they all show approximately the same motion in space, like a flock of birds. The members of such a flock are presumably all at about the same distance, and it is significant that they all appear to be of about the

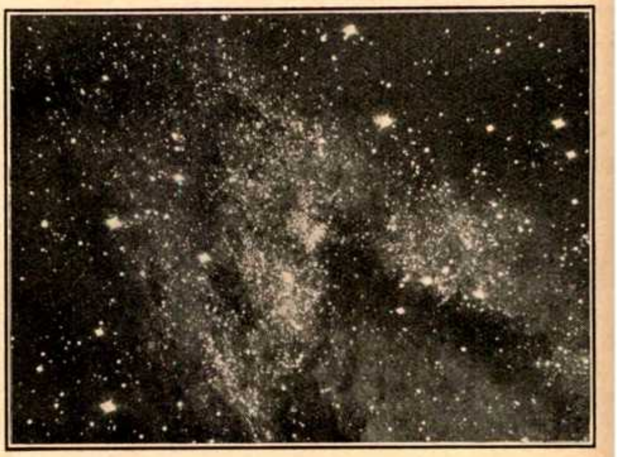
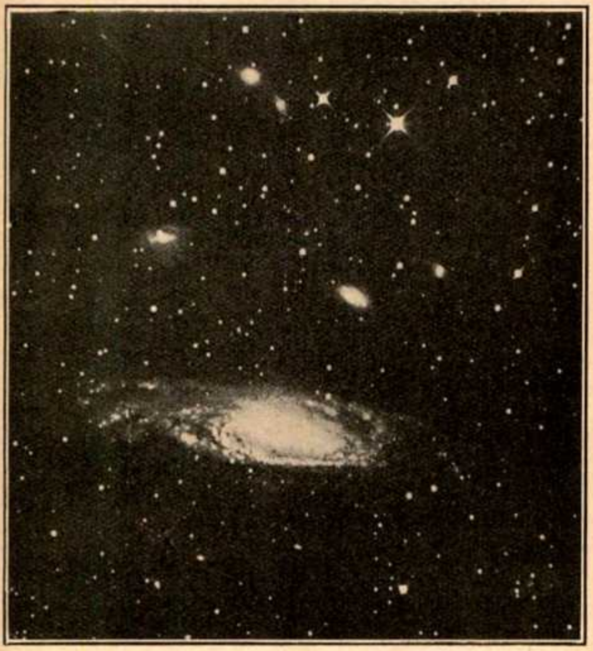


FIG. 2.—A small part (left-hand top corner) of the Great Nebula (M 31) in Andromeda, showing separate stars.

same size and brightness. The nebula in the lower half looks ten times as big because it is about ten times as near. The nebulæ still appear to be of very different shapes, but this is partly because they are differently oriented with respect to ourselves; we see them along different lines of sight.

We can avoid all complications caused by the different orientations of the nebulæ by the very simple device of rejecting all those which are not seen edge on, and confining our attention to those that are. We can do this quite recklessly, as some two million nebulæ can be seen in all.

In this way we can eliminate all the purely geometrical effects arising from differences of distance and of orientation, and are left with real physical differences of shape and constitution. We find that by far the greater number of our edge-on nebulæ can be arranged in a single continuous sequence (cf. Fig. 4); it is in brief a sequence which begins with spheres and ends with flat discs, although other features besides shape change as we move along it. The nebulæ at one end of the sequence consist solely of round fuzzy masses, and even the most powerful telescope shows no stars in these. About half-way along the sequence stars first begin to appear—in the outer edges of the nebulæ. Then, further along, come nebulæ similar to the Great Nebula in Andromeda, which consist of a comparatively small central fuzzy mass, surrounded by vast crowds of stars. At the extreme end of the sequence we have pure clouds of stars such as our own system. The comparison of the cart-wheel remains quite a good one throughout the second half of the sequence, because the nebulæ here generally have a thick central projection, the hub of the wheel, while the rest of their structure is flat.



Mt. Wilson Observatory.

FIG. 3.—Cluster of nebulæ in Pegasus and the nebula N.G.C. 7331, which looks ten times larger, because it is about ten times nearer.

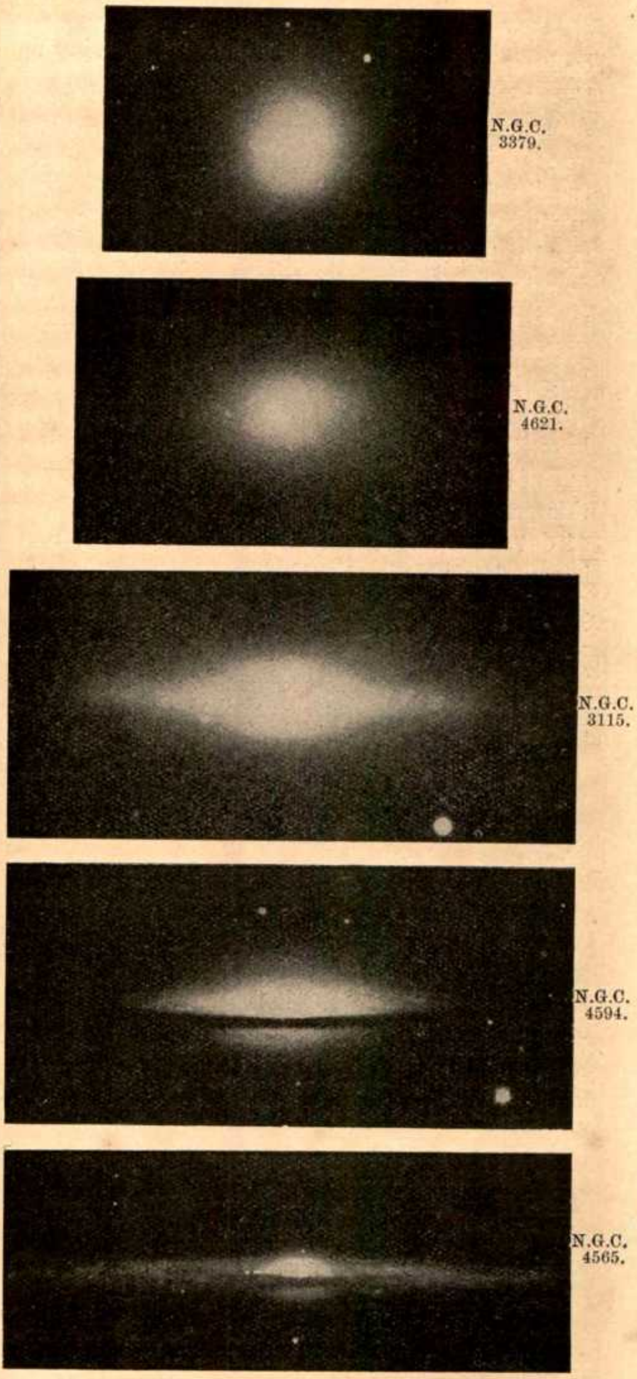


FIG. 4.—A sequence of nebular configurations providing a sort of cinematograph film of the birth of stars.
From "The Universe Around Us", by courtesy of the University Press, Cambridge.

In brief, our sequence is one of nebulæ arranged in order of flatness, and this suggests a simple theoretical interpretation of the sequence.

We know how increasing the speed of rotation of a body results in a flattening of its shape. The ordinary Watt governor provides an obvious instance—as the engine runs faster it flattens out. Astronomy provides innumerable instances of the same effect. The sun rotating only once every twenty-six days is an almost perfect sphere. The earth, rotating more rapidly, although still very slowly, is slightly flattened, so that we usually describe it as orange-shaped. Jupiter rotates still more rapidly—once every ten hours—and is much flatter in shape. It is natural, then, to try to interpret our sequence of nebulæ as one of bodies which are rotating at different speeds. As we know that the speed of rotation of a body increases as it shrinks, it seems likely that we may interpret this sequence of nebulæ as one of different stages of development or evolution. If this conjecture is sound, a nebula starting with little rotation at first and shrinking in size would gradually increase its speed of rotation as it shrank, *and would move steadily along the sequence as it did so.*

The way to test this conjecture is to calculate for ourselves how a mass of rotating gas would change in shape as it condensed and shrank. Although the mathematical analysis is not simple, and cannot be very precise, it is, I think, fairly conclusive; we find that the evolution of a mass of rotating and shrinking gas would be represented almost exactly by passage along the sequence.

THE BREAKING-UP OF THE UNIVERSE.

Let us look at the problem in its broadest aspects. Mathematical cosmogony suggests that the shapes of astronomical bodies are moulded by three main agencies, in addition, of course, to the universal and all-pervading forces of gravitation. These three are (1) rotation, (2) tidal action, (3) gravitational instability. The general effect of all three is to break up large bodies into smaller, so that the universe tends to evolve from a few large bodies to many small ones.

Let us consider these three agencies in turn, beginning with rotation. The simplest example of its action is to be found in the formation of binary stars. As a rotating star shrinks, its rotational momentum must remain always the same throughout its continual diminution of size, so that the star finds it necessary to push ever more and more of its mass out, away from its axis of rotation. First it flattens itself and so pushes its equatorial regions away from its axis. With further shrinkage this expedient becomes inadequate, and the mass stretches itself out into a torpedo-shaped body, spinning about its shortest diameter, the ends of this torpedo being, of course, farther from the centre than if it had retained its symmetrically flattened form. When this expedient also fails, the torpedo develops a sort of waist round its middle, in this way pushing even more of its substance to its own ends; this waist gets thinner and thinner until finally it fades into nothingness, and we are left with two detached bodies revolving about one another—the normal binary star. Rotation has broken one star into two (see Fig. 5*a*).

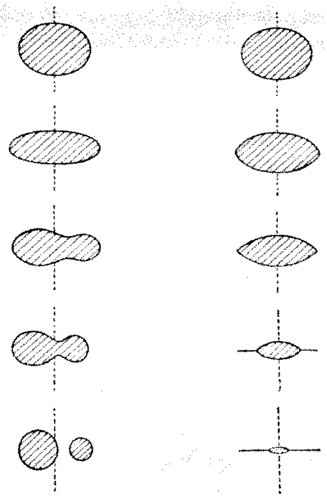

(*a*) liquid (*b*) gas

FIG. 5.—Sequence of configurations of rotating masses of liquid and gas.

From " The Universe Around Us ", by courtesy of the University Press, Cambridge.

Mathematical theory shows, however, that a purely gaseous mass could not break up in this way; the process we have described only occurs in bodies whose central regions are less compressible than a gas. When a purely gaseous body shrinks, and so increases its speed of rotation, the first result is again for it to become flatter in shape. But it never assumes the elongated torpedo-shape; its equator merely spreads out more and more until finally it becomes a sharp edge. The mass of gas has now assumed the shape of a double-convex lens. After this stage has been reached the mass cannot adjust itself to further shrinkage by a mere change of shape. It is like a fly-wheel which is rotating too fast for safety. With any further increase of speed the fly-wheel bursts, and, in the same way, the rotating mass of gas scatters matter out from its equator into its equatorial plane. This is precisely what we see in our sequence of nebulæ (compare Figs. 4 and 5*b*), and it suggests that, up to this point of their evolution at least, the nebulæ are rotating masses of gas.

The second of our three principal agencies is tidal action. Just as the sun and moon raise tides in our oceans, so any two astronomical bodies which come sufficiently near to one another raise substantial tides on one another's surfaces. We have seen how the earth's orange-shaped flattening, due to its rotation, is only the first link in a long and varied chain of configurations. So with tidal action—the feeble tides which the sun and moon raise in our oceans are only the first link in an equally long and varied chain of phenomena. As the tidal forces become more intense, simple tidal waves give place to huge excrescences of matter, and finally to terrific distortions of figure, which may end in the body being torn into two or more pieces by the tidal pull of its near neighbour.

Surrounding every massive body there is a danger-zone whose radius can be calculated. Any smaller body enters this danger-zone at the peril of its life, for there are large chances that it will be torn to pieces, and these chances become a certainty if it stays inside the danger-zone long enough. The simplest instance of the result of such action is probably to be found in the earth-moon system. Although this is far from certain, it is likely that the earth and moon originally formed a single body which was torn into two as a result of the tidal action of a larger body, probably the sun. A more striking instance is provided by Saturn's rings. These are known to consist of myriads of infinitesimal moons, each describing an orbit round Saturn at the speed appropriate to its distance. They are believed to be the broken fragments of a single moon which fell within the danger-zone surrounding Saturn and stayed there. The tidal forces of Saturn would continue to break up the unfortunate moon until each individual piece was small enough to resist their disruptive tendency—for the cohesive attraction varies as the square of the linear dimensions, while the disruptive tendency of tidal action varies as the fourth power. The asteroids—the swarm of tiny planets which circle round the sun between the orbits of Mars and Jupiter—may owe their existence to a similar occurrence. We have further instances of the same effect in the few observed cases in which comets have been broken into several pieces, or into swarms of meteors, by the tidal pulls of the sun or Jupiter.

The more weakly a body is held together, the more feeble the tidal forces which are needed to tear it asunder. Now by the time that a rotating mass of gas has reached the critical shape of a lens with a sharp edge, the matter of its equator is so weakly held that any tidal pull, no matter how feeble, will suffice to break it up. The equator of the nebula is in the state of a fly-wheel which is just about to burst; it will break first at its weakest point. The tidal action of distant bodies will raise tides on the equator of the rotating nebula, and the point at which these tides are highest will be the weakest point, since the gravitational hold of the nebula is feeblest there. Generally there will be two points of high tide antipodally opposite to one another, and when the nebula breaks up it will be through matter streaming away from these; thus we ought to see a lens-shaped mass with matter streaming out of two antipodal points of its equator. This is exactly what we do see when we view nebulæ full on, although our sequence of nebula (Fig. 4) naturally could not show it, because we saw them edge-on. Whenever, as for instance in Fig. 1, we can study the ejected matter in detail, it shows a marked tendency to form two symmetrical streams.

The third agency, gravitational instability, is the instability which must necessarily affect a mass of gas spread uniformly and acted on only by the mutual gravitational attractions of its molecules. The theory of its action is very simple. We know that every system tends to pass to a configuration of stable equilibrium in which its potential energy is a minimum. Now when a gas is spread uniformly through space, its gravitational potential energy is not a minimum but a maximum; it can fall to innumerable other states, all of which will have lower total energy. The process of so falling consists physically in the gas forming condensations and aggregating about these.

Mathematical theory not only shows that this process must occur; it also provides a formula giving the mass of each aggregate. Thus it is easy to test whether any group of bodies was formed by gravitational instability or not; we need only calculate the masses predicted by theory, and compare them with the observed masses of the actual bodies. Perhaps the planets of the solar system provide the simplest example of bodies formed by gravitational instability. It seems probable that a passing star pulled out a long filament of matter from the sun by its tidal action, and that gravitational instability then moulded the matter of this filament into the present planets. To test the conjecture, we calculate the masses of bodies which would be formed in this way; we find that they agree closely enough with the actual masses of the planets.

Still another example of the action of gravitational instability can be seen in the nebulæ we have been discussing. When a rotating nebula throws off streams of matter from its equator, this matter will at first be uniformly spread in filaments lying in the equatorial plane. These are not in stable equilibrium ; they can lessen their potential energy by forming into condensations, and accordingly do so. These are the condensations which we see gradually forming in the nebulæ as we pass along the sequence, and which we believe to be stars in the making. Again we can test our conjecture by calculating the masses of the condensations as predicted by theory; again we find that these agree well enough with the observed masses of actual stars.

We may, then, be fairly confident that this is the way the stars come into being ; the sequence of nebular configurations shown in Fig. 4 is, in effect, a sort of cinematograph film of the birth of the stars. We see rotation resulting first in a flattening of figure and then in a break-up of the nebula, tidal action determining the mode and place of this break-up, and finally gravitational instability carving up the ejected matter into stars. We notice that all the three principal cosmogonic agencies are called into play to bring the stars into being.

It cannot be claimed that this is the whole story of the evolution of the spiral nebulæ, since the spiral arms spread farther into space than can be accounted for by the centrifugal effects of rotation alone. There must be other factors at work, and these we do not yet understand ; the formation of the spiral arms remains a mystery. Possibly the theory of relativity may provide an explanation in time, but it has not done so yet.

Nevertheless, the agreement between theory and observation is good enough for us to feel on fairly safe ground in tracing the evolution of the universe back from stars to nebulæ. But how did the nebulæ themselves come into being ? The conjecture which at once comes to the mind is that the nebulæ may have been formed by the same process as the stars ; just as the stars came into being as condensations in a tenuous uniformly spread gas —the outer fringes of the nebulæ—so the nebulæ may themselves have previously come into being as condensations in an earlier mass of uniformly spread tenuous gas, the agency this time being gravitational instability acting alone. This can never be more than a conjecture, but, as we shall now see, there are strong arguments in its favour.

We have already seen how differences in size and brightness between nebulæ of the same shape are almost entirely due to a distance effect. In other words, the faintness of a nebula gives us a measure of its distance. This and other methods of a somewhat similar kind make it possible to estimate the distances of all nebulæ, even the very faintest, with fair accuracy. The faintest which can be observed photographically in the 100-inch telescope prove to be at the amazing distance of about 140,000,000 light-years. Dr. Hubble finds that the two million nebulæ which lie within this distance are fairly uniformly spaced at about 1,800,000 light-years apart. We can construct a model by taking apples and spacing them at about 10 yards apart until we have filled a sphere a mile in diameter. This will use about 300 tons of apples. This sphere is the fragment of space we can see in the 100-inch telescope ; each apple is a nebula containing matter enough for the creation of several thousand million stars like our sun ; each atom in each apple is as big as Betelgeux, with a diameter slightly larger than that of the earth's orbit.

The circumstance that the nebulæ are found to be fairly uniformly distributed through space gives a certain *a priori* plausibility to the conjecture that they may have originated from a primeval gas spread uniformly through space. But the real argument in its favour is that once again we can calculate the masses of the condensations that would form under the influence of gravitational instability, and once again we find that each condensation would have something like the same mass as the observed nebulæ. Or, to put the same thing in another way, the conjectured primeval gas would break up into condensations at distances apart comparable with the 1,800,000 light-years which Dr. Hubble finds for the average distances of the actual nebulæ. Thus although, from the nature of things, we can never know the truth for certain, there are good reasons for conjecturing that the nebulæ came into existence as condensations formed by a primeval gas which was spread uniformly, or at least with some approach to uniformity, throughout space.

Cosmogony presents us with a picture of the evolution of the universe—a cinematograph film—in which big bodies continually break into smaller ; the film shows the one for ever changing into the many. We see, conjecturally at least, one primeval gas producing millions of nebulæ, each nebula then producing millions of stars, many of these stars breaking up into binary or multiple systems, or perchance changing into a solar system and producing millions of planets, comets, and meteors. Even this is not the end of the story, for planets may break up and form satellites, satellites may break up and form rings of tiny moons, such as we see surrounding Saturn. The debris of all this breakage may form comets, and these may in turn break up into showers of meteors—tiny objects often no larger than a pea which we describe as 'shooting-stars' when they hurl themselves to death in our atmosphere and suffer still further break-up into their constituent atoms.

THE SCATTERING OF THE UNIVERSE.

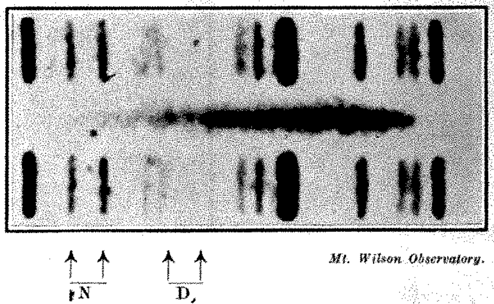
It might be thought that after all this breakage had occurred, the attractive forces of gravitation would tend to drag the broken fragments together again. The exact reverse appears to be the case. Not only is the substance of the universe for ever being broken into smaller pieces, but these pieces for ever tend to scatter farther and farther apart.

To take the example nearest home, the earth is for ever driving the moon farther away, through the agency known as tidal friction. When we watch the waves of the sea breaking against a sea-beach or a headland, we may reflect that their impact is not only slowing down the earth's rotation and so lengthening the day—it is also lengthening the month by driving the moon farther away from the earth. Incidentally it is also, through the solar tides, driving the earth farther from the sun, and so lengthening the year as well.

Again, every ray of sunlight that enters our eye carries mass with it; eight minutes previously this mass was part of the mass of the sun. Every second the sun loses more than four million tons of mass, in the form of sunlight and sun-heat. As the result of this continual loss of mass, the sun's gravitational hold on its family of planets for ever weakens and these are driven farther off into space. The earth's orbit round the sun is not so much like a circle as like a coiled watch-spring—a spiral path for ever receding into the cold and dark of space.

The same tendency affects the galactic system as a whole. The stars of which it is formed continually scatter their mass broadcast in the form of radiation. As they do so, their gravitational hold on one another weakens, so that the whole galactic system for ever expands. It must be the same with the other star systems in space. Throughout the universe, all the smaller broken pieces, satellites, planets, stars, are scattering away from one another in apparent opposition to the laws of gravitation.

Still more surprising and sensational is the recent discovery that the largest pieces of the universe—the great extra-galactic nebulæ we have been discussing—are to all appearances engaged in a similar scattering. When proper allowance is made for the rotation of our own system of stars, all, or nearly all, the nebulæ appear to be receding from it, the nearer nebulæ with small speeds, and the more remote nebulæ with greater speeds; in general speed is approximately proportional to distance. This simple law seems to hold to the very farthest of the nebulæ—Hubble finds that for every million light-years of distance there is a speed of recession of about 105 miles a second. The last nebula to be investigated at Mount Wilson shows a speed of recession of 12,300 miles a second (see Fig. 6); its distance, as estimated from its faintness, being about 105 million light-years. On the face of it, this looks as though the whole universe were uniformly expanding, like the surface of a balloon while it is being inflated, with a speed such that it doubles its size every 1400 million years.



Mt. Wilson Observatory.

FIG. 6.—Spectrum of the brightest nebula in the Leo Cluster.

At the top and bottom are the spectrum of an ordinary star. The pair of lines N are the *H* and *K* lines of calcium in their normal position. The middle spectrum is that of the nebula. The pair of lines D are the *H* and *K* lines of calcium displaced to the red by a fifteenth of their wave-length, this corresponding to a speed of more than 12,000 miles a second.

One of the great puzzles of astronomy at the present moment is whether these apparent motions of recession are real or not. The only evidence for them is that the nebular spectra show displacements to the red, which, interpreted in the most obvious way as Doppler effects, give the speeds already mentioned. Yet every spectroscopist knows that many factors besides motions of recession may redden light.

There is one strong theoretical argument in favour of regarding the apparent speeds as real. Einstein's original cosmology supposed the universe to be as full of matter as a universe of its size could possibly be without violating the theory of relativity. Recently, Lemaître of Louvain has shown that a universe of this type would not be static—there would be an unstable quality about it. The condensation of the primeval gas into distinct nebulæ, and the imprisonment of a large part of its free energy in these nebulæ, would cause the whole universe to start expanding, in which case it would continue to expand, its radius finally increasing exponentially with the time, until it ended up as an empty universe—finite matter spread through infinite space. Throughout the motion the relative speed of recession of any two nebulæ would be exactly proportional to their distance apart, so that, at first glance at least, this theory seems exactly to fit the observed facts. It not only provides a suggestion as to why the nebulæ may be receding; it goes much farther and predicts that they must be receding. If Einstein's relativity cosmology is sound, the nebulæ have no alternative—the properties of the space in which they exist compel them to scatter.

Yet the very magnitude of the apparent speeds casts doubt on their reality; they would reduce the whole existence of the universe to a mere flash—at any rate in comparison with what we have recently believed. If they are real, Eddington has calculated that the universe must have started from a radius of about 1200 million light-years, and that its total mass must be about $2{\cdot}3 \times 10^{55}$ gm., which is the mass of $1{\cdot}4 \times 10^{79}$ protons and an equal number of electrons. This amount of matter, spread throughout the initial universe of 1200 million light-years' radius, would give a mean density of $1{\cdot}4 \times 10^{-27}$ gm. per c.c. So far as we can tell from the masses of the extra-galactic nebulæ, the present average density of matter in space appears to be not less than 10^{-30} gm. per c.c., which, with the same amount of matter, would assign a radius of 13,200 million light-years to the universe—only eleven times its initial value. If, then, the motions are real, the universe is only at the beginning of its career; it cannot have doubled many times since it started. As it appears at present to be doubling in size every 1400 million years, the few doublings which these figures permit cannot have occupied more than 10,000 million years at most.

General calculations on the ages of astronomical bodies point to far longer periods of time. Both single stars and binary systems show an approximation to equipartition of energy which must have taken far longer than this for its establishment. If we concede that the universe has expanded to many times its original size, so that the stars were initially far more closely packed than now, the figure originally calculated of a few millions of millions of years may have to be reduced by a good deal, but not, I fear, by enough to remove the conflict of evidence.

In any event a piece of evidence remains which cannot be dismissed in this way. Spectroscopic binaries consist of pairs of stars revolving round one another. Observation reveals a complete sequence; it begins with systems which appear to have just broken into two as the result of rotation—pairs of stars describing circular orbits, and almost in contact—and ends with systems in which the two stars are far apart and describing elliptical orbits. Observation also shows that the stars at the beginning of the sequence are many times more massive than those at the end. It seems likely that those which are now at the end must have begun at the beginning, and lost the greater part of their mass in the form of radiation. To do this would take millions of millions of years, quite regardless of whether the universe was expanding or of what it was doing.

Considerations such as these make it very difficult to believe that the universe can be such an ephemeral concern as the apparent speeds of recession of the nebulæ would suggest.

There is, however, every reason to hope that within a very short time we shall know the truth about this puzzle, and, whatever the solution may be, there seems to be a considerable chance that it may provide us with a clue, perhaps even with a key, to the structure of the universe as a whole. Such a clue—and still more, such a key—would be of the utmost value. Until quite recently the man of science, like most men, accepted the fundamental ingredients of our experience—space, time, matter, and energy—more or less at their face value. The most obvious and superficial interpretation suggested by everyday experience was assumed to correspond fairly closely to ultimate reality. The theory of relativity has shown that we were utterly wrong about space and time, and we are beginning to suspect that we are still just about as far wrong about matter and energy. The concept of an expanding universe may prove after all to be a false scent, and the truth may lie in some other direction, but in either event the observed phenomena must mean something, and their true interpretation, when it is found, may carry us a step on towards the solution of the greatest mysteries of the external world—the nature of space, time, matter, and energy, and of the combination of all these which constitute the physical universe.

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the public the results of science in civic as well as in industrial life, and to extend the task of co-ordination so as to assist the growth of co-operation and the emancipation of industry and society from false values and mechanisation of life.

SCIENTIFIC information is disseminated in Germany in several ways. There is the scientific news service "Pallas", edited by Dr. Paul Neuburger, Berlin-Zehlendorf, Cecilienstr. 10. This distributes in very clearly printed typescript a foolscap sheet appearing about every other day. The paragraphs are of general interest and seem suited for immediate use in the daily press of German-speaking countries. The Reichszentrale für wissenschaftliche Berichterstattung Pressestelle, Berlin, N.W.7, Unter den Linden, 38, is another information bureau issuing scientific news. Its items seem suited for immediate use in scientific, technical, and educational journals, and by translation without further condensation they might be utilised in English journals. A good deal of the material is taken from *Forschungen und Fortschritte*, a journal of research and scientific progress appearing three times a month in some twelve pages under the editorship of Dr. E. Kiessling, Berlin, N.W.7, Unter den Linden 38. There are two editions, *Korrespondenzblatt*, printed on one side only of the paper, for 5 marks quarterly, and *Nachrichtenblatt*, printed on both sides, for 3 marks quarterly. The reprinting of signed articles is only permitted with acknowledgment of the source. This journal is written for more scientific and academic readers. The separate authors are specialists intimately concerned with the researches they describe. Special paragraphs are devoted to a diary of coming congresses and reports of international scientific organisations. *Die Naturwissenschaften*, edited by Dr. Arnold Berliner, and published by Verlag Julius Springer, Berlin, W.9, Linkstrasse 23-24, is a weekly journal of science. It is now in its eighteenth year and is the official organ of the German Association of Men of Science and Physicians. *Die Naturwissenschaften* may be particularly commended to those who are trying to acquire some general familiarity with scientific German in various fields. The editor is to be congratulated on having kept this journal alive during the difficulties of the past few years.

SIR ALEXANDER RODGER, chairman of the Department of Forestry, Section K (Botany) of the British Association, gave a short review, on Sept. 25, of the inception and development of forestry in the Empire during the last hundred years. Sir Alexander said that although forestry has, in some European countries, been long regarded as an important part of scientific knowledge, the 'forest sense' and the importance of forestry have only recently begun to come to the fore in Great Britain. With few exceptions, forestry was little understood throughout the Empire before the beginning of the present century. Sir Alexander quoted extracts from various recent forest reports, which showed that, until comparatively recently, the neglect and failure to apply the most elementary principles of forest management have led to direful results. The last twenty to thirty years have seen a realisation of the immense value of the forests of the Empire, depleted as many of them are. Since 1900, and even more since the War, the value of the forests has been continually impressed upon governments by imperial and other conferences. Technical instruction has of recent years made great strides, especially in Great Britain, where forest officers are trained for many parts of the Empire, and forest research in India, Canada, Australia, and Great Britain has attained an importance never before recognised for it. The skilled use of exotics also has turned out to be of the greatest importance in Australia, New Zealand, India, and elsewhere.

IN his Cantor Lectures at the Royal Society of Arts on "Some Recent Developments in Microscopy", Prof. L. C. Martin reviews a number of developments in microscopy, especially those respecting which not much has yet been published, such as ultra-microscopy, the theory of dark-ground illumination and resolving power with it, Gerhardt's interference method, and ultra-violet microscopy (*Jour. Roy. Soc. Arts*, Aug. 21 and 28, 1931, pp. 871 and 887). For the quartz homogeneous system employed for ultra-violet microscopy, it is necessary to use an immersion fluid of refractive index of 1·4961, and a solution of glycerin and water is employed. This mixture is, however, hygroscopic except in the driest atmosphere, and absorption of water vapour alters the refractive index. To obviate this, as cane-sugar solution is also transparent to ultra-violet light, it is suggested that a mixture of the glycerin and cane-sugar solutions of the proper refractive index may be made in such proportions that it neither absorbs water nor evaporates, but remains constant. The proportions would have to be adjusted for varying degrees of atmospheric humidity.

THE new Ramsay Memorial Laboratory of Chemical Engineering at University College, University of London, is to be opened on Nov. 26 by H.R.H. Prince George. The Laboratory is designed to provide a post-graduate training in the principles underlying the design, fabrication, and operation of all kinds of chemical plant. Special features of the building are a large industrial laboratory in which semi-large scale plant can be erected and tested, a well-equipped workshop in which plant units may be fabricated or repaired, a drawing office, and a general experimental laboratory. Special laboratories are devoted to the study of fluid flow, heat transfer, and the examination of fuels. Provision is also made for the original investigation of chemical engineering problems, either on a small or semi-large scale. The building is designed to accommodate fifty post-graduate students. Its erection and equipment have been made possible by the generous contributions of a number of firms of chemical manufacturers and chemical plant manufacturers.

THE new laboratory for physical chemistry in the University of Freiburg im Breisgau was opened on Oct. 30. At the same time honorary degrees were conferred on Lord Rutherford, Prof. Siegbahn, and Prof. Goldschmidt. The old laboratory was one of the first institutes for physical chemistry erected in Germany. The new laboratories are especially well equipped with apparatus for carrying out chemical analysis by X-rays, and extensive facilities are available for investigating the composition of minerals and alloys by chemical, radioactive, and spectroscopical methods. A large section of the laboratories is devoted to the study of diffusion phenomena, especially in alloys.

TEN years ago, on March 29, 1921, John Burroughs died. His writings, full of close observation of wild life, expressed with studied simplicity, have done much to encourage an interest in Nature in America and beyond. The John Burroughs Memorial Association has commemorated the tenth anniversary by the publication of "The Slabsides Book of John Burroughs", and one of the chapters appears in *Natural History* (New York, Sept.–Oct. 1931). It contains personal recollections of the poet-naturalist and of his life at his mountain retreat, the rustic cabin of Slabsides, near Riverby, by Clyde Fisher, whose friendship with Burroughs extended through many years. The article brings out very simply the ideas which governed the poet's life and writings, and the author's photographs add to the intimacy of his theme.

AT a meeting of the Royal Microscopical Society held on Oct. 21, Prof. K. Fujii of Tokyo, Prof. Victor Grégoire of Louvain, and Prof. O. Rosenberg of Stockholm were elected honorary fellows of the Society.

THE Streatfeild Memorial Lecture will be delivered at the Institute of Chemistry on Nov. 20, at eight o'clock, by Dr. J. V. Eyre, who will take as his subject "Recent Advances in the Fermentation Industries".

THE American Association for the Advancement of Science will hold its eighty-ninth meeting at New Orleans on Dec. 28, 1931–Jan. 2, 1932, under the presidency of Prof. Franz Boas, professor of anthropology, Columbia University.

AT the anniversary meeting of the Mineralogical Society, held on Nov. 3, the following officers were elected: *President*, Sir John S. Flett; *Vice-Presidents*, Dr. G. F. Herbert Smith, Prof. C. Gilbert Cullis; *Treasurer*, Mr. F. N. Ashcroft; *General Secretary*, Mr. W. Campbell Smith; *Foreign Secretary*, Prof. A. Hutchinson; *Editor of the Journal*, Dr. L. J. Spencer.

THE following officers have been elected for the Cambridge Philosophical Society for the year 1931–32: *President*, Prof. A. Hutchinson; *Vice-Presidents*, Mr. G. Udny Yule, Dr. W. H. Mills, Mr. F. T. Brookes; *Treasurer*, Mr. F. A. Potts; *Secretaries*, Mr. F. P. White, Dr. J. D. Cockcroft, Dr. H. Hamshaw Thomas; *New Members of the Council*, Dr. R. H. Rastall, Mr. C. F. A. Pantin, Mr. N. F. Mott.

THE following appointments have recently been made by the Secretary of State for the Colonies: Mr. C. E. J. Biggs, agricultural officer, Uganda, to be senior agricultural officer, Uganda; Mr. W. J. Badcock, to be agricultural officer, Uganda; Mr. G. D. P. Olds, to be agricultural field officer, Malaya. The following assistant conservators of forests have been appointed: Mr. F. G. Harper and Mr. F. J. Lyon (Gold Coast); Mr. C. V. Wallace (Sierra Leone); Mr. D. G. B. Leakey (Kenya); Mr. R. G. Miller (Northern Rhodesia); Mr. F. H. Landon (Malaya).

AT a general meeting of the Société française des Électriciens on Nov. 7, it was decided to confer the title of honorary member on Mr. Percy F. Rowell, secretary of the Institution of Electrical Engineers, in recognition of his work in establishing close collaboration between the French society and the Institution of Electrical Engineers, particularly during the Anglo-French Congress held in Paris in 1913, the meeting of the Institution held in France in 1929, and the Faraday celebrations held in London in 1931.

IT is announced by Science Service, Washington, D.C., that Prof. Theodore Lyman, emeritus professor of physics in Harvard University, has been awarded the Frederick Ives Medal of the Optical Society of America for his pioneer work on the ultra-violet spectrum of hydrogen gas. Prof. Lyman's name is commemorated in the 'Lyman series' of the hydrogen spectrum, which, with the series detected by Balmer and by Paschen, are of fundamental importance in modern views of the energy levels within the atom.

THE council of the Institution of Civil Engineers has awarded the Indian Premium for the session 1930–31 to Mr. G. C. Minnitt (Bombay). It has also made the following awards for the session 1930–31 in respect of selected engineering papers, published without discussion: A Telford Gold Medal to Mr. Herbert Addison (Giza, Egypt), and Telford Premiums to Mr. H. A. Sieveking (London), Dr. William Blackadder (Aberdeen), Mr. R. F. Legget (Montreal), and jointly to Messrs. R. G. C. Batson and H. R. Mills (Teddington). In respect of papers read at students' meetings in London, or by students before meetings of local associations, during the same session, the following awards have been made: The James Forrest Medal and a Miller Prize to Mr. I. W. G. Freeman (London), and Miller Prizes to Messrs. V. A. C. Durand (Cardiff), F. C. Ball (London), T. A. Burnside (Glasgow), F. R. Paynter (Newcastle-on-Tyne), D. H. McPherson (Glasgow), S. G. Barrett (Manchester), E. H. Ely (London), and H. E. Orr (Yorkshire).

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just issued a 'clearance' list of nearly 1000 second-hand books on geology, meteorology, mathematics, astronomy, chemistry, and physics. The prices asked are very reasonable.

THE Cambridge University Press announces for early publication Vol. 4 ("Meteorological Calculus: Pressure and Wind") of Sir Napier Shaw's "Manual of Meteorology". The work will contain a summary of contents and an index to the four volumes. The same house also gives notice of "Partial Differential Equations of Mathematical Physics", by Dr. H. Bateman, and "Cartesian Tensors", by Dr. Harold Jeffreys.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Viscosity of Liquids.

I WAS extremely interested to read, in NATURE for Oct. 24, Prof. G. W. Stewart's letter, in which he states that his X-ray diffraction experiments strongly support my theory of viscosity, and I look forward with eagerness to reading the full account of his results. We are both in agreement that the liquid state is more akin to the crystalline than to the gaseous state, and it is in this connexion that I wish to direct attention to another result of my theory which bears on this point, more especially as fuller publication has, by various mischances, been delayed.

I postulate that liquid viscosity is due to an interchange of momentum between adjacent layers, effected not, as in a gas, by a passage of molecules from one layer to the other, but by a temporary union of molecules, which does not endure for longer than the very brief time required for the molecule to acquire a common velocity of translation—a temporary holding of hands between individuals of two parallel rows moving past one another rather than a stepping bodily from one row to the other. The nature of the union need not be discussed here; all that is demanded of it is that it should produce momentarily a common velocity of the molecules. This leads to the expression

$$\eta = \frac{2m\nu}{\sigma}$$

where m is the mass of a molecule, σ the average distance between the centres of molecules, and ν the frequency of junction per second, which is also, of course, the frequency of disjunction, since the union is of negligible duration. The variation of ν with temperature is an essential feature of the theory, but I am not at the moment concerned with that, but rather with the value of ν at the melting point of the liquid.

Suppose that we make the assumption, which may appear startling, that when a solid is melted it still retains in the liquid form sufficient of its crystalline character for the molecules to possess a frequency of vibration which is practically the same as that of the solid form at the melting point. This is not so remote from Lindemann's theory, in which he derives the frequency of vibration of the solid state of elementary substances at the melting-point from the assumption that melting takes place when the amplitude of the atomic vibration becomes about equal to the average distance apart of the atoms. There is fairly good agreement between the values derived from other methods and those found from Lindemann's formula, which is

$$\nu = C\sqrt{\frac{T_m}{A V_A{}^{2/3}}}$$

where T_m is the melting point, A the atomic weight, and V_A the volume of a gram-atom at temperature T_m. Suppose that we substitute the frequency ν so found in the viscosity formula. Since $\sigma = \left(\frac{V_A}{N}\right)^{1/3}$, and $m = \frac{A}{N}$, where N is Avogadro's number, we obtain for the viscosity η_m at the melting point

$$\eta_m = 2C\frac{(AT_m)^{1/2}}{(NV_A)^{2/3}}.$$

Lindemann gives for the constant C the value $2 \cdot 8 \times 10^{12}$. Substituting this, and the value $6 \cdot 06 \times 10^{23}$ for N, we have

$$\eta_m = 7 \cdot 82 \times 10^{-4}\frac{(AT_m)^{1/2}}{V_A{}^{2/3}}. \quad . \quad . \quad (1)$$

The following table shows the calculated and experimental results for elementary substances, of which the viscosity of the liquid form in the neighbourhood of the melting point can be found from published experimental data. For many liquid metals the viscosities, as found by different workers, show such large discrepancies that they have not been used.

Element.	Melting Point.	Viscosity of Liquid in the Neighbourhood of the Melting Point.	
		Calculated.	Experimental.
Mercury .	234·2° Abs.	0·0283	0·021
Bromine .	265·7	0·0132	0·0147
Iodine .	386	0·0198	0·0235
Chlorine .	171	0·0104	0·0143
Oxygen .	54	0·0038	$>$0·0019
Hydrogen .	14	0·00051	$>$0·00013

As regards the viscosities of liquid oxygen and hydrogen, only one determination, that of J. E. Verschaffelt, exists, namely, at 90° abs. for oxygen ($\eta = 0 \cdot 0019$), and at 21° abs. for hydrogen ($\eta = 0 \cdot 00013$), temperatures which are respectively 67 per cent and 50 per cent above the melting point. It is certain that the viscosities at the melting point must be considerably higher than those shown in the table.

It should be emphasised that the constant in formula (1) is not arbitrary, but taken from Lindemann's formula. When this is remembered the agreement between experiment and calculation must be considered as very satisfactory, and furnishing a strong confirmation of the conception of the liquid state put forward, namely, that liquids at the melting point behave as crystals which have, so to speak, lost their general rigidity, while retaining local memory of their former state. I have sketched the argument leading to formula (1) as briefly as possible: I hope to make it a little more convincing when I have more space at my disposal.

E. N. DA C. ANDRADE.
Physical Laboratories,
University College,
London, W.C.1.

Anomalous Variation of the Electrical Conductivity of Quartz with Temperature at the Transformation Point.

FOR many years the variation of electrical conductivity of crystalline dielectrics with temperature has been studied by different physicists; for example, A. Joffé [1] has studied this problem with quartz, calcite, ammonium-alum, and copper sulphate, and found that their conductivity σ is expressed by $\log \sigma = \frac{A}{T} + B$, where T is the absolute temperature, A, B the material constants. More recently, W. Seith [2] has also studied this problem with lead chloride and iodide crystals and deduced the expressions $\sigma = Ae^{-Q/RP}$ for the chloride, and $\sigma = A_1e^{-Q_1/RP} + A_2e^{-Q_2/RP}$ for the iodide, where A, A_1, A_2 and Q, Q_1, Q_2 are material constants, T the absolute temperature, and R the gas constant. But no one has noticed that there exists any anomalous change of the electrical conductivity of quartz at the temperature 573° C.

It is well known that the index of refraction, specific heat, Young's modulus, and other physical properties of quartz, except its electrical conductivity, show anomalous changes at its $\alpha \rightleftarrows \beta$ transformation.

According to the investigation by X-ray analysis on the structure of α and β quartz given by W. Bragg and R. E. Gibbs,[3] the projective area of a triangle formed by silicon atoms on the plane perpendicular to the principal axis becomes smaller by its rotation at the transformation $\beta \longrightarrow \alpha$. Thus, it might be expected that the electrical conductivity of quartz would increase considerably at the $\alpha \longrightarrow \beta$ transformation. We measured the change of electrical conductivity of quartz with temperature with special precautions and accuracy, especially in the temperature range about 500°–650° C.

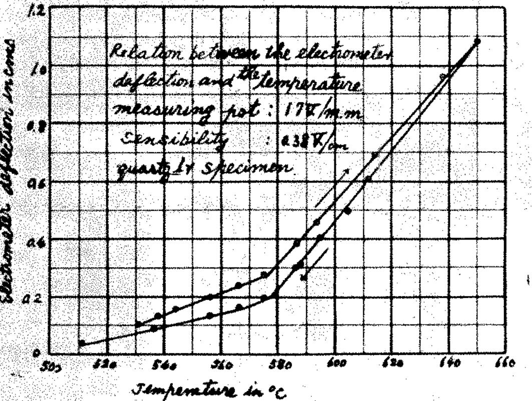

FIG. 1.

We used two different methods in our experiments. In one, we measured the voltage drop with time produced by a standard resistance connected with the specimen and the earth in series (the stationary value of the voltage drop will be proportional to the electrical conductivity of the specimen); and in the other, we measured the accumulation of charge on the specimen with time, and the conductivity is calculated by the ratio of the initial current (the initial tangent of the accumulating curve) to the applied voltage. Some of our results are given herewith.

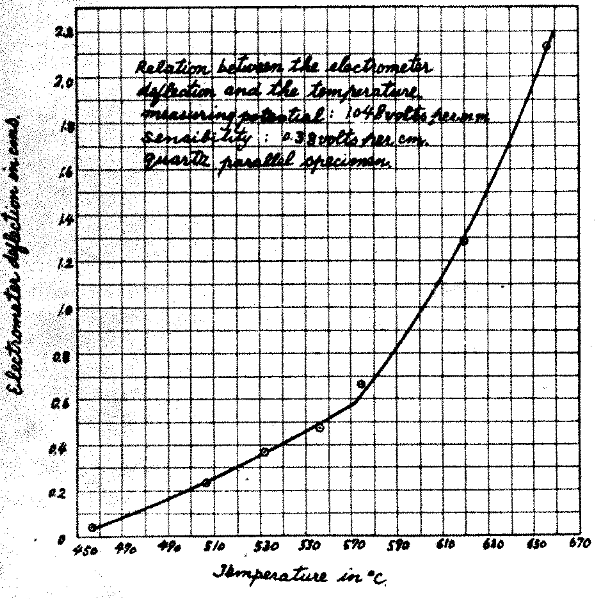

FIG. 2.

Fig. 1 shows the variation of the electrometer deflection due to the voltage drop of the standard resistance of 800,000 ohms with temperature for a quartz plate cut perpendicular to its optical axis. The ordinate is proportional to the electrical conductivity of the quartz. The arrows in this diagram show the results for heating and cooling, and the time intervals for heating and cooling are nearly the same and equal to about fifteen hours. Thus, the electrical conductivity of quartz varies anomalously at the $\alpha \rightleftarrows \beta$ transformation temperature 573° C. Fig. 2 shows a similar result for quartz plate cut parallel to its optical axis. In this case also the anomalous change of the electrical conductivity occurs at the transformation temperature 573° C. Fig. 3 shows the result by the accumulation charge method with the parallel quartz plate. In this case the conductivity increases discontinuously at the temperature 573° C.

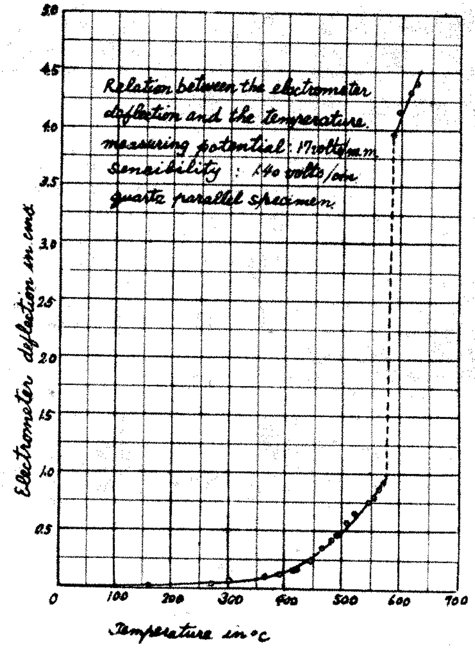

FIG. 3.

There is considerable difference between the results given in Figs. 2 and 3 on the variation of the electrical conductivity at the transformation point, but this is an apparent difference only, because, in Fig. 2, the stationary value of the conductivity is taken and in Fig. 3 the initial value of it is considered. We have already shown that the electrical conductivity of dielectrics is of two kinds, namely, true and apparent, and the latter decreases with time and tends to the stationary value.[4] It is the apparent conductivity which is measured in the experiments above on quartz.

Hence we conclude that the electrical conductivity of quartz increases with temperature, and at its transformation point, 573° C., it shows an anomalous variation similar to that of the other several physical constants of quartz.

H. SAEGUSA.
S. SHIMIZU.

Physical Institute,
Tôhoku Imperial University,
Sendai, Japan.

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[1] *Ann. der Phys.*, **72**, 495; 1923.
[2] *Zeit. für Phys.*, **56**, 802; 1929.
[3] *Proc. Roy. Soc.*, A, **109**, 405; 1925.
[4] *Sci. Rep. Tôhoku Imp. University*, **18**, p. 231; 1929: **19**, p. 69; 1930: **20**, p. 1; 1930.

Control of Prickly-Pear by the Cochineal Insect.

I HAVE read with interest the communications of Messrs. C. T. Jacob [1] and W. B. Alexander [2] on this subject. Referring to the introduction of the cochineal insect into India, the latter remarks: "In India, the offer was considered at a conference of the entomologists of the various provinces, and it was decided not to accept it, on the ground that prickly-pear was largely used for hedges, and that, where it threatened to become a pest, it could easily be eradicated, as abundant cheap labour was available". I am constrained to state that neither the first part nor the latter portion of this statement describes the real facts. I may state that, though the Government was not very enthusiastic about the introduction of this new insect, it never had any conference of provincial entomologists or gave any such opinion regarding the necessity for, or the easy method of, eradicating prickly-pear when needed. In South India the prickly-pear has been felt to be a very serious pest and nuisance for years, and the Government has been spending a great deal of money in getting the same eradicated in various ways without any appreciable success until now. Nor has it ever been felt by any responsible person that "it could easily be eradicated, as abundant cheap labour was available".

Anyone travelling, even along the railway tracts of South India, can easily form an idea of the extensive areas of valuable arable and pasture lands overrun by this terrible pest. It is not only harmful in harbouring dangerous reptiles, etc., as Mr. Jacob puts it, but also is in every way an undesirable weed. Among other things, it blocks up village footpaths, covers the banks and foreshores of streams and rivers, encroaches badly and quickly on cultivated areas, and in fact makes the whole country-side very unsightly. The introduction of this cochineal, though through a private agency, was certainly not a "thoughtless importation" of a strange animal; on the other hand, it is being felt as a real boon. By its steady and effective work of controlling the weed (*O. dillenii*) the insect has not only helped in the saving of thousands of rupees usually spent year after year to keep the same under some control, but it has also been clearing the country-side remarkably and very satisfactorily.

T. V. RAMAKRISHNA AYYAR.

Section of Entomology,
Department of Agriculture,
Madras, South India,
Sept. 24.

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[1] NATURE, **128**, 117, July 18, 1931.
[2] NATURE, **128**, 226, Aug. 8, 1931.

Control of Humidity of Air Currents.

PROF. J. B. SETH [1] has described a method of obtaining air currents of which the humidity can be regulated. I do not doubt that his method is a good one, though I have no experience of it. But may I point out that humidifying the air by mixtures of sulphuric acid and water is also a good method, provided that certain precautions are taken. It is perhaps unsuitable if large volumes of air are required. The air should be blown, not sucked, so that any leaks which may occur will be outwards. The air should not be bubbled through the acid, for that imparts to it an acid spray, which is most difficult to remove; it should pass through several Woulfe's flasks, containing pumice well wetted with the acid. Nearly all the humidifying (or drying) of the air takes place in the first Woulfe's flask, to which the gradual alteration in the strength of the acid is almost confined. After the last Woulfe's flask, arrangements should be made for drawing off a sample of the air stream; it may be bubbled through an indicator to show that it is free of acid; or it may go past a dew-point apparatus, enclosed in glass. This is most important, as it provides a method of hygrometry, perhaps the most suitable for this particular purpose. I have recently figured a convenient dew-point instrument.[2]

P. A. BUXTON.

London School of Hygiene and
Tropical Medicine,
University of London, Oct. 12.

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[1] NATURE, Oct. 10, p. 638.
[2] *Bull. Entom. Res.*, vol. 22, p. 431.

WE have read with interest the communication of Prof. J. B. Seth in a recent issue of NATURE [1] on a method of obtaining air currents of various relative humidities. The method described by Prof. Seth makes use of the principle of admixing appropriate proportions of desiccated and saturated air; it appears to be assumed, however, that saturation may be effected by bubbling air through a bottle full of water. In a recently published paper [2] we have shown that this assumption, which is very commonly made, is not justified. Passage of air at a rate of approximately 60 c.c. per min. through a Dreschel wash-bottle full of water produced a relative humidity of only 80 per cent; whereas at the same and much higher rates of flow complete saturation was obtained by admitting steam into the air current and condensing out the excess moisture under thermostat conditions. Lower relative humidities were obtained quantitatively by suitably admixing saturated and desiccated air.

Since the failure of the 'bubbling method' is undoubtedly attributable to factors connected with hydrostatic pressure, clearly it cannot be overcome merely by increasing either the number of bottles or the depth of liquid. The point to which we desire especially to direct attention is the doubt that must be associated with any method of saturating a stream of air that depends on its passage vertically through a column of water.

W. H. J. VERNON.
L. WHITBY.

Chemical Research Laboratory,
Teddington, Middlesex.

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[1] NATURE, Oct. 10, p. 638.
[2] *Trans. Faraday Society*, **27**, 248; 1931.

Short Wave Reception and Ultra-Radiation.

A FEW years ago W. Kolhörster [1] referred to the possible connexion between short wave fading and the fluctuations of ultra-radiation, and suggested comparative investigations. Up to now such investigations have not been undertaken, so that still nothing is known concerning this.

In the following I wish to direct attention to an undoubted analogy in the changes in short wave reception and in the changes in intensity of ultra-radiation during terrestrial magnetic disturbances. This permits conclusions to be drawn as to a connexion between the two phenomena.

The auditory reception strength for short wave long-distance reception increases gradually for a few days before a magnetic disturbance, until, on the day of the disturbance, it decreases suddenly, even to inaudibility. It first increases again in the course of the following days, there being a slow increase but for superimposed fading effects.[2] Corlin [3] has now been able to derive statistically a completely inverse picture from his ultra-radiation observations in northern Sweden in the winter of 1929–30. According to this, the strength of the radiation decreases slowly and continuously for some time before a disturbance, jumps strongly upwards at the beginning of the disturbance (the impetus stage), and then slowly becomes less again during the further course of the disturbance (the main oscillation stage) and its after-effects. This agreement must be more than accidental, and permits the conclusion, made with all due reservation, that increase of ionising ultra-radiation makes reception conditions worse, and conversely. The known deterioration of reception during the daylight hours, when there is an increase in ionisation in the upper layers of the atmosphere due to the ultra-violet radiation from the sun, also affords evidence for this inverse proportionality between reception strength and ionising radiation. W. M. H. SCHULZE.

Neue Mühle-Königswusterhausen,
near Berlin, Oct. 9.

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[1] W. Kolhörster, *Naturwiss.*, **15**, 126; 1927.
[2] K. Stoye, *Funk-Bastler*, **38**, 593; 1928: **39**, 617; 1931.
[3] A. Corlin, *Lund Observatory Circular*, **1**, 3; Mar. 31, 1931.

Rhythmic Breaking of Ship-waves.

ON a recent voyage from Australia, I observed a phenomenon in connexion with ship-waves to which no reference is made in the literature on waves with which I am acquainted. Dr. Vaughan Cornish's book on "Waves of the Sea", etc., makes no mention of it.

The diverging waves produced by the motion of the ship increase in height and steepness on the near-side as they move outwards from the ship and then break towards the ship. The fact to which I wish to direct attention is that this breaking is, under favourable conditions, regularly periodic.

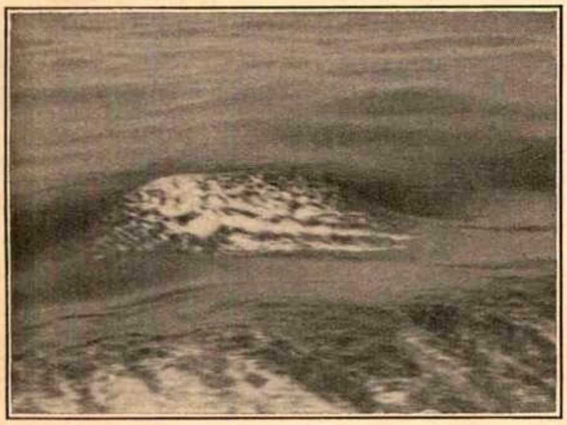

FIG. 1.

Prof. Hartung of Melbourne, who was a fellow-passenger, was kind enough to take some photographs of this effect (Fig. 1). Two parallel bands of foam are very definitely shown, a third not quite so definitely. Occasionally as many as half a dozen such parallel breaks in the wave-crest could be seen, though more frequently these are broken by transverse bands of turbulence. KERR GRANT.

Australia House, London W.C.2.
Oct. 8.

Constitution of the White Dwarf Stars.

IT is generally held that the white dwarf is in the degenerate state in the sense of the statistics of Fermi and Dirac. This assumption leads to another consequence bearing on the relative abundance of elements in the same star. Assuming further that (i) all atoms of various elements in the white dwarf are stripped of their extranuclear electrons, and (ii) all kinds of nuclei of atoms are formed entirely from protons and electrons, the thermo-equilibrium among them is determined from Milne's equations.[1] The simplified form is

$$\frac{1}{m_E}\left(\frac{c_E}{q_E}\right)^{\frac{2}{3}}=\frac{\mu}{m_P}\left(\frac{c_P}{q_P}\right)^{\frac{2}{3}}+\frac{\nu}{m_e}\left(\frac{c_e}{q_e}\right)^{\frac{2}{3}}+\frac{2}{h^2}\left(\frac{4\pi}{3}\right)^{\frac{2}{3}}U \quad . \quad (1)$$

with the equation of nuclear formation of an element E from μ protons (P) and ν electrons (e),

$$\mu P+\nu e \rightleftarrows E+U,$$

where m, c, and U denote respectively the mass of an atom, the concentration and the heat of formation. μ and ν are expressed by Z (the atomic number), and the mass of an atom as follows:

$$\mu=\frac{m_E}{m_P}, \quad \nu=\frac{m_E}{m_P}-Z_E. \quad . \quad . \quad (2)$$

Usually the first term of the right-hand side of (1) is negligibly small.

U is calculated from the mass-defect, with the result that U increases monotonically with the mass number of the element. As all terms of the right-hand side of (1) are positive, it is quite clear that the nuclear concentration of an element increases with its atomic weight (almost proportional to its square). Therefore it may be concluded that the heavy radio-elements exist abundantly in the white dwarfs.

SEITARÔ SUZUKI.

The Kyushu Imperial University,
Fukuoka, Japan, Sept. 16.

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[1] *Mon. Not. Roy. Ast. Soc.*, **90**, 769; 1930.

Dehydration of Salts.

IN the course of some investigations it was found advantageous to have a uniform and general method of dehydration. Such a method was found in the extension of the drying process applied originally to 2-nitro-*p*-cresol.[1] In general, dehydration was carried out by distilling a neutral liquid of high vapour tension containing the hydrated salt or its aqueous solution.

As an example, crystals of copper sulphate were placed in toluol and the latter distilled off until no further water could be detected in the distillate. The anhydrous copper sulphate so obtained, though lacking in cohesion, frequently retained its original crystalline form. Dried over solid paraffin in a desiccator, the copper sulphate was found as whitish fragile crystals free from water.

In a similar manner the dehydration of magnesium chloride and various salts of iron, nickel, and cobalt was carried out. This method practically eliminates decomposition of the product and side reactions, such as oxidation and reduction. Owing to its elasticity as regards medium, temperature, and pressure, the process may be of general application.

An attempt to extend Stephen's acetic anhydride dehydration of stannous chloride[2] to other salts met with but partial success.

Although dehydration was in most cases achieved, (1) the process was limited to solids in a finely divided condition; (2) in most cases the reaction was sluggish and required heating; (3) the dehydrated salts were found to retain tenaciously some acetic acid and its anhydride, a feature apparently general in the case of salt-acid mixtures.

MAURICE COPISAROW.

Research Laboratory,
145 Alexandra Road,
Manchester, S.W., Oct. 8.

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[1] Copisarow, *Jour. Chem. Soc.*, 251; 1929.
[2] *Jour. Chem. Soc.*, 2786; 1930.

Research Items.

Prehistory of West Africa.—In *Africa*, vol. 4, no. 4, M. P. Laforgue reviews the present state of our knowledge of the stone age in West Africa. Both the major divisions of stone age culture are represented with a distinct but ill-defined period of transition, revealed by a large number of 'Tardenoisian' implements. The African palæolithic peoples, like the Eurasian, lived in caves, rock-shelters, and in the forests, where they were succeeded by the neolithic peoples, as is shown by superimposed deposits. Three zones of prehistoric culture can be distinguished in strongly marked local developments of a basal culture: (1) a Saharan zone north of 18° N.; (2) a Sahelian zone between 18° and 14° N.; (3) a Soudanese zone between 14° and 4° N. The Saharan zone is distinguished by the use of flint and limestone. Weapons predominate, and the implements attain great perfection of form and technique. They point to a northern and eastern origin, and have been attributed to nomad hunting tribes. Pottery is rare and implements of agriculture non-existent. It is in this zone that the greater number of palæolithic sites are found, Mousterian industries predominating. (2) The Sahelian sites show a predominance of tools and the implements of agriculture. All kinds of stone are employed; arrow- and lance-points are found, but without the refinement of those of the Saharan zone. The industry as a whole is agricultural. Pottery is abundant; it is ornamented by the use of the tips of the fingers. (3) In the Soudanese zone, limestone is generally in use, the implements being axes, hammer-stones, grinding-stones, and numerous flakes of limestone and basalt, of which it is not possible to determine the use. Evidence from this part of Africa, especially in the forested area, is scant.

Indian Place-Names.—In the *Indian Antiquary* for October, Rai Bahadur Hira Lal discusses the origin of the place-names of the Central Provinces. During the times of Srî Râmacandra a great part of what is now the Central Provinces was, according to recent interpretation, Daṇḍakâranya or Daṇḍaka forest. The forest was inhabited by wild tribes, among whom the Gonds were prominent, as they are still. It is likely, therefore, that the place-names were in the language of the aboriginal tribes, especially of the Gonds and Oraons, though many of them have undoubtedly been Aryanised. Relics of tha Sabars' or Śavaras' language have been pointed out, for example, in Janasthâna from *jaitan*, 'below', or Daṇḍaka, 'full of water'. The following are examples of aboriginal names of Gondi origin which have undergone scarcely any change:—A large number of names derived from trees, for example, 'Barelî' from 'barelî', 'banyan' (*Ficus bengalensis*); 'Markâḍîh' from 'markâ', mango. In the single district of Jubbulpur alone there are more than fifty villages named 'Pipariâ' from 'pîpar' (*Ficus religiosa*). The Aryan names carry a suffix, for example, 'Belgâon' from 'bel', a tree, and 'gâon', a village. Certain names are derived from wild animals, birds, insects, etc., as applied to places to which they resorted; 'Malpârâ' from 'mal', a peacock, 'Koṇḍigâon', from 'Koṇḍâ', a bullock. Similar names are common in Aryan nomenclature; for example, 'Bâghpur' from 'bâgh', a tiger, 'Hâthîgadh' from 'hâthî', the elephant. Trees and animal names are joined with words signifying water; for example, 'Aunrâbândhâ', from 'aunrâ', a tree, and 'bândh', embankment, 'Bâghḍabri', tiger-pool. Examples of reptiles and birds are Nagpur, 'Cobra city', Kavâkhâpâ, 'Crow hamlet'. Onomatopœic names imitate the sound of running water or the cry of birds heard in the vicinity, such as Daldali, Murmur, Luṭluṭâ, Rigrigâ, Tuturiyâ.

False Killer Whale in Ceylon Waters.—The stranding of a large school of killer whales, *Pseudorca crassidens*, containing 167 individuals, upon the shores of Velanai in Ceylon, has already been mentioned in NATURE, and now Dr. Joseph Pearson describes the occurrence in more detail (*Spolia Zeylanica*, vol. 16, p. 199, Aug. 1931). Unfortunately the carcases were much decomposed before they were examined at the place of stranding, but one complete skeleton and twelve skulls were preserved for the Colombo Museum, and of these Dr. Pearson records the dimensions. He tentatively suggests that the occurrence of the species, which he regards as a cold-water form, in tropical seas may possibly be connected with a seasonal migration during the breeding season, in order that the young may be born under less rigorous conditions than those of higher latitudes. He cites the fact that the Ceylon school contained many pregnant females and appeared in August, a winter month in Antarctic seas. But our recollection is that the large Dornoch Firth school of October 1927, to which the author makes no reference, also contained pregnant females. It would appear that the three appearances off Ceylon and Southern India, and the rare appearances in the North Sea (two, however, of schools containing a hundred individuals or more), are indications of casual wanderings, occasionally in mass, of a species the headquarters of which may be in sub-Antarctic oceanic waters.

A Virus Disease of Roses in Australia.—A rose disease, known in Australia as 'rose wilt' and 'die back', began to become prevalent during 1908–1912, reached serious proportions in Victoria by 1915, and an alarming increase in the number of plants affected was observed in 1928. This disease, which is restricted to Australia and New Zealand, generally appears in epidemic form, causing great damage in a season, then seems to lose its virulence for some seasons, when it suddenly appears again. The first sign is a curiously recurved appearance of the leaves on young shoots. Defoliation then occurs, commencing at the tips of the shoots and progressing downwards, the 'rose wilt' stage, followed by discoloration and death of the stem, and this 'die back' condition may extend into the older wood. Prescott, Rossi, and others noted the presence of a bacterium in the diseased parts and assumed the disease to be caused by this organism. B. J. Grieve, investigating the disease on behalf of the National Rose Society of Australia (*Australian Jour. Exper. Biol. and Med. Sci.*, vol. 8, pt. 2, 1931, p. 107), finds, however, that in the early wilt stage organisms cannot be detected in the diseased tissues; these appear only in the late 'die back' stage and are probably adventitious. It was proved that both the unfiltered and the filtered juice from diseased plants produced the disease in healthy plants inoculated with it, thus demonstrating that the disease is an infective one and is caused by a filterable virus. A Seitz filter which did not permit a small bacterium to pass was employed. Experiments to test if the rose aphis is a vector yielded inconclusive results.

Tree Growth and Weather.—Having devised a special recording apparatus for the purpose, Hirokichi Nakashima gives very full figures for growth in length for the tree *Pinus nigra* Arnold, var. *austriaca* Hoss, in Japan, in the *Journal of the Faculty of Agriculture*, Hokkaido Imperial University, vol. 22, part 2. Growth is most vigorous from the end of May until the middle of July, and only during a relatively short period is an increase in height of the tree to be noticed. By July 19, 90 per cent of the extension growth had taken place. Increase in height is most marked in the evening; in the morning, just after sunrise, the increase is nil, or there is even a slight decrease in height. During the period of vigorous growth, evaporation has the most definite effect upon growth: on a sunny day, the morning cessation of growth is followed by more vigorous growth in the evening; but on a cloudy day, both fall in growth rate and subsequent increases in length are less marked. In the period that follows, when but a little extension takes place, the most significant factor seems to be the wind, a surprising effect being noted of windy weather which results, on the whole, in a greater increase in length.

Radium in Hawaiian Lavas.—Continuing his work on the radium content of rocks, C. S. Piggot has investigated thirteen samples of lavas from various islands of the Hawaiian group (*Am. Jour. Sci.*, July, 1931, pp. 1-8). The average amount determined is $0{\cdot}96 \times 10^{-12}$ gm. of radium per gm. of rock, the range being from 0·75 to 1·47. The rocks examined are basaltic, with one exception, the latter being a trachyte which gave 0·94, very near to the mean value for the series. Five of the samples were selected to represent various flows of different ages from Kilauea crater; all show practically the same radium content. four being 0·94 and the other 0·90. Poole and Joly in 1924 recorded 0·96 for a ropy lava from Kilauea. Piggot points out that the radium content of Hawaiian basalts is not very different from that determined for sixteen samples of granite from the eastern seaboard of North America from Georgia to Greenland (0·90). The average contents hitherto found for granite rocks range from 0·55 for Antarctica to 6·00 for the Aar Massif, so Piggot's result for granites need not be considered abnormal, though it is unusually low.

Cooling Effects of Ice on the Oceans.—The degree to which ice has an effect in reducing the temperature of the waters of the North Atlantic Ocean was one of the subjects investigated by the United States Expedition in the *Marion* to Davis Strait and Baffin Bay in 1928. In a comprehensive account of Arctic ice in Part 3 of the results of this expedition (United States Treasury Dept., *Coast Guard Bulletin* No. 19), Mr. E. H. Smith points out that glacial ice, which is only two per cent of the ice brought south by the Labrador current, melts mainly in coastal waters, and so cools oceanic waters only indirectly by the mixing of the two waters. The extent of this mixing, considering the ocean generally, is small. Further, he shows that in the area of the Atlantic invaded by pack ice the annual melting counteracts the solar warming of an 80-ft. surface layer by 6° F. Taking the limit to which solar warmth can penetrate as 480 feet, Mr. Smith concludes that melting pack ice opposes the warming of these 480 surface feet by only 1° F. The mean temperature rise by solar heating of the same thickness of surface water is calculated from observations to be 2·1° F. Thus the chilling of the North Atlantic by ice melting is about one-half of the warming during the summer. This was found to be only 10 per cent of the total cooling-effect resulting from the cold waters of the Labrador current. Since the relative proportions of ice and water are the same in the East Greenland current, it may be assumed that this figure of 10 per cent applies to the entire North Atlantic. These results support previous suggestions of Dr. G. Schott and Comdr. Campbell-Hepworth that the agency chilling the North Atlantic is not melting ice but cold water.

Determination of the Yard in Wave-lengths of Light.—Dr. A. E. H. Tutton has published the results of a direct evaluation of the yard in terms of the primary standard of length, the wave-length of the red cadmium line (*Phil. Trans.*, A, vol. 230, pp. 293-322). The determination was actually based upon the yellow neon line, but since the absolute wave-length of this is accurately known, the results may be readily reduced to the basis of the cadmium line. The baseline directly measured in wave-lengths was considerably longer than in any previous determination; the counting of more than five thousand fringes in a continuous sequence is a feat calling for a remarkable degree of visual endurance, and in fact was only achieved as the result of prolonged familiarity and practice. The micrometric comparisons involved in relating this baseline (1/16 in.) to the standard yard were greatly facilitated by the use of fiducial marks ruled by the late Prof. Grayson with almost superhuman skill. Their width was extraordinarily small—half a wave-length, as against fifteen in the case of the standard yard and metre—and they were spaced with even more extraordinary accuracy, of the order of one hundred-thousandth of an inch. Incidentally they dispose very effectually, as Dr. Tutton remarks, of the rather prevalent belief that objects smaller than one wave-length are necessarily invisible. A complete set of measurements was also made, using the red hydrogen line *Hα*. Dr. Tutton's final conclusion is that the yard contains 1,420,210 wave-lengths of red cadmium light.

Cathode Phenomena in the Glow Discharge.—Two papers by Prof. A. Güntherschulze and F. Keller, in the issue of the *Zeitschrift für Physik* for Aug. 15, contain much new information about the phenomena at the immediate surface of the cathode in the glow discharge between cold electrodes. This is a subject which has been little investigated, partly because of its difficulty, and partly perhaps because attention has been concentrated recently on other discharge forms of commercial importance. It has been found that the phenomenon of the primary dark space—the thin dark layer on the surface of the cathode, *within* the cathode dark space—is much more general than had been supposed, it being reported that this is present in discharges through oxygen and nitrogen, where it could not be detected by Dr. F. W. Aston and more recent investigators. It is found that the primary dark space disappears when the cathode fall in potential is raised to about a thousand volts, and it is suggested that this is because the positive ions proceeding towards the cathode then attain for the first time sufficient energy to excite the gas. Simultaneously, with a cathode of magnesium alloy in helium, a new cushion of green magnesium light appears on the cathode surface, and this in turn is separated from the electrode by a minute dark layer. It may prove possible to study cathodic sputtering very directly by this new method, the intensity of the green light being taken as a measure of the amount of magnesium vapour present in the neighbourhood.

Organic Compounds of Gold.—Gibson and Colles, in the *Journal of the Chemical Society* for September, describe the preparation of some co-ordination compounds of gold tribromide with substances such as pyridine, quinoline, and isoquinoline. They state that they have been unable to prepare some of the substances described by Kharasch and Isbell (Nature, Sept. 5, p. 415). The substance previously used in such work and considered to be gold tribromide is shown to be hydrated bromoauric acid, probably $HAuBr_4$, $3H_2O$. The methods of preparation of this substance and of pure gold tribromide, which is almost insoluble in ether and is regarded as $(AuBr_3)_2$ with the gold having a co-ordination number of 4 and not truly tervalent, are described in detail. Although the new co-ordination compounds were expected to be soluble in ether and hence suitable for use with the Grignard reagent, they were generally sparingly soluble, although the Grignard reaction could be carried out and diethyl gold bromide obtained. The yield was, however, smaller than with methods previously developed.

Low Temperature Carbonisation Test.—There exists a scheme of the Department of Scientific and Industrial Research whereby the staff of the Fuel Research Board tests, at public expense, processes for the carbonisation of coal at low temperatures. In accordance with the scheme a plant of the Leicestershire (L. and N.) Coal Distillation Co., at Ashby de la Zouche, has been tested and the report recently issued (London: H.M. Stationery Office, 9*d.* net). In this process the coal is carbonised in a revolving retort heated internally by products of combustion diluted with the gas leaving the retort. The coke product is quenched with water, whereby it is divided into two fractions, one which floats and one which, owing to a high ash content, sinks. The floating portion is briquetted with pitch and, if desired, recarbonised. The yield of clean fuel was 7·4 cwt. per ton of coal, and of tar 14 gallons per ton of coal. The gas is too poor to be of use. Although the yields of products are low, it is pointed out that the raw coal is practically unsaleable, and the product, owing to the character of the coal, makes an excellent fuel for open grates. It is, however, a process only applicable to the poorly caking coals such as occur in the Midlands.

Astronomical Topics.

New Comet.—Mr. J. W. Durrad, of Leicester, has announced the discovery on Nov. 5 of a new comet, visible to the naked eye. On Nov. 9 it was near σ Ursæ Majoris and moving about 4° a day south preceding.

The Leonid Meteors.—Although the rich shower of Leonids is not due until next year, the experience of 1898, combined with the tolerably rich display last year, gives ground for expecting something in the present year. The Computing Section of the British Astronomical Association has been working on the orbit of Tempel's Comet for the last two years. The date assigned as the most probable one for the comet's perihelion is Nov. 1, 1932. If this is near the truth, the comet will make a fairly close approach to the earth about mid-November. Its orbit, according to the calculations, is half a million miles nearer to the earth than it was in 1899, so there are good grounds for hoping that the disappointment of November 1899 will not be repeated.

The most probable date is the night between Nov. 16 and 17. Last year the maximum was about the end of Nov. 16 or early on Nov. 17. Neglecting the effect of perturbations (which have not been calculated for meteors so far from the parent comet), we should expect them to be six hours later this year, owing to the odd quarter day in the year. Hence the richest part of the shower may not come until after dawn on Nov. 17. But watch should be kept through that night, also on the preceding and following nights, as there are some stray members detached from the main stream. The radiant (in the sickle of Leo) does not rise until about 11 P.M., so the watch need not begin until then. Jupiter will be some 10° to the right of the radiant, and will form a convenient guide to it.

Motion of the Perihelion of Mercury.—The point that first attracted astronomical attention to Einstein's general theory of relativity was the close accord that it brought about between the calculated and observed motion of Mercury's perihelion. The agreement was undesigned, and resulted from the initial assumptions without any manipulation. It is not surprising, however, that the result caused closer examination to be made of the amount of the observed motion. *Mon. Not. Roy. Ast Soc.*, vol. 91, No. 9, contains an article on the subject by Dr. J. K. Fotheringham. He refers to an article by von Gleich in *Astr. Nach.*, vol. 241, which emphasises the need of correcting Le Verrier's value of the motion, in view of the evidence that is now available of changes, both secular and periodic, in the rate of the earth's rotation. This is a matter to which Dr. Fotheringham has given much attention; he has applied the latest values of the accelerations and fluctuations, and re-examined the discussions of the transits of Mercury that were made by Dr. Innes and Prof. de Sitter. His result for the excess of motion of Mercury's perihelion above that given by Newtonian theory is so close to Einstein's value that he feels justified in assuming that the Einstein motion applies also to the earth's perihelion. He then obtains 43·95″ for the observed centennial excess of motion of Mercury's perihelion above the Newtonian value. This is as close to Einstein's theoretical value, 42·9″, as could be expected. Fotheringham expresses indebtedness to von Gleich for having shown the necessity of considering the effect of changes in the earth's rotation.

Calendar Reform.—We have received from C. C. Wylie, secretary of an association in Iowa that is interesting itself in the subject of the reform of the calendar, a summary of the views expressed by various groups in the United States. They are printed under four headings: "Astronomy", "Banks", "Education", "Transport". The second group is practically equally divided for and against revision; the other three have decided majorities for revision, reaching 90 per cent in the third group. All the groups favour the retention of the 12-month division; a recent investigation in England (Nature, Oct. 10, p. 610) had a similar result, so that the suggestion of a 13-month year may be ruled out for the present. The main reason is probably its failure to divide into quarters, but the widespread prejudice against the number 13 may have influenced some voters.

It should be noted that the 13-month division is not the complete novelty that some people imagine. In ancient times, when most nations began their months at the new moon, seven years in nineteen were given a thirteenth month.

Recent Excavations at Vinča.

THE report on the excavations at Vinča in the summer of 1931, which was presented to Section H (Anthropology) of the British Association on Sept. 25, on behalf of Prof. M. Vassitz, fully confirmed previous opinion as to the importance of this site, which is now being excavated through the generous assistance of Sir Charles Hyde. It would seem to be abundantly clear that we now know the place, the time, and even the race of what is, up to the present, the farthest outpost to the north-west of Ægean civilisation. It dates possibly from the end of Early Minoan III, and certainly from the beginning of Middle Minoan I. It flourished until the arrival of the Romans about the year A.D. 6. The knowledge gained from Vinča, in Prof. Vassitz's opinion, poses new problems in pre-history not merely in relation to its immediate neighbourhood, but also in regard to a larger area, the Danube basin. It makes new methods of approach to the history of the Danube basin essential.

In the excavations of 1930 a depth of 8·8 metres was reached on one part of the site. Between the strata containing the earliest house remains which show a rectangular construction (down to 8·6 metres) and the original loess surface is a stratum of black earth about 7 metres thick, formed during the pit-dwelling period. In this, at a depth of 9·3 metres, a rectangular house foundation was discovered; but, apart from this, the site was marked from 9·1 to 9·3 metres by the contours of pit-dwellings. The pits are varied in shape, but the majority are round. There are cases of two pits connected by a neck. Apparently the pits were floored from time to time with a layer of clean clay, and in one case traces of reed walling or flooring were found.

In the same stratum as the pit-dwellings a tholos tomb was discovered with a dromos of unusual length approaching it. It contained nine skeletons. The tomb was roughly circular and 1·5 metres in diameter. It was probably roofed over with a wooden structure; for across the skeletons were traces of wooden beams charred or oxidised. Owing to the number of skeletons, in such a confined space, it was impossible to determine their original position or to allot the bones to individuals. One skeleton, however, it could be seen, lay on its face with the head turned on the left cheek and the left arm doubled beneath. All the heads, with two exceptions, were around the wall of the tomb, the feet to the centre. Interment was not simultaneous. The skulls, which are in a good state of preservation, differ in type, but have not yet been examined by an expert. This is not the first discovery of human remains on the site; but a skeleton, found in 1911 in a crouched position at a depth of 8·75 metres, was destroyed during the War. A number of fragments of skulls have been found at varying depths during the last three years, but they have been too small to afford any opportunity for drawing a conclusion from them.

The practice of burying the dead in the town and not in a separate graveyard can be paralleled at Sesklo (Thessaly), and in pre-Mycenæan times in the Ægean on Melos (Phylakopi). Another point in common with the Ægean is the interment of a number of persons in the same tomb.

The resemblance between the tombs of the Ægean and Vinča becomes the more striking and important in the light of a number of analogies and resemblances in other finds. This is especially marked in the plastic art. The type of head and face on the Vinča terra-cotta statuettes is the same as that of the Cycladic marble statuettes. One head shows exactly the same perforations as are found in the so-called Egyptian dolls of the XIIth Dynasty. Vases in the form of human or animal bodies, or ornamented with human representations, are numerous. A naked female figure recalls the naked goddess of Kadesh, while it is to be remembered that Egyptian girls until puberty wore a belt only. Again, the Hyde vase found last year has early analogies only in Egypt. These occur there as early as the Vth Dynasty, while in the Ægean they do not appear until the Greek Archaic period, apparently copied from Egypt. Vinča was thus in touch indirectly with Egypt, the Ægean affording the link.

A prosopomorphous lid, showing two diametrically opposed faces, points to Cyprus, double rhytons to Enkomi in Cyprus and farther afield to Assyria. Small offering tables with circular depressions, and all the more important forms of pottery, have analogies in the Ægean. They occur at Vinča from the earliest time, the pit-dwelling period. The technique of ornamentation on fragments from the black stratum, in which the finger or a special tool was used in marking a thin slip, seems to be an imitation of the barbotin technique of Knossos, *MMa* and *MMb*. If this supposition be correct, it affords valuable evidence for dating the commencement of the Vinča settlement.

These and other finds bear witness to the high civilisation of Vinča. The settlement would appear to have been due to colonists choosing this point on the Danube for the exploitation of the mineral wealth around Avala Peak. These minerals were galenite, cinnabar, and an ore which it is proposed to call avalite, a silicate of chromium which was used as a cosmetic, producing the green colour which in Egypt was obtained for the identical purpose from malachite. There is evidence to show that the cinnabar was worked at Vinča for red colouring matter, while the galenite was used instead of antimony as a cosmetic, though lead may also have been extracted from it. It is also possible that part of the silver found at Troy II and in Crete *EM* III and *MM* I may have been obtained in the country around Vinča.

Chemistry of the Vitamins.

A DISCUSSION on the chemistry of the vitamins and related substances in Section B (Chemistry) of the British Association on Sept. 25 was opened by Sir F. Gowland Hopkins, who referred to the difficulties which have attended all attempts at the isolation or determination of the constitution of the vitamins, and then discussed the general nutritional importance of the vitamins and the extremely small concentrations at which they are effective. There are marked differences in the constitution of the vitamins. All doubts as to the individuality of vitamin A and vitamin D have now disappeared, and in general, deficiency of either of these vitamins gives a totally distinct picture in the animal. The discussion of the establishment of biological standards by an international committee in London has indicated that we have now a technique capable of practical results, and the physiologist's next task is to determine the mechanism of the action of the vitamins in the human body. Success in this field will undoubtedly reveal a good deal more about the body itself.

Prof. P. Karrer, in opening the discussion on vitamin A and the carotinoids, said that two of the ten basic substances at present known to belong to the carotinoid group of yellow pigments are hydrocarbons, lycopene and carotene, having the composition $C_{40}H_{56}$. The results of oxidation experiments indicate that lycopene has an open chain with thirteen double linkings. Carotene occurs in two modifications, the α-modification being highly optically active, while the β-form is inactive. The two isomers differ in melting point and absorption spectra, and isomerism is probably due to different arrangements of the double bonds, both carotenes containing eleven double bonds and two cyclohexene rings, substituted with methyl groups in the 2 : 2 : 6-positions relative to the chain. They may possibly be derived from lycopene by ring closure. Partial hydrogenation of the carotenes yields the dihydrocarotenes. Carotene is not identical with vitamin A from cod-liver oil, although highly active preparations of vitamin A on ozonisation, like carotene, give geronic acid, and vitamin A of cod-liver oil accordingly may contain in its molecule the same pseudo ionone system as carotene and a hydroxyl group, being an oxidation product of carotene.

Biochemical experiments with carotenes and vitamin A described by Prof. H. von Euler have indicated that two forms of carotene exist in plants and a third isomeride can be regenerated from carotene triiodide. Accordingly, it is suggested that there are several fat-soluble factors of the vitamin A type, and concentrates with an extremely high biological activity giving a Carr-Price reaction more than a hundred times as strong as carotene have been prepared. Prof. R. Kuhn described the methods elaborated for the preparation of α-carotene, and the effect of carotene preparations on the growth and liver oils of rats; and Dr. T. Moore contributed a further account of experiments in which the vitamin A content of the liver oil of rats has been increased to about 100,000 B.U. for the entire liver, equivalent to a century's supply at the minimal curative dose, by feeding rats with either carotene or preformed vitamin A. The individual liver oils gave colour values as high as 600 B.U. per mgm. After saponification and removal of the crystalline matter, concentrates having values of 1200 to 2000 B.U. per mgm. were obtained, the final values being largely independent of divergent values of the samples before saponification. The results indicated that conversion of the carotene was accompanied by at least a tenfold increase in colour value. The best concentrates, however, did not appear to be more than two to three times as active as crystalline carotene.

The constitution of lycopene resembles that of squalene, and Prof. I. M. Heilbron and Dr. R. A. Morton have found that fish and mammalian liver oils and concentrates show an absorption band in the ultra-violet (maximum 328 μμ) varying in intensity over the range 1-20,000, which can be determined to within ± 5 per cent. Spectroscopic evidence shows that liver oils contain two chromogenic substances which behave as separate entities, although kinship is not excluded. The 328 μμ band and the 562-583 μμ band in the antimony trichloride colour test are valid quantitative criteria of vitamin A potency. Available evidence regarding the molecular weight of vitamin A and the percentage of inactive substances in the richest concentrates indicates a very high molecular extinction coefficient at 328 μμ, and a chromogenic value for the intensity of the blue colour with antimony trichloride many times greater than that of any known sterol or carotinoid.

The afternoon discussion was devoted to a discussion on the chemistry of vitamin B and related problems. Prof. B. C. P. Jansen opened with an account of the method by which he and Dr. Donath isolated the anti-neuritic B_1 vitamin from rice polishings. Only about 30 mgm. of pure B_1 vitamin hydrochloride were obtained from 100 kgm. after several months' work, but replacement of the phosphotungstic acid by silico-tungstic acid gave a much better yield. Dr. R. A. Peters reviewed the various methods of separating and concentrating the vitamin B complex. Vitamin B_1, like B_4 and B_5, is soluble in absolute alcohol as hydrochloride but insoluble in lipoid solvents. It is stable to acid hydrolysis, even to boiling nitric acid, and is also resistant to benzoylation, oxidation, and reduction and treatment with nitrous acid. It is inactivated by alkali, and the view that B_1 is a tertiary base is further supported by its absorption on charcoal at *p*H 9·0. Vitamin B_4, which is liable to accompany B_1, is differentiated by prior adsorption on charcoal at acid hydrogen ion concentration, and by the wide divergence in the ratio B_1/B_4 in different dilute aqueous and alcoholic hydrochloric acid extracts. It is precipitated by mercuric sulphate, and destroyed on prolonged treatment with nitric acid. Vitamin B_5 follows B_1 in phosphotungstic fractionation and is probably basic. It is more stable to alkali than B_3. Vitamin B_3 is not extracted from the wheat germ by warm dilute 97 per cent alcohol, and although resistant to heat and acid hydrolysis when combined, rapidly disappears when liberated from combination.

In a discussion on the chemistry of vitamin D and related sterols, Mr. R. B. Bourdillon and Drs. E. H. Reerink and A. van Wijk dealt with crystalline preparations of highly antirachitic substances, the latter describing the isolation of a crystalline antirachitic reaction product, m.p. 115°-117°, by irradiation of ergosterol in pure peroxide-free ether. This product is not very stable in solution *in vacuo*, and oxidises very rapidly in presence of oxygen. Its physical properties vary somewhat with the exact isolation conditions. It is possible that the three products isolated by these workers and by Prof. A. Windaus are mixtures of different proportions of two nearly isomorphic antirachitic compounds, one being fairly stable and dextrorotatory, and the other less stable and lævorotatory or slightly dextrorotatory.

Prof. I. M. Heilbron and Mr. J. C. E. Simpson described the preparation of a series of ergosteryl ethers. Ergosteryl methyl ether closely resembles ergosterol itself as regards colour reactions and absorption spectra, but does not yield an antirachitic product on irradiation, an observation which points to the necessity of the free hydroxyl group for the production of the antirachitic vitamin.

Phosphorescence of the Sea.

AN important article on the "Phosphorescence of the Sea" appears in the *Marine Observer* for November, which is published by the Marine Division of the Meteorological Office. Nothing is in reality known about this mysterious phenomenon, save that it is associated with floating animals, and possibly at times with floating plants. During the eleven years 1920–30, some 2200 observations were recorded and the localities of these are charted. The number of reports is affected by the number of observing ships and the lines of the main steamship tracks. But, even making due allowance for these and for the few routes across the Pacific, phosphorescence would seem to be more general near the sides of the oceans and of more frequent occurrence in the warm tropical seas. Thus in the Arabian Sea, which fulfils both these conditions, there are 500 records between the Red Sea and Ceylon, with a special preponderance near the ends of the line. Here monthly graphs show the largest percentage of observations in August, which is about midsummer in the water, but it is also the season of maximum forces of the currents of the East African and West Indian coasts.

The number of displays of phosphorescence in each month along a section across the North Atlantic from Newfoundland to the Bay of Biscay would also seem to fit in with the seasons when the great drift current of the Atlantic is at its strongest, namely, July to August to the east, and March to April to the west. Further support to this theory of the association of currents and phosphorescence is given by the figures shown in the counter equatorial currents, and there would seem also to be possible relationships with currents near Japan and in the Great Australian Bight.

The theory is that currents are carrying the floating animal life that produces the phosphorescence into new areas where it does not normally live, though why it should be stimulated to give its displays is unknown. It would appear that most of the animals in these currents are being carried to destruction, but the presence of differentiated phosphorescent organs in most forms is not consistent with its display being a morbid factor. Phosphorescence varies from sparks of light to a milkiness which may make every part of the deck visible and often fades to a multitude of globes beneath the surface of the sea. All variants of display may be found even in the same region, but we are not yet able precisely to associate the nature of the light with the phosphorescent animals. Why in one condition of the sea no phosphorescence is seen while in another it is brilliant—collections of the surface fauna showing precisely the same organisms—is quite unknown.

Acoustical Problems of Broadcasting Studios.

THE world-wide interest in broadcasting has, during the last seven years, stimulated research on architectural acoustics. An excellent survey of the result was given by N. Ashbridge in a paper on the "Acoustical Problems of Broadcasting Studios", read before Section G of the British Association in London on Sept. 25, and printed in full in *Engineering* for Oct. 16 and 23.

Although economic and practical considerations frequently prevent the adoption of an ideal specification, particularly when a studio has to be made in a building not designed for the purpose, in a new building, such as the Broadcasting House of the B.B.C. in Langham Place, London, almost ideal surroundings are provided for many of the studios. Continuous steel-frame construction is avoided, so as to prevent transmission to the studio of noises from other studios or from machinery. Traffic noises are excluded by the absence of direct openings to the street, fresh air being provided by a quiet ventilating plant serving one studio only, to prevent sound travelling along air-ducts from one studio to another. Walls, floor, and ceiling of a studio are made sufficiently rigid to avoid their tendency of acting as flexible diaphragms. Empirical rules have been found governing the shapes and sizes of studios and their reverberation periods.

It has been found that the physical property that determines almost entirely the value of the reproduction is the reverberation period, which should always be the same for a given size of hall. Although a small studio can readily be built to have plenty of room for an orchestra and a reverberation period of the same value as a concert hall, the intensity of sound in such conditions is often sufficient to be unpleasant for the performers and to overload the microphone. In a good studio the reverberation period is constant to within 20 per cent for all frequencies between about 40 and 10,000 cycles, although practical measurements usually cover only the range from 100 to 6000 cycles per second.

Many Continental studios have walls fitted with shutters having different surface treatment on each side, so that the reverberation period of each studio is variable. In Hamburg the volume of the studio can also be changed by moving the position of one end wall. The range of intensity of sound that can be tolerated by transmitter or receiver is less than half that produced by an orchestra. The position of the microphone in relation to the instruments of an orchestra involves complex factors.

University and Educational Intelligence.

CAMBRIDGE.—The following appointments have been made: A. E. Watkins, St. John's College, University lecturer in cytology; Dr. E. J. Maskell, Emmanuel College, University lecturer in plant physiology; W. J. Dowson, Christ's College, University lecturer in mycology; G. C. Grindley, University demonstrator in experimental psychology, and E. H. B. Boulton, St. Catharine's College, University lecturer in forestry (re-appointment).

H. R. Barnell, Downing College, has been appointed to the Frank Smart University Studentship in Botany.

The governing body of Emmanuel College invites applications for a research studentship which will be awarded in July 1932. Applications must be sent to the Master, Emmanuel College, Cambridge, in time to reach him not later than June 30, 1932. Preference will be given to candidates who have already completed one but not more than two years of research. The studentship, which must be held at Emmanuel College, and has a maximum annual value of £150, is awarded and normally held for two years. The successful applicant must be admitted by the University of Cambridge as a Research Student and begin residence in October 1932.

NOTICE is given by the Institution of Chemical Engineers that application forms for the 1932 examination for the associate-membership of the institution must be returned to the Hon. Registrar, Abbey House, Westminster, S.W.1, by Dec. 21. Copies of the application form and a memorandum on "The Training of a Chemical Engineer" are obtainable from the Hon. Registrar.

THE Chemical Society announces that applications for grants from its Research Fund must be made on forms obtainable from the Assistant Secretary, Burlington House, W.1, by, at latest, Dec. 1. It gives the reminder that the income arising from the donation of the Goldsmiths' Company is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry, and that the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal tar and allied industries.

APPLICATIONS for the following research fellowships for women are invited by the British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3:

a Senior International Fellowship in mathematics, physics, chemistry, geology, and biological sciences (including physiology and pathology), value £250 (offered by the International Federation of University Women); an American International Fellowship, value 1500 dollars (offered by the American Association of University Women); an International Residential Scholarship at Crosby Hall, value £100 (offered by the British Federation of University Women); a Swiss Research Fellowship in arts (including theology and jurisprudence), value 4000 Swiss francs (offered by the Swiss Association of University Women); a Rose Sidgwick Memorial Fellowship, value 2000 dollars; and an Ellen Richards Research Prize, value 2000 dollars.

THE German university system is discussed in a report, published in the October number of the *Universities Review*, of a commission of investigation appointed by the Association of University Teachers. The materials for the report were gathered by a party of university teachers from Aberystwyth, Birmingham, Cardiff, Cork, Exeter, Liverpool, London, Manchester, Nottingham, and Oxford in the course of a tour in Germany during the Easter vacation, the universities visited being Berlin, Göttingen, and Hamburg. Among present-day tendencies noticed in the report is the increasing emphasis on 'bread-and-butter' studies at the expense of the traditional function of the university as a training ground in philosophic method. This is attributed to the revolution and the consequent freer entrance to and overcrowding of the universities, and the growth of unemployment. The large post-War increase in the numbers of students is also responsible for fostering the growth of an examination system somewhat similar to that of Great Britain, and for restricting individual contact between teachers and taught. Interest in physical training has developed notably since the abolition of compulsory military service, and some universities require all students to attend, unless medically exempted, during two semesters at the highly organised physical training courses provided. The complete absence of tutors and similar advisers is referred to as a disadvantage, only partially overcome by the issue of booklets containing advice to students, and by *Fachgemeinschaften* societies for establishing closer academic contacts between staffs and students working for the same examinations, and providing opportunities for joint discussions. The report is a sequel to a similar report prepared last year on the French university system.

THE Bradford Education Committee has published a *Journal of Research* of the Bradford Technical College (vol. 1, 1930, pp. xii + 295). "I am anxious", says the chairman of the Technical Education Sub-Committee in the foreword, "that the volume of research in the College shall increase. I hope that the bi-annual publication of this journal will be possible"—hopes in which everyone interested in the importance of strengthening the link between technical education and industry will join. Far too little is known of the research work which proceeds steadily in technical institutions. Nor has the full capacity for research of which they are capable been yet realised by the institutions themselves. This volume will, we hope, range industrialists still further on the side of those who would break down the barriers which tend to prevent research development in technical institutions —regulations governing the superannuation of teachers form one of them. The majority of the papers now drawn together have previously appeared in various scientific publications. Well printed and clearly illustrated, they show powerfully the wide scope of the work carried out in one of our large technical institutions; they include descriptions of research carried out in practically all departments—textiles, chemistry, physics, mathematics, mechanical and electrical engineering. Invidious as it may be to name any of the papers which make up the volume, nevertheless its scope can better be seen if we indicate: "Bradford and Continental Systems of Yarn Manufacture", "Decomposition of Substituted Carbamyl Chlorides by Hydroxy-Compounds", "A Graphical Analysis of Stress", "The Measurement of the Voltage Amplification Factor of Tetrodes", "Refraction and Dispersion of Gaseous Carbon Disulphide", "Note on Green's Lemma and Stokes's Theorem".

Societies and Academies.

LONDON.

Society of Public Analysts, Nov. 4.—**W. R. Schoeller** and **C. Jahn**: A reliable method for the quantitative separation of titanium from tantalum and niobium. The oxalate salicylate method for the separation of titania from the earth acids has now been perfected, with the result that an almost quantitative recovery of the earth acids is achieved, and that less than 1 mgm. of titania remains in the final pentoxides. The process is claimed to be accurate within 0·5 per cent.—**E. F. Waterhouse** and **W. R. Schoeller**: The separation of the earth acids from metals of the hydrogen sulphide group. The separation of tantalum and niobium from antimony, bismuth, and copper was studied. When the mixed oxides were fused with bisulphate, the mass dissolved in tartaric acid, and the clear solution treated with hydrogen sulphide, the sulphide precipitate was always found to be contaminated with earth acid. The co-precipitation is ascribed to hydrolytic decomposition of the tartaric earth-acid complexes. The separation is completed by further treatment of the sulphide precipitate.—**J. Reilly**, **N. Noonan**, and **P. J. Drumm**: The evaluation of the menthone content of peppermint oil. A method of determining menthone as its semicarbazone is described. In test experiments with pure menthone the results were approximately ninety-five per cent of the theoretical amount.—**D. M. Freeland**: The determination of vanillin in chocolate and cocoa butter. A 2 per cent solution of ammonia in 95 per cent alcohol is used to extract vanillin from cocoa butter, the extracts are evaporated at 70° C. to remove alcohol, the aqueous solution is extracted with ether, the ethereal extracts purified and evaporated at a low temperature, and the residue of crude vanillin dried and weighed. A volumetric method of determination is also described. For chocolate, the fat is first extracted with petroleum spirit.—**H. R. Ambler**: The direct determination of nitrogen in gases. All gases other than nitrogen are removed with only one manipulation of the sample, by (1) burning the combustible constituents in a regulated stream of electrolytic oxygen, and (2) absorbing the excess of oxygen by introducing pyrogallol into the same vessel in the presence of the gas. The residual gas, consisting of nitrogen, is then directly measured. A special combustion vessel is used.

PARIS.

Academy of Sciences, Oct. 5.—**Emile Picard**: The fifth general meeting of the International Research Council.—**L. Massoutié**: Fermat's last theorem.—**Jacques Herbrand**: The theory of bodies of numbers of infinite degree.—**F. Leja**: A property of series of polynomials.—**Bertrand Gambier**: The simultaneous integration of two differential equations of the first order.—**W. Fédoroff**: A characteristic property of monogene functions.—**Kiveliovitch**: Shocks in the problem of a body attracted by two fixed centres.—**Lucien Féraud**: Properties resulting from the arithmetical nature of characteristic exponents.—**Jean Louis Destouches**: An equation of quantum mechanics.—**A. Grebel**: Automatic self-tightening bolts. A general discussion of the subject showing that the faults of existing devices are in part due to failure to grasp the problem as a whole.—**R. de Mallemann**: The molecular theory of electro-optical phenomena.—**A. Piccard, E. Stahel, and F. Dony**: The absorption of the penetrating gamma rays by lead screens 12-30 cm. thick. In the case of the thickest screen, allowing the passage of less than one millionth of the original gamma rays, a preparation of 6 grams of elementary radium was employed. There was no evidence of an ultra-penetrating component. This result, combined with the fact that at an altitude of 16,000 metres gamma rays are found, is contrary to the hypothesis according to which the cosmic rays would be the penetrating part of an ordinary radioactive effect.—**Ch. Bedel**: The electromotive forces developed between silicon and some substances in solution in hydrofluoric acid, sulphuric acid, and soda.—**Charles Dufraisse and Marius Badoche**: Researches on the coloured hydrocarbons: a violet hydrocarbon $C_{36}H_{22}$. This hydrocarbon is obtained by removing two atoms of hydrogen from dephenylorubrene.—**André Meyer and Robert Vittenet**: The azomethines of homophthalimide and its *N*-aryl derivatives.—**S. Goldsztaub**: The dehydration of the natural ferric hydrates.—**Jacques Bourcart**: Some new data on the problem of the limit between the Moroccan Haut-Atlas and Moyen-Atlas.—**Henry Hubert**: Researches on the climatology of French West Africa.—**L. Grigorakis**: The morphology and cytology of the Actinomyces.—**R. Argaud**: Veins with ribbed wall.—**Ouang Te Yio**: The physiological nature of the diastase secreted by the eclosion gland in the Plagiostomes (*Scylliorhinus canicula*). This diastase resembles trypsin, and acts in neutral or faintly alkaline medium. It acts at a much lower temperature than trypsin.—**A. Perrier**: Researches on the rôle of pectinase in the fermentation of coffee.—**A. Blanchetière**: The action of trypsin on solutions of monoamino acids, isolated or mixed.—**G. Dinulescu**: A larva of the gad-fly producing tumours in the duodenum of horses in Spain.

BRUSSELS.

Royal Academy of Belgium, April 11.—**Paul Stroobant**: The rotation of the galaxy and the solar apex shown by the radial velocities of the helium stars. A study in 1926 of the distribution of the radial velocities of the helium stars has led to the indication of a movement of translation of the whole of these stars.—**E. De Wildeman**: Concerning the northern limit of the tropical forest in the Mele region (Belgian Congo). Study of the causes of the contraction of the virgin forests in this region.—**M. Dehalu**: The observation of the total eclipse of the moon on April 2, 1931, at Cointe. The end of the totality was found to be $8^h\ 54^m\ 2^s$ by direct observations: from photographs the values $8^h\ 54^m\ 45^s$ and $8^h\ 54^m\ 41^s$ were obtained by two different methods of measurement.—**Th. De Donder**: Affinity (2). Fourth communication.—**Lucien Godeaux**: (1) Involutions of the second order of space. (2) The canonical pencil of a surface.—**A. C. Seward**: Some late Palæozoic plants from the Belgian Congo.—**Constant Lurquin**: The extension of the Bernoulli-Poisson law.—**Ray, M. Bouillenne and P. Prévot**: A plant association with *Empetrum* in the Fagnes de Clefay.—**Mlle. M. Charpentier**: The extension of Baire's problem to certain dependences considered in the theory of differential equations.—**J. Genard**: The scheme of levels of the diatomic vapour of sulphur.—**P. Gilard**: The ultra-violet transmission of glasses. A systematic study of glasses in which the proportion of one ingredient was varied. The influence of the addition of rare earths (cerium, didymium, neodymium, lanthanum) was also examined: these were not found to be specially favourable to the transmission of ultra-violet rays. The presence of the oxides of iron and manganese was found to be definitely unfavourable to the passage of the ultra-violet.—**R. H. J. Germay**: The calculation of the elliptical elements in the determination of the orbit of a planet from three observations.—**R. Deaux**: Conical helices.—**Mlle. G. Schouls**: The study of dynamic azeotropism.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 7, July 15).—**Wilder D. Bancroft, J. W. Ackerman, and Catharine Gallagher**: Optical sensitisation. Grotthuss (1818) showed that an alcoholic solution of ferric chloride is reduced by sunlight; the alcohol reacts with the chloride preventing the reverse action. Similarly, solutions of ferric chloride and silver nitrate free from organic matter are reduced by light when light-sensitive dyes are added. Optical dyes in photography are light-sensitive and adsorbed by silver bromide, and they are, or become, reducing agents capable of reducing the bromide.—**Wilder D. Bancroft and G. H. Richter**: Reversible coagulation in living tissue (4). The chronaxie of the nerve portion of a frog muscle-nerve preparation—that is, duration of stimulus required to produce an effect where the voltage is twice the minimum effective voltage (Lapicque)—first decreases and then increases with addition of a coagulating solution. Chronaxie of both nerve and muscle passes through a maximum with varying hydrogen ion concentration at about the isoelectric point for many proteins. These results support Claude Bernard's view that anæsthesia is due to reversible coagulation of nerve protein.—**R. E. Bowen**: The cupula of the ear. A mucilaginous substance coagulates on the crista under the action of fixing agents to form the so-called cupula. The cupula does not exist as a definitely formed structure in the living ampulla. The tectorial membrane may similarly be a coagulation product.—**B. R. Coonfield**: The cilia of *Naphthys bucera*.—**F. D. Murnaghan and A. Wintner**: A canonical form for real matrices under orthogonal transformations.—**R. B. Lindsay**: Wave motion and the equation of continuity.—**Edwin H. Hall**: Electric conductivity and optical absorption in metals (supplementary).—**Benedict Cassen**: Electromagnetic fields derived from non-commutating potentials.—**Howard B. Frost**: Uncomplicated trisomic inheritance of purple verus red in *Matthiola incana*.—**Ralph E. Cleland**: The probable origin of *Œnothera rubricalyx* " Afterglow " on the basis of the segmental interchange theory.—**Nelson F. Waters**: Inheritance of body weight in domestic fowl. The Light Brahma breed is about twice the weight of the Single Comb White Leghorn, and breeding tests with these races suggest that the difference in weight between the breeds depends primarily on two pairs of factors, each of which affects the weight of the individual equally, and which together have cumulative effects. A genetically big bird grows more rapidly and more persistently than a genetically small bird, and hybrids are intermediate except in so far as they are affected by hybrid vigour. Maximum hybrid vigour seems to go with the completely heterozygous condition of all its allelomorphic pairs of genes and vice versa.

Official Publications Received.

British.

Journal of the Institute of Actuaries Students' Society. Vol 3, No. 5. Pp. 291-354. (London: C. and E. Layton.) 3*s*.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol 61, January to June. Pp. xli + 285 + 37 plates. (London.) 15*s*. net.

The Strangeways Research Laboratory, Cambridge. Report of Trustees for 1930. Pp. 16. (Cambridge.)

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Air Council for the Year ended March 31, 1931. (M.O. 338) Pp. 54. (London: H M. Stationery Office.) 9*d*. net

Government of India: Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1927, under the direction of Dr. S. K. Banerji. Pp. iv+182+6 plates. (Calcutta: Government of India Central Publication Branch)

N Z. Department of Scientific and Industrial Research Bulletin No. 26: Influence of Season and Fertilizer on the Yield and Composition of a Typical Dairying Pasture, Nelson, N.Z. By T. Rigg and H. O Askew. (Cawthron Institute Pasture Research Publications, Nos 7, 8 and 10.) Pp 32+35+14. (Wellington, N.Z . W A. G. Skinner.) 2*s*.

Proceedings of the Royal Irish Academy Vol. 40, Section B, Nos. 5, 6, 7, 8, 9: The Synthesis of Chromano-Quinoline Derivatives, by Dr. Joseph Algar and T. A. M'Cullagh, Orientation in the Aromatic Ether Series, by J. Reilly, P. J. Drumm and B. Daly; Studies in the Pyrazole Series (Diazotisation of Aminophenyl Pyrazoles), by J. Reilly, B. Daly and P. J. Drumm, Lichenin and Lichenin Nitrate, by J Reilly, Miss M. Hayes and P. J Drumm; The Constitution of Fischer and Bulow's Pyrazole, by P. J. Drumm Pp. 84-108. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*.

County Borough of Middlesbrough Education Committee: Constantine Technical College. Full Time Foundry and Metallurgical Courses. Pp. 12. (Middlesbrough.)

Australian Association for Fighting Venereal Disease (Victorian Branch). Report for Year ending December 31st, 1930. Pp 11. (Melbourne.)

Journal of the Royal Statistical Society. New Series, Vol. 94, Part 4. Pp. 487-685+xvi. (London.) 7*s*. 6*d*.

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 8, September. Pp. 345-392+xl. (London.)

Indian Central Cotton Committee. Technological Laboratory. Technological Bulletin, Series A, No. 18: Technological Reports on Standard Indian Cottons, 1931. By Dr. Nazir Ahmad. Pp. iv+116. (Bombay.) 2 rupees.

Gold Coast Colony. Report on the Survey Department for the Year 1930-31. Pp. ii+26. (Accra. Government Printing Office, London: The Crown Agents for the Colonies.) 2*s*.

Foreign.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 85: The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Seasons 1926–27 and 1927–28. By Dr. W. Lawrence Balls and Armenag Eft. Bedevian Pp. 61+27 plates. 5 P.T. Bulletin No. 100: Developments of the Existing System for Seed Supply of Cotton in Egypt. By Dr. W. Lawrence Balls. Pp 11+3 plates. 5 P.T. Bulletin No. 101: Growth Fluctuations during the Development of Seed-Cotton. By Dr. W. Lawrence Balls Pp. 15+2 plates. 5 P.T. Bulletin No. 104: The Operation of the Seed Control Law upon the Pedigree of Cotton Seed in Season 1926 to 1930, with a Discussion of Evasions of the Law. By Dr. W. Lawrence Balls and Armenag Eff. Bedevian. Pp. 28 + 23 plates. 10 P.T. (Cairo: Government Press.)

Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band 65. Synopsis Rosarum Spontanearum Europae Mediae · Übersicht uber die mitteleuropaischen Wildrosen mit besonderer Berucksichtigung ihrer Schweizerischen Fondorte Von Dr. Robert Keller. Pp xii+796+40 Tafeln Band 66, Abh 2: Der Vogelzug in der Schweiz. Von Dr. Konrad Bretscher. Pp 79-114+2 Karten. (Zurich: Gebruder Fretz A.-G)

Publications of the Observatory of the University of Michigan. Vol 4, No 3. The Spectral Variations of 25 Orionis and 52 (π) Aquarii. By Dean B. McLaughlin Pp. 37-51. (Ann Arbor, Mich.)

Proceedings of the American Philosophical Society. Vol. 70, No. 4. Pp. 317-398. (Philadelphia.)

Proceedings of the United States National Museum. Vol. 79, Art. 10: Report on Birds recorded by the Pinchot Expedition of 1929 to the Caribbean and Pacific. By Albert K. Fisher and Alexander Wetmore. (No. 2876) Pp. 66+10 plates. Vol. 79, Art. 18: Two New Lungworms from North American Ruminants, and a Note on the Lungworms of Sheep in the United States. By G. Dikmans. (No. 2884) Pp. 4+2 plates Vol. 79, Art. 19: A New Genus and New Species of Trematode Worms of the Family Plagiorchiidae. By John T. Lucker. (No. 2885.) Pp. 8+1 plate (Washington, D.C.: Government Printing Office)

Technical Books of 1930: a Selection. Compiled by Donald Hendry. (Twenty-third Issue). Pp. 28. (Brooklyn, N.Y.: Pratt Institute Free Library.)

Agricultural Experiment Station of the Rhode Island State College. Bulletin 228: Inheritance of Body-Weight in Domestic Fowl. By Nelson F. Waters. Pp 105. (Kingston, R.I.)

U.S. Department of Agriculture. Circular No. 165: Plowing as a Control Measure for the European Corn Borer in Western New York. By H. N. Bartley and L. B. Scott. Pp. 28. (Washington, D.C.: Government Printing Office) 10 cents.

Memoires du Musée Royal d'Histoire Naturelle de Belgique. Hors Série. Résultats scientifiques du voyage aux Indes orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. Publiés par V. Van Straelen. Vol. 3, Fascicule 7: Opilions. Par Louis Giltay. Pp. 24. Mémoire No. 44: Considérations sur la stratigraphie du terrain Houiller de la Belgique, par Armand Renier; La faune continentale du terrain Houiller de la Belgique, par Prof. Pierre Pruvost. Pp 282+14 planches. (Bruxelles)

Sveriges Geologiska Undersokning. Ser. Aa, No. 168: Beskrivning till kartbladet Malingsbo. Av A. Hogbom och G. Lundquist. Pp. 181+1 tavla. 4.00 kr. Ser. Aa, No. 173. Beskrivning till kartbladet Goteborg Av R. Sandegren och H. E. Johansson. Pp. 141+1 tavla. 4.00 kr. (Stockholm: P. A. Norstedt and Soner.)

Pubblicazioni del R Osservatorio Astronomico di Merate (Como) succursale del R Osservatorio di Brera (Milano). N. 5: Ricerche sulla frequenza delle grandezze assolute delle stelle, delle diverse classi spettrali. Per Gino Cecchini. Parte 2: Distribuzione delle grandezze assolute. Pp. 112. (Milano: Ulrico Hoepli.) 30 lire.

Catalogue.

A Clearance List of Books on Geology, Meteorology, Mathematics, Astronomy, Chemistry, Physics, etc. (Clearance List "B".) Pp. 28. (London: Wheldon and Wesley, Ltd.)

Diary of Societies.

FRIDAY, November 13.

Biochemical Society (at Imperial College of Science and Technology), at 3.—T. Moore: High Potency Vitamin A Concentrates.—S H. Piper: X-Ray Analysis of Certain Long Chain Paraffins, Ketones, and Alcohols.—A. C. Chibnall: The Metabolism of Plant Waxes.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.—J. A. B. Smith: The Glyceride Fatty Acids of Certain Forage Grasses.—C. R. Harington and S. S. Randall: Synthesis and Properties of *l*-β-Hydroxyglutamic Acid.—W. L. Davies: The Inactivation of Lipase in Dairy Products by Traces of Heavy Metal Salts.—J. Pryde and R. T. Williams: The Structure of Borneol Glucuronic Acid Synthesised *in vivo*.—T. S. G. Jones and E. T. Waters: A Note on the Sugar of the Nucleic Acid of *Bacillus Tuberculosis*.—H. J. Phelps: The Influence of Hydrogen-ion Concentration on the Response of Tissues to Histamine.—P V. McKie: The Nitrogen Metabolism of the Lupin Seedling —A. C. Chibnall and R. G. Westall: The Estimation of Glutamine in the Presence of Asparagine —J. M. Gulland and W. H. Newton: Observations on the Purification of the Oxytocic Principle of the Posterior Lobe of the Pituitary Gland.—*Demonstrations*:—S. H. Piper and A. C Chibnall: Apparatus for Distillation in High Vacuo of Substances with a High Melting Point.—G. H. Bell and A. R. Craig Paterson: A Chart for *p*H Calculations.

Royal Society of Arts (Indian Meeting), at 4.30.—Lt.-Col. M. L. Ferrar: The New Penal System in the Andamans.

Royal Society of Medicine (Clinical Section), at 5.30.

Malacological Society of London (at Linnean Society), at 6.—Prof. A. E. Boycott, C. Oldham, and A. R. Waterston: A Trip to Kerry.—N. H. Odhner: New and Little Known African Land Shells.—Prof. S. Hirase: The Adaptive Modifications of *Stilifer celebensis* Kuk.—F. F. Laidlaw: Notes on Zonitidæ from the Malay Peninsula with Descriptions of New Genera.—A. E. Ellis: The Habitats of Hydrobiidæ in the Adur Estuary.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.—J. W. Hobson: The Care and Maintenance of the Industrial Steam Locomotive.

Institution of Electrical Engineers (London Students' Section), at 6.15.—W. A. Bishop · Short Wave Transmission.

Institution of Welding Engineers (at Chamber of Commerce, Birmingham), at 7.—E. W. Thompson and A. Jeavons: Some Details of the Progress reached in Forge and other Welding in Boiler Works Practice.

Manchester Association of Engineers (at Engineers' Club, Manchester), at 7.15 —J. E. Hurst: A Comparative Study of the Properties of British Pig Irons.

Junior Institution of Engineers, at 7.30.—Annual General Meeting.

Keighley Association of Engineers (at Queen's Hotel, Keighley), at 7.30.—E. Clegg: The Industrial Smoke and Grit Problem.

Institute of Metals (Sheffield Local Section) (at University, Sheffield), at 7.30.—E A. Smith: Engineering Silver Solders.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—D. McDonald: Platinum.

Royal Society of Medicine (Ophthalmology Section), at 8.30.—R. Gunn: Some Points in the Fitting of Contact Glasses.—F. Ridley: The Use of Antiseptics.

SATURDAY, November 14

British Mycological Society (in Botanical Department, University College), at 11 a.m.—Dr. B Barnes: Some Aquatic Fungi new to Britain.—T. H. Harrison: A Species of *Lambertella* Parasitic on Apple. —Prof. N. J. G. Smith: Some of the More Curious South African Fungi.—Dr. R. G. Tomkins: Measuring Germination.

Royal Institution of Great Britain, at 3.—F. E. Yerbury: Present-Day Architecture on the Continent; Modern Buildings in Scandinavia.

MONDAY, November 16.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at University, Liverpool), at 7.—Prof. E. W. Marchant: Oscillographs.

Royal Institute of British Architects, at 8.—H. S. Goodhart-Rendel: Modern European Architecture.

Royal Geographical Society, at 8.30.—W. S. Barclay: The Basin of the Parana.

TUESDAY, November 17.

Royal Institution of Great Britain, at 5.15.—Prof. J. B. S. Haldane: New Light on the Origin of Species (1).

Royal Statistical Society (at Royal Society of Arts), at 5 15.—R. G. Glenday: Business Forecasting: A Quantitative Investigation of the Influence of Money on Trade Development.

Royal Society of Medicine, at 5.30.—General Meeting.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of October

1931.—H. R. Hewer: Studies in *Zygæna* (Lepidoptera): (*a*) The Female Genitalia; (*b*) The Male Genitalia.—Dr. F. Gwendolen Rees: An Investigation into the Occurrence, Structure, and Life-Histories of the Trematode Parasites of Four Species of *Lymnæa* and of *Hydrŏbia jenkinsi* (Mollusca) in Glamorgan and Monmouth.—Dr. Awadh Behari Misra: On the Internal Anatomy of the Male Lac Insect, *Laccifer lacca* Kerr.—W. S. Bristowe: (*a*) A Preliminary Note on the Spiders of Krakatau; (*b*) The Mating Habits of Spiders, and a Description of a New Thomisid Spider from Krakatau; (*c*) Spiders of the Farne Islands.—Dr. G. S. Sansom: Notes on Some Early Blastocysts of the South American Bat *Molossus*.

Institution of Civil Engineers, at 6.—H. C. Whitehead and F. R. O'Shaughnessy: The Treatment of Sewage Sludge by Bacterial Digestion.

Royal Aeronautical Society (Students' Section) (at 7 Albemarle Street), at 6.30.—Prof. L. Bairstow: Applications of Aeronautical Research.

London Natural History Society (Botany Section) (at London School of Hygiene and Tropical Medicine), at 6.30.—J. Ross: Common Wall Mosses.

Institution of Electrical Engineers (East Midland Sub-Centre) (at College, Loughborough), at 6.45.—N. B. Rosher: Address.

Institution of Automobile Engineers (Wolverhampton Centre) (at Seagrave Club, Wolverhampton), at 7.30.—B. G. Robbins: The Training of Young Automobile Engineers.

Royal Society of Arts, at 8.—M. Hochstadter, W. Vogel, and E. Bowden: The Pressure Cable: An Advance in the Construction of High Voltage Cable Installations.

Royal Aeronautical Society (Bristol Branch).—Major J. S. Buchanan: High Speed Aircraft.

Royal Photographic Society.—J. Reid Moir: Ancient Men in East Anglia.

WEDNESDAY, November 18.

Society of Glass Technology (at University, Sheffield), at 2.

Royal Meteorological Society, at 5.—J. E. Clark, I. D. Margary, R. Marshall, C. J. P. Cave, and L. C. W. Bonacina: Report on the Phenological Observations in the British Isles, from December 1929 to November 1930.—Sir G. T. Walker and A. C. Phillips: The Forms of Stratified Clouds: Part 1, Experimental; Part 2, Discussion.—W. Dunbar: Eighty Years Rainfall at North Craig Reservoir, Kilmarnock.

Royal Microscopical Society (at B.M.A. House, Tavistock Square), at 5.30.—Conrad Beck: The Substage Diaphragm and its Functions.—Dr. A. A. Tarkhan: The Effects of Fixatives and other Reagents on Cell-size and Tissue-bulk.

Geological Society, at 5.30.—Prof. A. C. Seward: (*a*) Fossil Plants from the Bokkeveld and Witteberg Beds of South Africa; (*b*) Carboniferous Plants from Sinai.—Dr. T. N. George: The British Carboniferous Reticulate Spiriferidæ.

Illuminating Engineering Society (at 4 Dowgate Hill, E.C.4) at 7.—R. H. Monier-Williams: The Tallow Chandlers' Company and their Craft.—W. J. A. Butterfield: The Historical Development of Gas Lighting.—J. Swinburne: The Early Days of Electric Lighting.

Institution of Automobile Engineers (Leeds Centre) (at Hotel Metropole, Leeds), at 7.15.—B. G. Robbins: The Training of Young Automobile Engineers.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—W. Pratt: Turbine Gearing.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

Royal Society of Arts, at 8.—P. H. Jowett: The Royal Society of Arts Competition of Industrial Designs, 1931.

Folk-Lore Society (at University College), at 8.—R. E. Enthoven: The Lime, Rice-Straw, and the Convolvulus in Indian Primitive Practice

THURSDAY, November 19.

Royal Society, at 4.—Special General Meeting to consider the Annual Report of Council.—At 4.30.—Prof. A. V. Hill: Myothermic Experiments on the Frog's Gastrocnemius.—J. E. Barnard and W. J. Elford: The Causative Organism in Infectious Ectromelia. Appendix—Filtration Experiments with Virus of Infectious Ectromelia.—V. B. Wigglesworth: The Extent of Air in the Tracheoles of some Terrestrial Insects.

Linnean Society of London, at 5.—Celebration of Robert Brown's Discovery of the Nucleus of the Vegetable Cell:—J. Ramsbottom: Robert Brown as Botanist.—S. Savage: Robert Brown as an Official of the Linnean Society.—The President: Reading of Brown's Contribution.—Lt.-Col. J. Stephenson: Relation of Brown's Discovery of the Nucleus to the History of the Cell Theory.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.—B. G. Luff: Notes on the Mica Industry in Bihar, India.—F. W. Armstrong: Models of Mines and Orebodies.

Institution of Electrical Engineers, at 6.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—H. Constant. Aircraft Vibration.

Institution of Electrical Engineers (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.

Chemical Society, at 8.—R. S. Cahn, A. R. Penfold, and J. L. Simonsen: Dehydrogeranic Acid.—W. Charlton, J. C. Earl, J. Kenner, and A. A. Luciano: The Nitration of Oximes.—Prof. C. S. Gibson and J. D. A. Johnson: 10-Chloro-5:10-dihydrophenarsazine and its Derivatives. Part XVII. Constitution of the Nitro-derivatives produced from 3-nitrodiphenylamine-6′-arsenic Acid and its Homologues.—R. P. Linstead: Investigations of the Olefinic Acids. Part VI. Lactonisation and Allied Additive Reactions. Part I. The System, αβ-acid-βγ-acid-γ-lactone.

Royal Society of Tropical Medicine and Hygiene (at Hospital for Tropical Diseases), at 8.15.—Clinical and Laboratory Meeting.

British Institute of Radiology, at 8.30.—Dr. F. Roberts: Some Criticisms of the International Protection Recommendations.—G. E. Vilvandre: The Radiology of Gall-stones and the Gall-bladder.

Institution of Mechanical Engineers (Manchester Centre) (at Manchester).—Ll. B. Atkinson: The Mechanical Aspects of Electricity (Thomas Hawksley Lecture).

FRIDAY, November 20.

Royal Society of Medicine (Physical Medicine Section) (at British Red Cross Clinic, Peto Place, N.W.1), at 5.

Physical Society (at Imperial College of Science), at 5.—Miss F. Lowater: The Band Spectrum of Zirconium Oxide.—W. A. Wood: Lattice-distortion of Cold-drawn Constantan Wire.—Dr. F. Aughtie: (*a*) A Remote Electrically Recording Accelerometer with Particular Reference to Wheel-impact Measurements; (*b*) A Remote Electrically Recording Load-gauge for Wheel-impact Measurements.—Prof. E. V. Appleton and G. Builder: Wireless Echoes of Short Delay.—Kerr Grant: *Demonstrations*:—A Contrivance for Demonstrating the Law of Errors; a New Type of Surface-tension Meter; and a New Type of Static Electrometer.

Society of Chemical Industry (Liverpool Section) (at University, Liverpool), at 6.—Prof. I. M. Heilbron: Nature's Variations on the Isoprene Theme.

Institution of Mechanical Engineers, at 6.—Presentation of Sixth Report of the Marine Oil Engine Trials Committee.

Society of Dyers and Colourists (at 36 George Street, Manchester), at 7.—C. M. Whittaker: Random Leaves from a Viscose Yarn Dyer's Notebook.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry—South Wales Section) (at Technical College, Cardiff), at 7.30.—Dr. J. H. Quastel: Dyestuffs and Biological Activity.

Society of Chemical Industry (Glasgow Section) (at St. Enoch Hotel, Glasgow), at 7.30.—Prof. J. C. Philip: The Abstracting of Chemical Literature.

Junior Institution of Engineers, at 7.30.—H. G. Brown: Modern Pressed Brick Manufacture.

South London Botanical Institute (323 Norwood Road), at 8.—J. E. Lousley: Plant Parasites (Lecture).

Royal Society of Medicine (Radiology Section), at 8.30.—Discussion on X-ray Diagnosis of Diseases of the Chest.

Royal Institution of Great Britain, at 9.—Prof. C. H. Lander: Oil and Petrol from Coal.

Royal Aeronautical Society (Hull and Leeds Branch).—Lt.-Col. W. L. Marsh: Speed in Aviation and what it means.

SATURDAY, November 21.

Royal Institution of Great Britain, at 3.—W. Perrett: The Music of Ancient Greece (1): The Enharmonic Genus.

British Psychological Society (at King's College), at 3.—Rev. H. L. Philp: Frustration of Will Acts.—M. F. Lowe: Blood Distribution during Mental Activity.—*Demonstrations*:—A. G. Caws: Perception of Tachistoscopically Exposed Symbols.—R. Westgate: Effect of Affective Stimuli on Muscular Work.

PUBLIC LECTURES.

FRIDAY, November 13.

King's College, London, at 5.30.—J. Benda: L'exploitation de la Science par la Littérature au 19e Siècle.

Bedson Club (at Armstrong College, Newcastle-upon-Tyne), at 6.30.—Prof. J. Read: Some Researches on Essential Oils.

Chadwick Trust Lecture (at Gateshead Town Hall), at 7.30.—Sir Robert Philip. The Outlook on Tuberculosis—Then and Now.

SATURDAY, November 14.

Horniman Museum (Forest Hill), at 3.30.—M. A. Phillips: Nature at Home.

MONDAY, November 16.

University, Leeds, at 5.15.—Prof. J. B. S. Haldane: Evolution in the Light of Genetics.

Royal Anthropological Institute (at University College), at 5.30.—J. V. S. Wilkinson: Historians and Painters of the Mughal Court.

University College, at 5.30.—Prof. B. Ohlin: Some Remedies for Unemployment (Newmarch Lectures in Statistics) (1) (Succeeding Lectures on Nov. 17, 18, 19, and 20.)

Royal School of Mines, at 8.—Dr. C. J. Smithells: Metallurgy in the Electrical Industry (Armourers' and Brasiers' Company Lectures). (Succeeding Lectures on Nov. 23 and 30.)

TUESDAY, November 17.

University College, at 3.—Dr. W. Stephenson. Clinical Mental Tests.

Gresham College, at 6.—A. R. Hinks: Unanswered Questions in Astronomy. (Succeeding Lectures on Nov. 13, 19, and 20.)

Institute of Industrial Administration (at Institute of Hygiene, 28 Portland Place, W.1), at 6.30.—J. Fearn: Industrial Russia.

WEDNESDAY, November 18.

Royal Institute of Public Health, at 4.—Dr. P. Chalmers Watson: The Food of the Citizen

London School of Economics, at 6.—Dr. L. J. Comrie: Modern Babbage Machines.

Museum and Art Gallery, Belfast, at 8.—Dr. A. Mahr: Megaliths in Prehistoric Europe, with Special Reference to Irish Evidence.

THURSDAY, November 19.

Science Museum (South Kensington) (in connexion with Exhibition of Modern Glasses), at 4.45.—A. L. Marden: The Electrical Incandescent Lamp.

FRIDAY, November 20.

University College, Dundee, Scientific Society (at Dundee), at 4.30.—Prof. J. Read: An Organic Chemist looks at Australia

Institute of Chemistry, at 8.—Dr. J. V. Eyre: Recent Advances in the Fermentation Industries (Streatfeild Memorial Lecture)

SATURDAY, November 21.

Horniman Museum (Forest Hill), at 3.30.—H. St. George Gray: The Romans in the South of England.

SATURDAY, NOVEMBER 21, 1931.

CONTENTS.

PAGE
Zoological Survey of India 849
Upwards and Downwards in the Calculus. By E. H. N. 851
Physical and Colloidal Chemistry 852
"Of composts shall the Muse disdain to sing?" By Prof. F. L. Engledow 854
Short Reviews 855
A Century of Geology. By Prof. J. W. Gregory, F.R.S. 857
The Volta Conference at Rome 861
Radio Research in Great Britain 861
Obituary:
Prof. J. S. C. Douglas 862
News and Views 863
Letters to the Editor:
Representation of Crystal Structure.—Prof. E. B. Bailey, F.R.S. 869
Effects of Inadequate Feeding on Insect Metamorphosis.—Dr. Hem Singh Pruthi . . . 869
The Spin of the Photon.—Prof. M. N. Saha, F.R.S., and Y. Bhargava 870
Light Scattering in Liquids.—S. Venkateswaran 870
Photoelectrons and Negative Ions.—Dr. J. L. Hamshere 871
Change of Dielectric Polarisation of Carbon Disulphide with Temperature.—Prof. M. Wolfke and Dr. J. Mazur 871
Diamagnetism of Liquid Mixtures.—S. Ramachandra Rao and G. Sivaramakrishnan . . 872
Duration and Magnitude of a Lightning Discharge.—R. S. J. Spilsbury 872
Structure of the Azide Group.—T. C. Sutton . 872
Slow Combustion of Hydrocarbons.—Dr. R. Spence 873
Occurrence of *Lithothamnion* in the South Indian Cretaceous.—Prof. L. Rama Rao . . . 873
Research Items 874
Astronomical Topics 876
Educational Broadcasting 877
Control of West Indian Insect Pests. By Dr. A. D. Imms, F.R.S. 878
Measurement of Pressure and Temperature in the Upper Atmosphere. By E. V. Newnham . . 878
Prehistoric Society of East Anglia 879
The Rubber Research Institute of Malaya . . 880
University and Educational Intelligence . . . 880
Birthdays and Research Centres 881
Societies and Academies 881
Official Publications Received 883
Diary of Societies 883

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Zoological Survey of India.

THE Government of India, like many other governments of the world, is at present passing through a financial crisis, and in order to balance its budget finds it necessary to effect heavy retrenchments in expenditure. Proposals for retrenchment have been submitted to Government by certain committees appointed for the purpose, composed of members of the Indian Legislative Assembly; the proposals which affect the Zoological Survey of India are contained in the Report (Interim) of the General Purposes Sub-Committee of the Retrenchment Advisory Committee (Part I.), recently published, and Sir C. V. Raman has considered these proposals in a pamphlet which he has issued entitled "The Zoological Survey of India—Memorandum on the Proposals for Retrenchment".

The Zoological Survey, instituted in 1916, inherited, as the Sub-Committee observes, the duties of the zoological and anthropological section of the Indian Museum; it acts as a guardian of the zoological collection of the Indian Empire and obtains and utilises information about the systematic and geographical zoology of India. The budget of the Survey for the present financial year is Rs. 2,30,000 (about £17,250); that proposed for next year is Rs. 60,000, about a quarter (26 per cent) of its present amount. One of the eight officers at present on the cadre of the Survey has been newly appointed for fisheries work in the Andamans; it is proposed by the Sub-Committee that this work should go on, at a cost of not more than Rs. 12,000 (about £900). The figures adopted by Sir C. V. Raman are exclusive of this allocation for fisheries; as he puts it, an annual budget of Rs. 2,18,000 is being cut down to Rs. 48,000 (£3600, or 22 per cent of this year's amount); as a matter of fact, the zoological work which is the primary reason for the existence of the Survey is in worse case than is implied by even this, since the anthropological section of the Survey, as well as the fisheries, is also to be continued and financed out of the reduced budget.

"We feel", says the Sub-Committee, "that the essential duties can still be carried on with the budget proposed by us provided that all unnecessary items of expenditure are deleted." *Prima facie* it is unlikely that "the essential duties" of any department can be carried on on a quarter (or, taking Sir C. V. Raman's interpretation, a little more than one-fifth) of its actual present-day cost; and in particular that the zoological and anthropological needs of an area the size of western Europe, with a fauna and a human population far richer and more diversified than those of Europe, can be cared for on an expenditure of £3600 per annum. Leaving entirely aside the wider duties of the Survey, mere maintenance charges—the upkeep of the collections of the Museum, the display of specimens in the galleries, the pay of clerks and attendants, the maintenance of the library (probably by far the best zoological library in the whole of Asia), including the purchase of books and periodicals as well as their care—these indispensable charges swallow up a sum which will permit the payment of the salary of only a single officer, who would be entirely occupied with the administration of the Museum; while the valuable series of the *Memoirs* and *Records of the Indian Museum* must, of course, cease immediately.

There are at present seven officers (exclusive of the one recently appointed for fishery work) on the Survey; in 1906 there were four officers in the zoological section of the Indian Museum; the number had risen from one in 1875; if the Sub-Committee's retrenchment proposals are adopted, the officers of the Survey must be disbanded, the research work of the Survey must come to an end, and the hands of the clock will be put back to a period fifty years ago.

The Sub-Committee, it is fair to say, probably does not intend this; it states that "Zoological Survey work is not normally of a systematic nature, and the work of the Universities could and should be of the nature which must overlap the activities of a Government zoological department. Further, zoological survey cannot be said to have economic value." There seems to be some misunderstanding here, or rather several misunderstandings. Zoological survey work is in the first place and above all 'systematic' (in the zoological sense), and 'systematic' zoology is not the division that either is or usually can be taken up in universities. As Sir Venkata shows convincingly, the work in universities is and must be mainly morphological; facilities for 'systematic' work—large named collections for comparison, and especially a complete and up-to-date library—do not exist at the universities, and can only be had at the Survey headquarters at Calcutta; and the teachers of zoology have neither the leisure nor, it may be added, in most cases the training, for undertaking the work of the Survey in addition to their own duties. "The functions of a State Museum of Zoology, namely, the care and preservation of the national collections, the proper arrangement of zoological exhibits in the public galleries with a view to educate the public, and research in systematic zoology, cannot be relegated to a University without seriously affecting the usefulness and efficiency of both the University and the State Museum." It may perhaps be added that even if these functions could be so relegated, they would presumably have to be paid for; and the Government of India would be paying for amateur work done by servants of other institutions what it now pays to its own experts. Further, all but one (Calcutta) of the Indian universities which grant degrees in zoology are at a distance of hundreds of miles—a number at more than a thousand—from the Museum and Survey headquarters.

Regarding the alleged economic worthlessness of zoological survey work, Sir Venkata quotes the words of the late Dr. Annandale, the first Director of the Survey: ". . . Our primary function can hardly be to conduct either morphological or economic research. These are subjects rather for the colleges of India on the one hand and for the technical departments on the other. Our investigations must be those of pioneers preparing the road along which morphologists, biologists, economic entomologists, students of fisheries, and others may travel in the future. . . . We are convinced that it is impossible to build a solid structure of practical results except on a sound basis of pure science." For readers of NATURE this point need not be laboured. The first requisite for zoological work is to know what one is dealing with; before extended zoological work of any kind is so much as possible we must know what our animals are, we must get them described, named, and classified; neither economic nor any other branch of zoology is possible otherwise; in Sir Venkata's words, "Systematic Zoology is, therefore, the bed-rock on which all zoological research, economic or otherwise, stands". Yet according to the Sub-Committee "zoological survey work cannot be said to have economic value"!

Sir C. V. Raman considers that the Sub-Committee's proposals, if carried out, mean not only the end of the Survey, but also the end of the Museum. "Anyone who has knowledge of the organisation of the Museums of even some of the smaller countries in Europe will at once realise that the proposals leave no alternative but that of breaking up and distributing the collections to those institutions that can afford the expert staff to look after them." The collections are worth crores, and while the museums of Europe and America would be only too glad to acquire them, the universities of India can neither afford them nor spare the staff and money to look after them; there is no public or private institution in India which can house even a small portion of the collections. The question of disposal, however, simplifies itself, since, under the provision of the Museum Act, the zoological and anthropological collections, except those purchased by the Government after the Zoological Survey was instituted, are the property of the Asiatic Society of Bengal, administered by the Trustees of the Indian Museum. If the Government of India terminates the trust, the collections must be handed over to the Asiatic Society or its assignees. As the Society found it necessary in 1875 to transfer all its collections to the Museum, it certainly cannot accommodate them now, after they have grown steadily for more than half a century, and they would necessarily have to be disposed of abroad.

Retrenchment on a reasonable scale, on a scale such as is contemplated for salaries, or for most of the other departments, the Survey can accept. The Department which is considered by the Sub-Committee immediately after the zoological is the archæological; a budget of 16 lakhs is here cut down to 10½—a reduction of one-third (still, however, leaving the allocation seventeen and a half times that for zoology). "We do not consider it desirable", says the Sub-Committee, "that this department [*i.e.* Archæology], which is engaged in work of considerable national importance, should be crippled." No plea of economic advantage is put forward; the Sub-Committee can, it appears, look on intellectual activities as ends in themselves, not merely as means to some material end. The claim of zoology is doubly strong; even were there no economic advantage, the Sub-Committee might well be asked to consider the works of Nature as being equally worthy of study with the works of man, and the wonderful Indian fauna as, equally with the archæological monuments, "of considerable national importance".

Upwards and Downwards in the Calculus.

Advanced Calculus: a Sequel to An Elementary Treatise on the Calculus. By the late Prof. George A. Gibson. Pp. xvii+510. (London: Macmillan and Co., Ltd., 1931.) 20*s.* net.

THE late Prof. Gibson's "Elementary Treatise on the Calculus" won the admiration of scrupulous teachers for a carefulness far in excess of what was thought adequate thirty years ago in a first course on the subject. After his resignation in 1927, Prof. Gibson prepared a sequel, of which with surprising energy he completed the manuscript within two years. At the time of his death the book was in the press and he had revised three-quarters of the proofs; Prof. MacRobert accepted the responsibility of producing the volume, and his editorial work has been done well.

Education in the calculus, as in every branch of mathematics, begins in the middle. The contents of this "Advanced Calculus" are outlined by the editor as follows:

> "The treatise begins with Dedekind's theory of irrational numbers; then follow discussions of bounded sets, sequences, limits, and differentiation of functions of one variable and of functions of several variables. Chapter v. deals with existence theorems for implicit functions and with the theory of Jacobians. Three further chapters contain accounts of infinite series, complex functions of a real variable, Lagrange's expansion, maxima and minima, infinite products, and Gamma Functions.
>
> "The integration of bounded functions forms the subject of Chapter ix.; next come expositions of curvilinear integrals, multiple integrals, and surface integrals. In Chapter xii. improper integrals . . . are introduced; and the two succeeding chapters are concerned with improper double integrals. The book closes with a chapter on the applications of the theory to the integration of series and to the Gamma Function."

Thus the title is somewhat misleading. On one hand, the volume does not touch on Fourier series or on the calculus of variations; on the other, it includes a study of first principles such as we regard as forming an introduction to analysis. It might seem that it has only to be combined with treatises on the theory of functions of a complex variable and on differential equations to provide a course truer to life than those to which we are accustomed, since in fact an English student has always some practical familiarity with the processes and applications of the calculus and with the algebra of complex numbers before he opens the works of Hardy, Goursat, or Jordan.

Unfortunately, the volume is not well suited to a place in such a scheme, for two reasons. First, there is an avoidance of the complex variable which, quite different from tacit reliance on treatment elsewhere, can only be described as morbid. All the work on series, even on power series, is subject to this criticism, and the result is that when occasionally the complex variable is admitted, some of the reasoning which is meant to be complete in itself is invalid. For example, there is no proof that an absolutely convergent series can be deranged if the terms are complex, since the only proof given for real terms involves the sums of the positive and the negative terms; the paragraph headed "Derangement of a Series" concerns double series, and while it is true that for the theorem of this paragraph " the proof for complex terms is the same as when the terms are real", this proof depends on the corresponding theorem for single series.

Secondly, the account of first principles is not wholly satisfactory. Extremely lucid in places, it is marred by locutions of a kind which can only cause the student unnecessary mistrust of his own judgment; for example, " ξ is said to be . . . interior to the interval (a, b) if there are numbers x', x'' such that $a<x'<\xi<x''<b$ ". In the treatment of exponentiation with an irrational index ξ, nothing but a tradition apparently invulnerable can account for the use of an arbitrary sequence tending to ξ, with the complication of proving that the number determined is independent of the sequence; the better the reader has understood what has gone before, the more puzzled he will be that the number required is not defined immediately as a bound. On the other hand, the theorem that for any integral value of n, nth powers are everywhere dense among the rationals, is not so trivial that it can fairly be taken for granted, and certainly an argument to which this theorem is essential is not " merely a repetition of the process " by which the product of two real numbers is shown to be definable. The discussion of the Riemann integral by Darboux's method is clear, and for the simple integral is satisfactory; in dealing with several variables, some fundamental topological difficulties must be shirked, but the possibility that a region connected in a rectangle may give rise to groups of regions in each quarter when the rectangle is subdivided ought not to be ignored. It is to be added that no other integral than the Riemann integral is introduced.

Development of technique is, however, a different task from stabilisation of foundations; it proceeds at a different pace and lays a different stress. In this field there could not be a better guide than Prof. Gibson. It was a habit of Herman's to protest to his pupils that they were slavishly dependent on contour integration: "I have never seen the integral yet that I couldn't do as easily without a contour as with one, and there are plenty for which Cauchy's theorem is no use at all". I am afraid that most of us took this wholesome corrective with more salt than it needed. The range of Prof. Gibson's examples of definite integrals is astonishing, and should convince the student that it is worth while to be as familiar with the methods explained as with those which are deliberately avoided.

The part of this volume which is covered by the title is valuable, and fills admirably a place not occupied by any other English work. If there are slips, these are easily corrected, and a blunder at the foot of p. 118 is too grotesque to mislead anybody. The treatise will be of great service to teachers and students of analysis. E. H. N.

Physical and Colloidal Chemistry.

(1) *Spatial Arrangements of Atomic Systems and Optical Activity; Methods, Results and Problems of Precise Measurements at High Temperatures; The Constitution and Structure of Ultramarines.* By J. M. Jaeger. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 7.) Pp. vii + 450. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 20*s.* net.

(2) *The Measurement of Hydrogen Ion Concentration.* By Dr. Julius Grant. Pp. viii + 159 + 2 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.) 9*s.* net.

(3) *Association Theory of Solution and Inadequacy of Dissociation Theory.* By Jitendra Nath Rakshit, Rai Sheheb. Pp. v + 298. (Calcutta: S. C. Auddy and Co., 1930.) n.p.

(4) *A Textbook of Practical Physical Chemistry.* By Prof. K. Fajans and K. Wüst. Translated from the German by Bryan Topley. Pp. xv + 233. (London: Methuen and Co., Ltd., 1930.) 15*s.* net.

(5) *Colloids: a Textbook.* By Prof. H. R. Kruyt. Translated from the Manuscript by Prof. H. S. van Klooster. Second edition, revised and enlarged. Pp. xiii + 286. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 17*s.* 6*d.* net.

(6) *Traité de biocolloïdologie.* Par W. Kopaczewski. Tome 1: *Pratique des colloides.* Deuxième édition entièrement remaniée et mise à jour. Fascicule 3: *Mésures capillaires et électriques.* Pp. 361-527 + viii. (Paris: Gauthier-Villars et Cie, 1930.) 40 francs.

(7) *Lehrbuch der physikalischen Chemie.* Von Prof. Dr. Karl Jellinek. Fünf Bande. Band 3: *Die Lehre von der Statik chemischer Reaktionen in verdunnten Mischungen (Lösungen).* Erste und zweite Auflage. Lieferung 9. Pp. xv + 657-893. (Stuttgart: Ferdinand Enke, 1930.) 21 gold marks

(1) THE publication of the lectures delivered at Cornell by the non-resident professors (of whom two are appointed in each year) has the effect in many cases of bringing a number of distinct and

independent monographs within the covers of a single book. This is perhaps inevitable as a method of providing a permanent souvenir of the lectures, but from the point of view of the reader and purchaser this system of grouping is not always ideal. Thus the present volume contains, in addition to an introductory lecture and an excellent portrait of the lecturer, reports of three courses of lectures, which have no obvious relationship to one another except that they deal with subjects which have all been studied in the laboratory at Groningen.

The principal interest of the first course on " Spatial Arrangements of Atomic Systems and Optical Activity " is to be found in the evidence that, after spending a decade in plotting graphs in illustration of the Cotton phenomenon, the author is now becoming interested in the mathematical form of his curves of rotatory dispersion, and in the circular dichroism which gives rise to them. It is a curious coincidence that an attempt to solve this problem was being made by Dr. Werner Kuhn in Heidelberg at the time when these lectures were being delivered, and that a provisional solution has been given by Kuhn and Braun whilst the lectures were being prepared for publication.

The second course of lectures, on " Methods, Results and Problems of Precise Measurements at High Temperatures ", describes the work that has been done in the author's laboratory in measuring the surface tension of liquids between − 80° and 1625°, with similar determinations of density, viscosity, electrical conductivity, and specific heat. In the same way, the closing lectures on " The Constitution and Structure of Ultramarines " describe the work which was summarised at the recent discussion of the Faraday Society on " X-rays and Molecular Structure ".

The collection of so much work into a single volume, as an alternative to a disperse system of serial publication, will be welcomed by many readers, and, apart from the pleasure given by a continuous and readable narrative, the book will be of real service as a guide to the hitherto uncollected works of an author who has been prolific in exact research in more than one important field.

(2) In view of the fact that at least three books on the determination of hydrogen ions are already available, it was not obvious, from an inspection of the cover and title, why this volume should have been produced. The preface makes it clear, however, that the standard works on the subject have proved too difficult for use in the many industries in which strict control of acidity has been found to be essential. The present volume was therefore written to supply the " needs of the busy worker on strange ground ", who is more interested in the practical applications of this type of measurement than in its theoretical basis.

The book begins badly by asserting that " acidity and alkalinity are not opposites, but merely represent stages or levels on a common scale "; and it is equally at fault in asserting that " a base is dissociated in solution into negatively-charged hydroxyl ions and a positively-charged residue ", since this definition implies that aniline must not be described as a base except when it acts in the presence of water. It is not surprising that a definition such as this is followed by a confession that " it is difficult to distinguish between an alkali and a base ". This confusion is confirmed and increased by a further statement that " The former term is used for soluble hydroxides of metals or of ammonia, whilst a base is essentially a salt-forming substance which yields OH′ ions in solution ". The author's incidental references to Debye and Hückel and to " E. H. Armstrong " are as unsatisfying as his definitions of acids and bases, and have evidently been added to satisfy the author's conscience, rather than for the sake of the busy worker, since they introduce an element of complexity, which might have been avoided by one who was himself more at home amongst modern developments in these directions.

In spite of the difficulties besetting so many writers on the theory of solutions at the present time, which the author himself has not been able to avoid, his presentation of the subject is attractive and appears likely to prove of real value to workers for whom the existing monographs are perhaps too formidable and almost certainly too expensive. Its utility is increased considerably by a section in which the methods and technique applicable to particular cases are described. Mention must also be made of the ample supply of references to original literature, which in this particular section occupy four pages of the text, and of seven pages of tabulated data which are collected at the end of the book.

(3) It is interesting to find that it is still possible to produce a book setting forth the " inadequacy of the dissociation theory " of solution and setting up the " association theory " as an adequate substitute. It is, indeed, not difficult to discover data which cannot be predicted by the theory of electrolytic dissociation, either as enunciated by Arrhenius or as developed by Debye and Hückel; but the association theory owes its popularity, not merely to the elements of truth which it obviously contains, but even more clearly to the fact that

it makes no predictions, and is sufficiently vague and intangible to be invoked as an explanation of almost any conceivable series of data. Thus it can be used to ' explain ' a contraction or an expansion, an increase or a decrease of conductivity, or a change of optical rotatory power of any and every type, but only *after* the relevant data have been established.

The author is very persistent in the claims which he makes on these lines on behalf of the theory " that in solution the solutes form compounds with solvent in proportion equal to the dilution ", which is really a reversion to the views of Berthollet rather than of Mendeléeff or Pickering. His comments are, however, destructive rather than constructive, and the limitations of his point of view are indicated by the fact that no reference is made either to Debye or to the Braggs, and that the index does not include any reference either to the quantum theory or to the electronic theory of valency. The book contains a large number of misprints, a few of which have been corrected in a table of errata; it is copiously supplied with references and contains many tables of experimental data.

(4-7) It is only necessary to put on record the fact that the " Practical Physical Chemistry " of Fajans and Wüst, which was reviewed in these columns (NATURE, March 8, p. 380; 1930), has been translated into English, with a preface by Prof. Donnan, in which he states that the translation will be used in his own laboratory. The book is nearly three times as big as the original German version, but this is due merely to the use of a different kind of paper, since the number of pages is very nearly the same. We may also welcome, without comment, the appearance of a second English edition of Prof. Kruyt's excellent textbook on " Colloids ", and note the appearance of further instalments of Kopaczewski's book on " Biocolloidologie " and of Jellinek's " Lehrbuch ", of which earlier portions have already been reviewed.

"Of composts shall the Muse disdain to sing?"*

The Waste Products of Agriculture: their Utilization as Humus. By Albert Howard and Yeshwant D. Wad. Pp. xiv + 167 + 14 plates. (London: Oxford University Press, 1931.) 7*s.* 6*d.* net.

SWIFT decay, undeniably manifesting itself in many parts of rural England, has evoked divers proposals for changes in farming policy. ' Extensive ' methods, in imitation of the large scale, fully mechanised corn-growing of certain overseas countries, have been widely advocated. But the past year or two has seen, also, the growth of an entirely contrary opinion. This holds that common sense or shattering competition is bound shortly to restrict wheat and the other great crops to those areas which, biologically and economically, offer them the best environment; and in these chosen areas, crop production will be intensive. So far it is only in America that this view has been publicly ventilated, and the volume in which Howard and his collaborator range themselves solidly on the side of ' high farming ', and propound a basis for it, thus makes a timely appearance. For these authors the road to success is systematic conversion of agricultural waste products into humus. But, condemning separate methods such as green manuring, making manure in yards, etc., they insist on a single process whereby all available kinds of waste are converted together into a finely divided end product. The method, as they say, is a highly developed form of ' composting '.

The early chapters are occupied in making out the case for the authors' contention that " humus provides the very basis of successful soil management and agricultural practice ". They open with a brief but critical survey of the farming systems of the world. In the policies of America and other agriculturally comparable areas they perceive the need for a great change-over which will concentrate effort on ever-increasing yield per acre rather than upon yield per man. They suggest that " a portion of the impoverished prairie lands should go back to grass "; and they charge Europe, and all other areas which have a highly developed agriculture, with an error of the first magnitude. " To supply the large quantities of combined nitrogen needed [by land from which virgin fertility has been withdrawn] all possible sources except the right one—the systematic conversion of the waste products of agriculture into humus—have one after another been utilised; guano . . . nitrate of soda . . . synthetic compounds. . . ." Cultivators in the east, desperately in need of combined nitrogen for the betterment of their humble crops, cannot afford to buy it. But, having cheap labour and an abundance of vegetable and other waste, they can be taught how to become their own " chemical manufacturers ".

Drawing mainly on the studies of Waksman and others on organic matter in the soil, strong emphasis is laid on the importance of humus as a habitat for soil micro-organisms and on the dual nature of the utilisation of waste products. Humus formation (by bacterial and fungoid action) must be regarded as quite distinct from the utilisation of formed humus by the plant. Moreover, the requirements of the first phase—the preparation of humus and its incorporation into the soil mass—are " so intensive that if the process takes place in the soil itself, it is certain to interfere with the development of the crop ". From this point of view, therefore, most of the customary methods of making humus, and particularly green manuring, are fundamentally wrong. The reader may find in this phase of the argument an over-insistence upon the importance of combined nitrogen, to the neglect of considerations of soil texture. But he will find a very interesting case for the 'single source' method of supplying organic material to the soil, with the details of which the greater part of the volume is concerned.

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* "The Sugar Cane", by James Grainger, M.D., 1764.

One may doubt whether a method involving many operations, sound judgment, organisation, and careful control can be operated by native cultivators without somewhat close supervision. Experience alone can test this point, but the Indore method has, at any rate, been worked out in full detail and with much ingenuity. The raw material comprises soiled cattle bedding, cotton stalks, cane trash, weeds, fallen leaves, green manure crops (cut and carted off), urine, wood ashes, etc. There is nothing casual in providing or assembling this waste; for all relevant operations, for example, the method of littering the working cattle, are so planned as to fit into the general scheme of " humus manufacture ". Fermentation, effected in pits, is initiated by addition of a simply made " fungus culture ". Three turnings of the material in the pit are needed, and from start to finish of the process occupies about ninety days. With suitable modifications for monsoon weather, etc., manufacturing is kept in progress throughout the year. Prolonged experiment has furnished interesting data as to the influence of water content and temperature of the pit, the optimum carbon-nitrogen ratio of the raw material, the phases of fermentation, and the manurial value of the final product.

In the chapter describing working details, the practically-minded reader will scarcely pass by a single page without commenting on the heaviness of labour requirements. He may feel, too, that even mechanisation, which the authors point to, may never avail to meet the difficulties where labour is costly. But the authors have an answer—perhaps the only answer that could be given in such a case. They have perfected the process on the Indore station and have given full details of work, of raw materials, of the relation of head of working cattle to land area, amount of waste, and output of manurial product.

There can be no doubt about the novelty of these proposals, their boldness, their ingenuity, and the interest they are certain to arouse. This is far more than a controlled method of composting; it is, rather, a new system of farming designed upon a basis of composting. As to possible difficulties of application even in tropical countries, there is, equally, no doubt. But, against this, it must be remembered that in boldness the proposals are matched by the aim, which is to make intensive cultivation possible without the use of purchased nitrogenous fertilisers.

F. L. Engledow.

Short Reviews.

(1) *The Printing of Textiles.* By Rego Capey. Pp. x + 138 + 29 plates. (London: Chapman and Hall, Ltd., 1930.) 13*s.* 6*d.* net.

(2) *Textiles on Test: a Study for Distributor and Consumer of the Wearing and Washing Properties of Fabrics and Garments.* By J. Guilfoyle Williams. Pp. viii + 194 + 40 plates. (London: Chapman and Hall, Ltd., 1931.) 7*s.* 6*d.* net.

(3) *Soies artificielles et matières plastiques.* Par Robert Gabillion. (Collection Armand Colin: Section de Chimie, No. 129.) Pp. 204. (Paris: Armand Colin, 1931.) 10·50 francs.

(1) It needs technical specialists to do justice to such subjects as these three books take into consideration. That the authors are well equipped for their several tasks is quite evident. But with due respect to Mr. Capey, exception must be taken to the association of a fifth century B.C. fabric with the subject of the Annunciation; nor does this seem to be a slip for 'A.D.' He is doubtless correct in stating that textile printing was probably independently developed in many countries; the diagrams and illustrations endeavour to lighten a dull text.

(2) Mr. Williams, in a companion volume, shows how to make such a highly technical subject attractive reading, irrespective of the numerous illustrations the book contains. His extensive knowledge is placed generously at the reader's service.

(3) M. Gabillion discourses with insight upon the subject of artificial silks and plastic materials. *Inter alia*, the pages dealing with the introduction and development of Lincrusta Walton and linoleums are not the least interesting of the two hundred pages to which the book extends. It is eminently practical, proving more readable than Mr. Capey's, though lacking the attraction attached to Mr. Williams' treatise, to which Mr. Gordon Selfridge supplies a foreword.

P. L. M.

Non-Metallic Inclusions in Iron and Steel. By Dr. Carl Benedicks and Helge Löfquist. Pp. xi + 311 + 44 plates. (London: Chapman and Hall, Ltd., 1930.) 30*s.* net.

THE useful properties of steel, especially of the higher qualities of steel, depend in large measure on the degree of freedom from non-metallic inclusions. These inclusions, by providing regions of concentration of stress, lower the resistance to fatigue, whilst they also influence the behaviour of the steel towards corrosive agents. Improvements in the manufacture of steel are largely directed towards their elimination, and for the success of such improvements a knowledge of the composition and mode of origin of inclusions is essential. The chemistry of the bath reactions in the steel furnace, by which most of them are formed, is complex, and the authors of this work have had a difficult task in their critical examination of the data. Their presentation is clear and systematic, and for the first time a mass of detailed information concerning inclusions in steel is brought together and discussed in the light of physical chemistry. Metallurgists will not all agree with some of the hypothetical equilibrium diagrams, but these furnish at least a basis for discussion.

The volume is well printed and abundantly illustrated. The micrographic and analytical methods for the identification of inclusions are described, and a general account of ingot structure is included. The practical metallurgist will also find the discussion of the means adopted to lessen the quantity of inclusions, or to disperse them in the least harmful way, an interesting study.

Nutrition and Food Chemistry. By Barnard S. Bronson. Pp. viii + 467. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 18*s.* 6*d.* net.

THE author has attempted a presentation of the scientific principles of nutrition in simple form and suitable for students with little foundation in physiology and none in organic chemistry. The book includes the elements of digestion and metabolism, with details of the composition of many foods. Data are supplied from which it is possible to construct diet sheets and to estimate the suitability of common diets, but for useful dietaries the reader must consult books on dietetics.

The work is based on American practice, and includes descriptions of methods of treating or manufacturing common foodstuffs, as well as of the standards with which various foods must comply: thus, the pasteurisation of milk, the manufacture of ice-cream, and the baking of bread are described, and standards for milk and eggs are given in detail. Although certain portions are not applicable to conditions in Great Britain, the tables of analyses will be extremely useful to all those who wish to know the exact composition of any particular diet: this applies especially to research workers, since unsuspected impurities in a purified diet may markedly affect its nutritive value. For these, the appendices on the vitamin, iron, and copper contents of foods should prove of value.

The work as a whole appears to be rather advanced for elementary students, although the earlier chapters on digestion and metabolism might be read with profit: the later appear more suitable for the specialist.

The Theory of Ruled Surfaces. By W. L. Edge. Pp. ix + 324. (Cambridge: At the University Press, 1931.) 20*s.* net.

THE general type of ruled surface of the fourth order was mentioned by Chasles in 1861. In 1864 and 1868 these surfaces were studied and classified, though not quite completely, by Cayley, who obtained his different types by means of directing curves and gave algebraic equations for them. The complete classification was first given by Cremona (1868), who used the method of correspondence between two curves. Ruled surfaces of the fifth order were classified by means of their double curves by Schwarz in 1867.

Mr. Edge gives an account of this work and supplements it by his own researches, which include what appears to be the first serious attempt to enumerate the ruled surfaces of the sixth order. He employs two powerful general methods, considering the surfaces as curves in a five-dimensional space, and projecting from space of even higher dimensions. The first chapter contains an account of the principle of correspondence and of other ideas fundamental in modern algebraic geometry. There is no other book easily accessible to English readers where these are explained and applied so extensively. The properties of the ruled surfaces of orders four, five, and six are collected in tables, but there is, unfortunately, no index.

H. T. H. P.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Editorial Board: Carl S. Marvel, Editor-in-Chief; Roger Adams, W. H. Carothers, H. T. Clarke, J. B. Conant, Henry Gilman, C. R. Noller, F. C. Whitmore, C. F. H. Allen. Vol. 11. Pp. vii + 106. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 8*s.* 6*d.* net.

THIS volume contains particulars of thirty-one preparations. Of the contributors, fourteen are from the United States, two from Germany, and one each from Canada, India, and Austria. Among the interesting preparations are itaconic anhydride and acid (from citric acid), citraconic anhydride and acid (from itaconic anhydride), mesaconic acid (from citraconic anhydride), cyanogen bromide (from sodium cyanide and bromine), ethyl pimelate (from salicylic acid), fumaric acid (in 58 per cent yield from technical furfural), and thiobenzophenone (from benzophenone dichloride and sodium hydrosulphide). The conversion of acrolein into *dl*-glyceric aldehyde in 11 per cent yield is described through the following intermediates: β-chloro propionaldehyde acetal, acrolein acetal, and *dl*-glyceric aldehyde acetal. The revised collection of preparations contained in the first nine volumes of this valuable series is to appear soon.

J. R.

A Century of Geology.*

By Prof. J. W. Gregory, F.R.S.

THE geological problems of special interest in 1831 are shown by the contributions prepared at the request of the British Association, with first amongst them Conybeare's "Report on the Progress, Actual State, and Ulterior Prospects of Geological Science". His report summarised the position in general stratigraphy, which was still based on two divisions—the primary and the secondary. The secondary group, thanks to William Smith, had been classified into four systems—the Carboniferous including the Old Red Sandstone, the New Red Sandstone, the Oolitic, and the Cretaceous. All below the Old Red Sandstone was left as the primitive and transition series. The pre-Carboniferous and post-Cretaceous beds were still in confusion, but Conybeare's section from the north of Scotland to the Adriatic near Venice shows that the general succession had been established from the Tertiary to the Carboniferous and Old Red Sandstone.

The first great stratigraphical advance after 1831 was Lyell's classification in 1833 of the post-Cretaceous strata. Lyell's achievement was followed by the foundation of the Silurian system by Murchison Murchison, in 1834, showed that the 'Upper Grauwacke Series' included four fossiliferous series, which in 1835 he grouped as Silurian. Sedgwick, a month later, in a communication to the Association at its Dublin meeting, founded the Cambrian system for the fossiliferous rocks below the Llandeilo and the schists of Anglesey and Carnarvonshire.

The fundamental advance in geology in the decade beginning 1830 was Lyell's demonstration of the uniformity of geological dynamics. The first volume of his "Principles" was published in 1830, and Murchison hailed it as "beginning to unfold the true papyri of geological history".

A different estimate was expressed by Adam Sedgwick, then the leader of British geology, who declared that Lyell's championship of uniformitarianism violated sound reasoning on geological phenomena, and that

> "warped by his hypothesis . . . in the language of an advocate, he sometimes forgets the character of an historian". According to Sedgwick, if Lyell's views of the uniform order of physical events were correct, "the earth's surface ought to present an indefinite succession of similar phenomena. But as far as I have consulted the book of nature, I would invert the negative in this proposition, and affirm that the earth's surface presents a definite succession of dissimilar phenomena. If this be true, and we are all agreed that it is, . . . then 'the undeviating uniformity of secondary causes', 'the uniform order of physical events', 'the invariable constancy in the order of nature', and other phrases of like kind, are to me, as far as regards the phenomena of geology, words almost without meaning. They may serve to enunciate the propositions of an hypothesis; but they do not describe the true order of nature."

Sedgwick agreed with Brongniart that the geological and historical periods were essentially distinct; and he remarked regarding the recent appearance of man, "were there no other zoological fact in secondary geology, I should consider this, by itself, as absolutely subversive of the first principles of the Huttonian hypothesis".

Murchison, on the contrary, held that Lyell's demonstration of the unbroken transition between the Pliocene and post-Pliocene had completely swept away the arbitrary demarcation between "what had been termed the ancient and existing orders of nature".

The geologists of 1831 worked under the handicap of three fundamental uncertainties. The problem of sea-level so exercised the Geological Committee in 1831, that it asked Robert Stevenson—the authority on coastal engineering and grandfather of R. L. Stevenson—to report upon the erosion of the English coast and "the permanence of sea-level". He replied that he had little to add to his previous papers (1816 and 1820) The variability in sea-level is of perennial interest as many issues depend upon it. The test case about 1830 was that of the Baltic. Celsius in the eighteenth century had remarked that the Baltic was receding along the Swedish coast; but, as the German coast had undergone no such change since Roman times, the Swedish evidence was doubted. Leopold von Buch reconciled the observations by the hypothesis that the Swedish coast was rising about a pivot, while the German coast remained stationary. The facts were reaffirmed by a joint inquiry of the Swedish Academy of Sciences and the Russian Ministry of Marine; but the rise of the land was rejected by Lyell. He attributed the recession of the sea to the accumulation of sediment and the wind.

Lyell fortunately examined the evidence for himself, and in a paper read to the Association in 1834, accepted von Buch's conclusion that parts of the Baltic coast are rising two to three feet in a century, while other parts are stationary.

The Baltic, therefore, gives convincing testimony of the mobility of the land, which is accepted in an extreme form by some champions of isostasy. That principle was put forward from the geological evidence that the rate of the accumulation of sediments so often coincides with the rate of subsidence that the two processes must be dependent, the weight of the sediment being the cause of the subsidence. The correlative, that the unloading of an area by denudation causes its uplift, was advanced by Clarence King (1876). This cause of the rise and fall of land was maintained by Airy and Pratt, and was supported by the gravity surveys by Hayford, Hecker, and Duffield. The relief of the earth was attributed to the differences in the density of the crust, and therefore the subsidence of the crust to form oceanic basins, and its uplift into continental masses from oceanic depths would be both impossible. That theory was of service as a reaction against the lightly assumed interchange, as pictured by Tennyson, of roaring streets and central seas; but the form of isostasy that represents the earth's major relief as determined by the perfect hydrostatic equilibrium of the crust is opposed to weighty evidence.

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* From the presidential address, entitled "Problems of Geology Contemporary with the British Association", to Section C (Geology) of the British Association, delivered in London on Sept. 24.

The mathematical data for the permanence of the ocean basins seem unreliable. That the ocean floors consist of a continuous sheet of heavy material (sima) was supported by gravity determinations; but the calculations are based on the assumption that the sea surface stands at the spheroid of reference.

That some parts of the crust are in such delicate isostatic equilibrium that the surface rises when material is removed by denudation and sinks when loaded with more sediment is well established; but other parts of the surface have not this delicate poise. Faults have a downthrow of 10,000 feet, and there is no evidence that their cause was sedimentation. The dependence of subsidence and sedimentation may often be true for the geosynclines, which, owing to the rupture or instability of the crust in consequence of its deformation, are bands of long-continued weakness—or asthenostrophes (weak bands or belts).

Reluctance to accept the hydrostatic equilibrium of all parts of the crust is not due to prejudice against isostasy. But its extension to the whole surface of the earth and the claim that it proves the subsidence of an area to an oceanic depth to be a physical impossibility are contradicted by geological evidence, which appears more reliable than calculations based on uncertain assumptions.

THE FIXITY OF SPECIES.

The second hindrance to geological progress in 1831 was the belief in the fixity and special creation of species, which was then entrenched by theological authority.

The fixity of species had been attacked by Lamarck, but his view of the evolution of one species into another was emphatically rejected by British authorities. Buckland, who was the president of the Association at its first full meeting, denied that he was in any way disposed to favour Lamarck's theory of "the derivation of existing species from preceding species by successive Transmutations of one form of organisation into another form, independent of the influence of any creative Agent". Sedgwick repudiated "the doctrines of spontaneous generation and transmutation of species with all their train of monstrous consequences". The latter doctrine, with all its momentous consequences, was added to the principles of geology by a recruit of 1831. Early that year, Charles Darwin began the study of geology, and on his return from his first long geological excursion, which he made with Sedgwick in North Wales, received the invitation to go as naturalist with the *Beagle*. He sailed in her from Plymouth in December 1831.

Darwin's work on the voyage was mainly concerned with volcanic rocks, with gravity differentiation in molten rocks, with uplifts accompanying earthquakes, and with the evidence of widespread areas of subsidence and uplift as proved by his luminous and now firmly established theory of coral islands. His work on crustal movements was of primary importance; but by his doctrine of evolution by natural selection, he was the most potent influence on the thought of the Victorian era. According to the general interpretation of the geological record, evolution has been mainly controlled by the environment, and has proceeded slowly during the long periods of relative quiescence and more quickly when the tumultuous heaving of the crust produced relatively rapid changes in the physical conditions, as in the depth of the sea, in the temperature of sea-water, and in climate owing to the altered distribution of land and water and relief of the land.

The influence of Darwin on the whole philosophy of geology was so helpful that he was the dominant factor in its progress during the second quarter-century of the Association's work.

The geological point of view of the day as regards the relations of geology and theology was shown in Buckland's "Bridgewater Treatise" (1836, p. 414). He argued that zoophytes show such perfect unity of design that we can find no explanation of such otherwise mysterious uniformity than by referring it to the agency of one and the same creative intelligence. He extended this argument to the whole organic world. The persistence of the same structural plans and the absence of those freak animals which might be expected if animals had arisen by special creation —instead of being regarded as evidence of evolution—was claimed by Buckland as proof of special creation by one Creator.

Buckland, though he defended the creation of man at 4004 B.C., and declared in regard to the six days of creation, "I see no reason for extending the length of any of these beyond a natural day", was, nevertheless, too heterodox for some members of the Association. His view that the earth is indefinitely older than the creation of man was vehemently attacked by Dean Cockburn, the Dean of York, in 1838, and at the meeting of the Association there in 1844. It was not until about thirty years later that geology secured the independence claimed in 1832 by its doughty champion, Murchison, in his assertion of the "entire disconnexion of our science with the inspired writings".

THE ORIGIN OF ORE-DEPOSITS.

The third geological problem to which the Association directed attention was the nature of ore-deposits.

The classification of mineral veins in 1791 by Werner attributed them to the filling of fissures from solutions. Hutton, in 1795, declared the deposition of native metals from solution a "physical impossibility", and that sulphide ores could only be formed at high temperatures. In 1831, in reaction from such speculations as to genesis, the standard classifications relied on the form of the deposits; Taylor rejected the formation of lodes by igneous injection and attributed ordinary ores to sublimation. As many mineral veins were too wide to have been formed by the infilling of open fissures, the electric deposition of the ores was advocated by R. W. Fox in papers to the Association. Ami Boué, in 1822 and 1829, supported the general association of mineral veins and igneous rocks, and A. L. Necker also urged, despite a few apparent exceptions, the general "connexion of igneous with metalliferous deposits".

In 1835 the main alternative explanation—the connexion of mineral veins with great fractures—was put forward by J. Fournet. He assigned the minor veins to the filling of shrinkage cracks and small faults, and the veins of most economic value, to deposition along major faults.

That the ores along these fractures were due to rising waters was rendered the more probable by the paper contributed by C. G. B. Daubeny at the 1836 meeting on "Mineral and Thermal Waters". Meanwhile, the theory that ores were derived from waters percolating through the rocks beside the veins had been revived by Bischof (1847), but was generally rejected until Forchhammer and Sandberger found particles of the ordinary ore metals in all kinds of ancient rocks.

The ascensionist was then replaced by the lateral secretion theory, which was dominant for twenty years, until in 1893 the deep-seated source of most ores was advocated by Posepny. An intermediate view, advocated by Kemp, redirected attention to the general association of mineral veins with igneous rocks; and the view that the constituents of the lodes are derived from igneous rocks is perhaps still the generally accepted theory. There are serious objections to it: for though many metals occur in the igneous rocks, the quantity appears insufficient to have furnished the lodes. Many of the claims for the presence of such metals as primary constituents of igneous rocks are invalid. The distribution of ores indicates their derivation from a layer below the igneous rocks.

The deep-seated source of ore-deposits bears on the geology of the inner earth, which was exercising geologists in 1831, when amongst subjects recommended for examination were the "accurate examination of the conclusions deducible from the known density of the earth, as to the solid structure and composition of its interior", and "the examination of the visible disk of the moon, with the view of extending our general knowledge of volcanic forces".

When the efforts to correlate the main relief of the earth were resumed, the most stimulating worker was Élie de Beaumont. His correlation of mountain chains was based on the view that the interior of the earth is slowly cooling and contracting so that the outer shell undergoes alternate deformation and recovery of the spheroidal form. He concluded that these crustal movements account for the mountain ranges and main relief of the earth. He realised that the crust is a unit which is affected as a whole by each of the orogenic episodes which upheaved mountain systems at the same date in even distant parts of the earth. He held that fold-mountain chains of the same orogeny are recognisable by their trend, and classified the mountains of Europe into four systems, each with a characteristic trend. As the trends were determined by the fracture of a spherical or subspherical shell, he considered that they would be on a regular geometrical pattern.

Élie de Beaumont's views attracted earnest attention, and at the first meeting of the Association Sedgwick and Conybeare were asked to report whether his maxim that mountain ranges with the same trend were of the same age holds true for the British Isles. Sedgwick replied that the older British strata are in strict accordance with Élie de Beaumont's theory, and expressed enthusiastic approval of it in his presidential address to the Geological Society. He declared—

> "that the system of M. Élie de Beaumont is directly opposed to a fundamental principle vindicated by Mr. Lyell cannot admit of doubt. And I have decided, to the best of my judgment, in favour of the former author, because his conclusions are not based upon any *a priori* reasoning, but on the evidence of facts; and also because, in part, they are in accordance with my own observations."

Conybeare was more critical of Élie de Beaumont's theory. He objected to describing the Urals and the American Cordillera as parallel, and held that the correlation of English folds by parallelism is unsatisfactory.

Élie de Beaumont's work laid the foundations of the modern study of the general plan of the earth. His fundamental principles were that the main movements in the earth's crust are due to its compression owing to the shrinkage of the internal mass, and that the collapse of the crust determines the main features in the relief of the globe. The shrinkage is probably due more to closer packing of the constituents than to cooling. That the main folding of the crust has been due to compression that at first acted on all parts of the earth, and later was confined to special belts, seems one of the most certain of geological facts.

Élie de Beaumont unfortunately adopted as the basis of his fold-and-fracture pattern the pentagonal network, which had to him the recommendation of its possession of a high degree of symmetry. The most obvious fact in the map of the world is that it has no such highly developed symmetry.

I endeavoured to show in 1899 that Lowthian Green's theory agrees with the existing distribution of ocean and continent, and with geological history, as it explains the alternation of the slow subsidence of the ocean floors and of crustal storms during which fold-mountain chains are raised by lateral compression; it also explains the alternate emergence of the lands as the ocean basins are enlarged by the sinking of their floors and submergence of the lands by the world-wide advance of the sea due to the shallowing of the oceans when the spheroidal form is recovered after the tetrahedral deformation has exceeded the stability of the crust.

Élie de Beaumont's elaborate classification of mountains has collapsed; for although the foundations were sound, his superstructure was not. Knowledge of the structure of mountain chains was then inadequate and much of it was erroneous. Beaumont's conception of mountains was defective; he regarded them as symmetrical ridges, and he failed to appreciate the contribution to the Association in 1842 by Henry Darwin Rogers, which laid the foundation of the modern theory of mountain formation. In 1842 Rogers read to the Association his joint paper with his brother, W. B. Rogers, "On the Physical Structure of the Appalachian Chain, as exemplifying the Laws which have regulated the elevation of great Mountain Chains generally". The Rogers considered the facts at variance with Élie de Beaumont's hypothesis. They explained mountain chains as waves in the crust due to a broad belt being pushed forward with accompanying asymmetric folding, overfolding, and inversion.

Suess showed that the existing physiography of Europe was mainly due to the Alpine System—including the Pyrenees, Alps, Carpathians, and Balkans—having been pushed northward against resistant masses which threw back the waves like forelands along a coast. Suess had the advantage over the geologists of the 'thirties of more certain petrology. They still worried over the igneous origin of granite, and even a decade later were at issue as to whether granite had been injected as a molten mass at a high temperature, or was due to aqueo-igneous action at a low temperature.

A great advance in the interpretation of the igneous and metamorphic rocks followed Sorby's application to them of the microscopic study of transparent sections. He announced its illuminating results to the Association at Leeds in 1858, showing that the crystals and bubbles in the fluid cavities in granite prove its deep-seated origin, and that the Vesuvian lavas demonstrate that the sequence of minerals in igneous rocks is determined not by their fusibility but by their order of crystallisation out of a cooling solution.

The interpretation of mountain structure had an important reaction on stratigraphy. Suess's study of world geology led to the recognition that some encroachments of the sea upon the land were world-wide; he called them the marine transgressions, and explained them by the reduction of the ocean basins

Many cases of the rise of the sea surface may be due to changes in the ocean basins and not to a vertical uplift of the land. Suess regarded some high-level horizontal beds as left in their original position by the down-sagging of the crust elsewhere. He was so impressed by the predominance of downward movements in sunklands, rift-valleys, and oceanic deeps, and by the absence of any mechanism which he regarded as adequate for widespread horizontal uplifts, that he considered all vertical regional movements must be downward. In this he went too far; but that the land sometimes emerges owing to lowering of the sea surface, and at others is submerged by the rise of the sea-level, is now universally admitted.

In 1831 Conybeare dismissed the stratigraphical principle, "Werner's dogma of Universal Formations", as he held that in distant lands corresponding formations are not synchronous. This idea, also adopted by H. D. Rogers in a paper to the Association in 1834, was a forecast of Huxley's doctrine of homotaxis, which is less important now that as much time is available as the greediest geologist can desire.

The zonal divisions, however, are being found less universal than had been thought. The view of Oppel (1856, etc.) that ammonite zones in all parts of the world follow in an identical succession, and the expectation that graptolite zones are equally regular and world-wide, have proved exaggerations; Dr. Spath has pointed out that the sequence of zonal ammonites differs in different basins. Geologists were once confident that the gaps in the geological column in Europe would be filled by discoveries elsewhere; such terms as Permo-Carboniferous, Permo-Triassic, etc., expressed the hope that the beds thus named would fill gaps in the European sequence. Most of these strata have been found to correspond in time with those known in Europe. Extra-European stratigraphy has shown the world-wide range of the geological systems.

THE GEOLOGICAL LEADERS OF THE FOUR QUARTER-CENTURIES.

My impression is that from 1830 until 1855 the true prophet of geology was Lyell, with his establishment of the mobility of the land and the uniformity of geological processes. From 1855 until 1880 the main advance was Darwin's establishment of evolution, which enabled fossils to be interpreted more intelligently and reliably. About 1880 the geologists of the United States revealed phenomena in their western mountains which showed that the yardstick reliable in north-western Europe and the Atlantic States of America was not applicable everywhere. The United States Geological Survey began its great influence about 1880. Nevertheless, despite the powerful stimulus of North America on geological thought in the third quarter of the past century, the most profound individual influence was that of E. Suess.

The last quarter-century is still too near for reliable appreciation of its achievements; but among the fundamental advances have been those revealing the structure of the inner earth, and especially the interpretation of earthquakes, in which the pioneer was John Milne. The recent study of ore-deposits confirms the evidence from earthquakes that the core of the earth is surrounded by concentric shells and that the metallic ores arise from the shell below the plutonic rocks as gases and solutions. The geology of mineral fields and the extension to most of the younger mountain ranges of the world of the thrustplanes which, though early recognised in mining, were first demonstrated in stratigraphy by Lapworth in the north-west of Scotland, have proved that fold-mountains are formed along belts of compression.

The Volta Conference at Rome.

THE second Volta Conference was held in Rome from Sunday, Oct. 11, until Saturday, Oct. 17, and was devoted to the subject of nuclear physics. The proceedings were opened on Sunday morning by a reception, at which addresses were given by the Marchese Marconi and Prof. Corbino—the Prime Minister, the Duce Mussolini, presiding. Six morning sessions and three afternoon sessions were held, during which many interesting contributions were made. A full report of these is to be published shortly by the Royal Academy of Italy.

The subject of penetrating radiation was handled by Dr. B. Rossi, and led to a very interesting discussion. It appears that we are yet a long way from understanding this phenomenon, but a variety of new methods of investigation are now being applied, which at least promise to yield important information. A considerable part of the conference was devoted to the discussion of the general applicability of our present theoretical ideas to nuclear problems, and it appeared, largely through the important contributions of Prof. N. Bohr, that we cannot expect the present quantum mechanics to apply to the nucleus without undergoing such a fundamental change that it might almost be said to involve a new mechanics, including the present quantum mechanics as a limiting case. In particular, it may be noted that it appears difficult to calculate the probabilities of occurrence of the different nuclear processes to within even an order of magnitude, so that it is quite impossible to decide whether there is or is not a discrepancy between theory and experiment in comparing such experimental results as the number of long-range α-particles and the number of quanta of the corresponding radiation emitted by the excited nucleus. The position appears to be that we should scarcely anticipate that the quantum mechanics would apply even to the α-particles in the nucleus as well as it does, and there is clear evidence that the questions connected with the electrons in the nucleus raise problems quite outside its scope.

Most of the nuclear phenomena which are open to experiment were discussed, such as the values of the nuclear moments, the artificial and natural disintegration of the elements, the excitation of nuclear γ-rays, the absorption of radiation by the nucleus, the information about the α-particle stationary states in the nucleus and their association with the γ-rays, and also the transference of energy from the excited nucleus to the electronic structure.

The general impression appeared to be that a definite stage in attacking the problem of the nucleus had already been reached in that recognised experimental methods had been adopted, and the general scope of the information they could provide was understood. The problem of the nucleus can at least be divided into several smaller problems, and to each there is now a definite approach by experimental methods.

The α-particles and the protons seem likely to be treated at least approximately by the present quantum mechanics, and it is possible that in the not far distant future a reasonable account of the behaviour of the light and heavy nuclei may be given in terms of certain experimentally defined stationary states of α-particles and protons, the existence of which may at least be made plausible by theoretical calculations based on the equilibrium of such particles inside a potential box. On the other hand, the question of the behaviour of the electrons appears to introduce problems which are not found elsewhere in physics. This point was specially emphasised in connexion with the discussion of the continuous spectrum formed by the disintegration electrons from radioactive bodies.

It would be difficult to express adequately the thanks which the delegates owe to the organisers of this conference, not only for the admirable arrangements which were made for the scientific discussions, but also for the magnificent hospitality which was shown to them. The success of this conference was largely due to the untiring efforts of Prof. O. Corbino and the secretary to the conference, Dr. E. Fermi, who managed to combine both the necessary firmness in directing the conference with the freedom which is so essential for fruitful discussion.

Radio Research in Great Britain.*

THE Report for last year of the Radio Research Board to the Committee of the Privy Council for Scientific and Industrial Research is of interest, as it marks the beginning of a new stage in the investigations. In the earlier work, apparatus and methods have been perfected so that trustworthy and consistent results can be obtained. It is now considered undesirable to proceed further in this direction. Scientific research on which future progress depends is divided into two branches. The first is the fundamental research undertaken without any immediate practical application in view. The second is to initiate experiments likely to indicate solutions of the urgent problems at present engaging the attention of radio engineers.

The Board considers that, while a proportion of the problems of fundamental research can be undertaken in the confines of a university laboratory, there are many problems that cannot be carried out in this way, as they require the co-operation o observers at great distances apart. This work is continued by the Board, although priority is given to experiments the application of which is clear. During last year, close collaboration was maintained with the radio research boards established by the governments of New Zealand and Australia. Priority is being given to the study of high frequency

* Department of Scientific and Industrial Research. Report of the Radio Research Board for the Period ended 31st December 1930. Pp. iii+90+4 plates. (London: H.M. Stationery Office, 1931.) 2s. net.

transmissions of wave-lengths less than ten metres. Much use has been made of the frequency-change method developed by Prof. E. V. Appleton for the study of the ionisation of the atmosphere and its effect on the propagation of waves. The most noteworthy advance made in the study of atmospherics during the year has been largely due to the new cathode ray oscillograph developed by Baron Manfred von Ardenne, of Berlin. By its use it was possible to photograph the wave forms of atmospherics previously observed visually.

In the frequency-change method, a small continuous change is made in the waves being generated. This produces at the receiving station a succession of interference maxima and minima due to the ground waves and the waves deviated by the upper atmosphere. It is possible to estimate from these effects the relative intensities of the ground and atmospheric waves and the angle of incidence of the latter with the ground. A comparison of the phase differences between the two sets of waves can be deduced from the interference fringes and this gives information as to the polarity of the down-coming waves. Strong experimental evidence is given of the existence of three zones of ionisation in the atmosphere. The region of ionisation which normally reflects long waves and broadcasting waves is referred to as the *E* region, while hypothetical reflecting layers above and below the *E* region are called the *F* and *D* regions respectively.

It was found that with a wave-length of 400 metres the secondary fringes were observed during the night, but that about forty minutes before sunrise their amplitude began to diminish, until only the primary fringes remained. It is concluded that with these waves the cessation of the influence of the ultra-violet radiation after sunset leads to a recombination of ions and thus causes a slow increase in the height of the equivalent layer which only ceases on the advent of sunrise. A converse effect then ensues. Observations on ‘ phase fading ’ confirm this.

The experiments show that the maximum value of the height of the ionised layer is about 126 km., but on certain nights the height remains constant at 100-110 km. The reason for this is obscure. According to the ordinary theories of radio propagation, a greater density of electrons is required to reflect or refract short waves than long waves. A study of the *F* region (the highest) is therefore more conveniently made with short waves. The experiments made with 100-metre waves confirm theory. The variations observed during the daily runs enabled the times at which the lower *E* region just began and just ceased to reflect 100-metre waves to be accurately determined. This wave-length seems to have been fortunately chosen, as it is a critical wave-length. On some days the waves penetrate the *E* region and on others they are reflected by it.

In England the equivalent average heights of the *E* and *F* (upper) regions are about 100 km. and 230 km. respectively. Using results obtained in Washington, and adopting the two-layer hypothesis, led to heights of 105 km. and 235 km., and this shows that the hypothesis is a useful one. Work on short waves (50 metres wave-length and less) is being carried out. Already evidence has been obtained bearing on the influence of magnetic storms on the ionised layer. As the problem is closely linked with the explanations of skipped distances and Stormer's theory of long retardation echoes, the results will be important. It has been found that on the occasion of a magnetic storm the ionisation of the *E* (middle) region is sufficient to reflect 50-metre waves which normally are reflected at vertical incidence. This indicates a marked increase in ionisation above the normal value. So far, the experiments on the propagation of long waves have not led to any very definite results.

Excellent results have been obtained with the development of radio frequency standards. It is clear that the various national standardising laboratories of the world are able to measure frequency to an accuracy which surpasses the constancy of the instruments used in its comparison. The agreement between the National Physical Laboratory, the Post Office, and the American Navy on the two occasions when measurements were made was to about one part in 100,000. Experiments prove that the inaccuracy of the National Physical Laboratory's measurements of frequency did not exceed three parts in a million. Much of the credit of this great achievement must be attributed to Dr. W. D. Dye.

Obituary.

PROF. J. S. C. DOUGLAS.

THE sudden death of James Sholto Cameron Douglas on Oct. 30 at Llandudno, where he had gone to recuperate after a long illness, was a very great grief to his many friends. Prof. Douglas was more closely in touch with his colleagues, both scientific and medical, than is usual in a university; for not only had he held the Joseph Hunter chair of pathology at the University of Sheffield since 1915 and been Dean of the Faculty of Medicine since 1923, but his professorship also involved him in a multitude of administrative duties, including the direction of the pathological work at the various hospitals in the city. In addition, he was always being called upon by his medical colleagues for expert advice on pathological matters. Not only did he carry out his duties with unsparing zeal, but as a most unselfish man he also responded willingly to all demands for assistance.

All this work of necessity limited Douglas's time for his own investigations. To some this was a matter of regret, especially as his published work revealed the mind of a capable investigator; but, after all, the unselfishness and high skill possessed by Douglas were of infinite value to his colleagues and other medical men of the city. His kindness and genial nature, together with the great pains he took in his work, have only increased the sense of loss felt by his colleagues. Prior to his appointment to the chair of pathology at Sheffield, Douglas was lecturer in this subject at the Universities of Birmingham (1907–11) and Manchester (1911–15).

Douglas was primarily interested in problems of immunity, but he also published some work on morbid anatomy. The most fruitful period of research included the years 1914 and 1915. In these years he published a paper on "The Cytology of the Blood in Passive Immunity", and, with the collaboration of Prof. Boycott, other papers on the composition of the tissue fluids. His other publications dealt with the adsorption of agglutinin and other immune bodies by charcoal (with Prof. Dreyer), the effect of diaphyte tubercle vaccination in guinea-pigs, relapsing pyrexia in lymphadenoma (with Prof. Arthur Hall), a study of cardiographic tracings from the base of the human heart, and the invasion of the pericardium by malignant tumours. As an investigator his work was characterised by meticulous exactness.

Douglas was born in 1879 at Leicester, the elder son of Mr. Claude Douglas, consulting surgeon to the Leicester Infirmary, and brother of Dr. C. G. Douglas, F.R.S., the distinguished Oxford physiologist. He was educated at Wyggeston Grammar School, Haileybury College, and at Christ Church, Oxford. He graduated at Oxford in 1902 and entered St. George's Hospital. After qualifying he studied abroad, mostly at Copenhagen and Dresden, as a Radcliffe travelling fellow. In 1911 he married Mary Victoire, the daughter of Mr. Richard Brice, of Burnham, Somerset. He has left behind him the best memorial any man could wish —the reputation of an able scientific worker and administrator of unlimited kindness and geniality.

THE death has occurred in Vienna of Prof. Guido Holzknecht at the age of fifty-eight years. Holzknecht was one of those medical men who took up the scientific study of X-rays soon after their discovery. He was responsible for the exploitation of X-rays especially in the field of examination by means of the fluorescent screen. In the years before the War he was perhaps more responsible than anyone for perfection in this technique, and at the Vienna General Hospital it was developed to such an extent that photography in X-ray work was of minor account. Holzknecht was a prolific writer, and there is scarcely a branch of radiology upon which he did not make important contributions. His device known as the chromoradiometer was an early attempt at measuring the doses of X-rays given to the surface of the body. Holzknecht was a big figure in the X-ray world, whether from a diagnostic or therapeutic point of view, and by his work during the last thirty years, in which, unhappily, he suffered what proved to be fatal damage to himself, he did much to put the subject on a scientific basis.

MR. EDWARD STEP, who died on Nov. 8, aged seventy-five years, was widely known in the world of entomology and natural history, and by his books was undoubtedly one of the pioneers of the popular study of Nature. He had just completed a book on "Bees, Wasps, Ants, and Allied Insects of the Wayside and Woodland", which will be published shortly. For more than fifty years Mr. Step had been a member of the South London Entomological and Natural History Society, was one of its early presidents, and was to have been president for the coming year. He was also a fellow of the Linnæan Society. In 1928 he was president of the British Empire Naturalists' Association.

WE regret to announce the following deaths:

Prof. Edward S. King, Phillips professor of astronomy in the Harvard College Observatory, known for his pioneer work in photographic photometry, on Sept. 10, aged seventy years.

Dr. John Sampson, formerly librarian in the University of Liverpool, known for his work in gypsy lore, and author of "The Dialect of the Gypsies of Wales," on Nov. 8, aged sixty-nine years.

Prof. Charlotte A. Scott, formerly professor of mathematics in Bryn Mawr College, the first woman wrangler in the University of Cambridge, on Nov. 8, aged seventy-three years.

Major U. P. Swinburne, formerly Chief Inspector of Mines of the Union of South Africa, on Nov. 7, aged sixty-two years.

News and Views.

DRS. BOSCH and Bergius, who share the Nobel prize for chemistry in 1931, represent German developments in industrial chemistry which have earned the admiration of the whole scientific and industrial world and have stimulated extensive researches along parallel lines in other countries. Dr. Bosch's name is indissolubly associated with that of Prof. Haber in regard to the catalytic production of ammonia from atmospheric nitrogen, whilst Dr. Bergius's researches on the production of volatile hydrocarbons by hydrogenation of organic material under pressure have already given us the expressive term 'berginisation'. Thus the fame of each rests on the reaction of hydrogenation under pressure leading to materials of international importance. The catalytic synthesis of ammonia originated with Haber and van Oordt's work in 1905, when atmospheric pressure was employed, but as the work progressed, and was taken up by Nernst, Jost, and others, the question of providing adequate experimental facilities for working under pressure arose; the process was adopted by the Badische Anilin und Soda Fabrik in 1910, and Dr. C. Bosch, whose name is particularly associated with studies on the catalyst poisons, took a prominent part in its development. The success with which his pioneering investigations were conducted is illustrated by the world-wide use, at the present time, of the Haber-Bosch process for the fixation of nitrogen.

Dr. F. Bergius, who was born on Nov. 11, 1884, at Goldschmieden, near Breslau, has made the study of the influence of high pressure on chemical reactions his chief interest. This work, which was described in his book, "The Use of High Pressures in Chemical Actions", was preliminary to the development of his widely known process for the manufacture of oil from coal—a process which was first patented in Great Britain so long ago as 1914. The importance of the process to a coal-producing and oil-importing country such as Great Britain is obvious, and it was therefore not surprising that the speakers at the symposium on the British fuel problem, recently held by the British Association, devoted attention to its advantages and limitations.. Much work on the subject has been done under State as well as private auspices, and it is of interest that, on Nov. 24, the production of oil and petrol from coal is to form the subject of an address to the Imperial College Chemical Society by Prof. C. H. Lander, formerly Director of Fuel Research. The award of the Nobel prize for 1931 for physics has been postponed until next year.

The Polish Physical Society, the Polish Chemical Society, and the Society of Polish Electrical Engineers, with the support and assistance of the Polish Academy of Sciences, Cracow, the Polish Academy of Technology, the scientific societies of Warsaw and Lwow, and various other Polish scientific institutions, arranged for a celebration of the Faraday centenary, on Nov. 6, at Warsaw, in the large hall of the Technical High School. The President of the Polish Republic, Prof. Moscicki, and three members of the Government were present; the British Embassy was also represented. After a short introductory speech, made by Prof. St. Pieńkowski, Dr. Ladislas Natanson, professor of natural philosophy in the Jagellonian University, Cracow, delivered a lecture on the "Life and Discoveries of Michael Faraday". Addresses were also delivered by Prof. W. Swietoslawski, of the Warsaw Technical High School, who discussed and explained Faraday's chemical and electrochemical researches, and Mr. T. Czaplicki, who chose for his subject, "Faraday and the Modern Science of Applied Electricity". The proceedings concluded with an exhibition of various pictures connected with Faraday's life and work. The commemorative meeting was an impressive testimony of the deep reverence and gratitude which, in Polish scientific circles, is attached to Faraday's memory.

The following is a list of those recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on Nov. 30: *President,* Sir Frederick Hopkins; *Treasurer,* Sir Henry Lyons; *Secretaries,* Dr. H. H. Dale and Sir Frank Smith; *Foreign Secretary,* Lord Rayleigh, *Other Members of Council,* Dr. J. A. Arkwright, Prof. G. Barger, Prof. W. L. Bragg, Prof. E. P. Cathcart, Mr. A. C. G. Egerton, Mr. R. H. Fowler, Prof. E. S. Goodrich, Prof. G. H. Hardy, Prof. W. N. Haworth, Prof. C. E. Inglis, Prof. O. T. Jones, Sir Thomas Lewis, Dr. N. V. Sidgwick, Prof. A. G. Tansley, Prof. G. I. Taylor, Prof. D'A. W. Thompson.

A recent issue of the *Dalhousie Review* contains an interesting article by Dr. D. F. Fraser-Harris, entitled "Medical Pioneers in Science". In substance, however, this brochure selects and records accurately the upbringing and achievements of those presidents of the Royal Society of London who, successors of Newton, have held medical degrees. This method of discussing the data of biography often affords unexpected comparisons and coincidences. There seem to have been, within the defined period, nine presidents possessing medical degrees, namely: Sir Hans Sloane, Bt. (1727–41), Sir John Pringle, Bt. (1772–78), W. H. Wollaston (June 1820–Nov. 1820), Sir Benjamin Brodie, Bt. (1858–61), Sir Joseph Hooker (1873–78), T. H. Huxley (1883–85), Lord Lister (1895–1900), Sir Charles Sherrington (1920–25), and Sir F. Gowland Hopkins. Of these, only three may be said to have followed medicine or surgery as a means of livelihood, though the remainder were closely associated with medical studies. Sloane was created a baronet by George I., an honour to which no English physician had before attained. Lister was raised to the peerage (1897), the first medical man receiving that dignity. Lately, various character adjectives have been applied to Faraday; the author deems Lister to have been "learned, dignified, gentle, courteous, strong, industrious, modest"—we may surely add that above all he was serene. Eight of the foregoing presidents were married, Wollaston being the exception. He himself was one of the seventeen children of a Norfolk clergyman, whilst Sir Benjamin Brodie was, alike, one of the seventeen children of the rector of Winterslow, Wiltshire.

In connexion with the award of medals by the Royal Society for the present year (Nature, Nov. 14, p. 821), it is interesting to recall that the Copley Medal for 1831 was allotted to Sir George Biddell Airy for his papers on the construction of the achromatic eye-pieces of telescopes and on the achromatism of microscopes, on the spherical aberration of eye-pieces, and for his other papers on optical subjects in the *Cambridge Philosophical Transactions.* Airy was not at the time a fellow of the Royal Society, that honour being given him later, namely, in 1836. In the year previous to this, he had been appointed Astronomer-Royal. Airy was president of the Royal Society from 1871 until 1873, whilst on five occasions he was chosen president of the Royal Astronomical Society. With regard to the awards of Royal medals, it appears that none were made in 1831 or 1832.

In delivering the fifteenth Bedson Lecture at Armstrong College, Newcastle-on-Tyne, on Nov. 13, Prof. John Read dealt with researches on essential oils. He pointed out that the unique flora of Australia belongs to an ancient, slowly-changing order of things which, standing aloof in the isolated Australian environment, has stamped its impress deeply upon the indigenous organic products of the continent. In a laudatory reference to the collaborative work of R. T. Baker and H. G. Smith, the striking fact was mentioned that the merit and value of Smith's work were imperfectly understood in Australia, and "the classical researches of this pioneer chemist of the Southern world remained unappreciated during his lifetime by all but a scanty few of his British colleagues". After giving a general review of the chemical characteristics of the Australian flora, Prof. Read explained some of the recent work which has been carried out in the St. Andrews laboratories upon piperitols and menthols. Among the interesting exhibits was a 50-gram specimen of pure dextro-menthol, prepared by a new process from 200 grams of *dl*-menthol.

IN concluding his lecture, Prof. Read urged his listeners to avoid an undue restriction of vision in their chemical studies. "The conditions under which much of our chemical research work is carried out at the present day", he said, "are such as to produce, in the absence of correctives, a species of mental myopia among chemists. We chemists should strive to acquire balance and a broader vision; to pay more attention to economic and geographical considerations and to the chemical resources of our Empire; to cultivate an interest in botany, agriculture, and other related branches of science: in brief, we should learn to 'think imperially' in chemistry. The test-tube and the still, the transactions and abstracts of our chemical societies, are the tools of our craft; but we are citizens of a wider world. Let us stand back from our laboratory benches occasionally and contemplate the results of our own and our colleagues' researches against the background of our science, our Empire, and our world."

THE Thomas Hawksley lecture to the Institution of Mechanical Engineers was delivered on Nov. 6, by Mr. Ll. B. Atkinson, who chose as his subject the mechanical aspects of electricity. He pointed out that to mechanical engineers some of the modern theories must appear very nebulous. They cannot escape from the fact, however, that electrical and mechanical actions involve an interchange between visible motion and invisible motion. When electrons are moved from positive ions by mechanical motion, there must be some motion somewhere as the equivalent of the mechanical work which will reappear when the surrounding field collapses owing to the return of the electron to the atom to which it belongs. The fact that it has been proved that magnetic fields are due to electron rotations premises rotational energy as the form of the energy hidden from sight, but, nevertheless, existing and recoverable from the magnetic field. These ideas must in some way incorporate themselves into the explanations which will emerge in the future. Physicists, having failed to explain magneto-electrical actions which involve wave effects by the old mechanics, are now trying, with considerable success, to explain the old mechanics by wave effects. But, just as Faraday's and Maxwell's conceptions explained action at considerable distance by action at atomic distance, so explanation of atomic actions by wave mechanics must ultimately resolve itself into finding out the nature of the medium in which the wave takes place. The joy and satisfaction of scientific inquiry lie in the continual striving after fuller explanations.

TEN years ago, practically the only ignition system for the internal combustion engines used on British and Continental cars included the use of a magneto. At the present time, coil (or battery) ignition systems are used on at least eighty per cent of the cars being produced. The chief reasons for the adoption of coil ignition are its lower cost on multi-cylinder engines, the avoidance of difficult problems in the driving of the ignition unit, and the difficulty in finding a suitable type of magneto when high-speed engines are under consideration. Hence the paper read by E. A. Watson on Oct. 30 to the Institution of Electrical Engineers is a timely one. It is now commonly assumed that the amount of energy delivered in the discharge by the ignition system bears no direct relation to the energy necessary for the ignition of the explosive charge. In all cases the latter is a very small quantity and the electrostatic energy stored in the capacitance connected with the sparking plugs is always sufficient to cause ignition of the explosive mixture employed in the cylinder of an internal combustion engine. The mathematical theory of the induction coil, considered as two separate coils, is well known and is directly applicable. Prof. Taylor-Jones has shown how to find the coefficient of coupling which will give the best results. A clear and scientific account is given of the theoretical principles underlying the application of the induction coil to the specific purpose of ignition. The problems still left to the manufacturer are in connexion with small matters of detail, points conducive to cheapness of manufacture and trustworthiness in operation. Coil ignition is now practically a standardised method.

THE Imperial Bureau of Animal Genetics, established under the directorship of Prof. F. A. E. Crew, at the University of Edinburgh, is one of a series of nine imperial agricultural bureaux designed for the purpose of collecting, collating, and disseminating amongst research workers in the British Empire information of a scientific and technical character. It has already made good progress in a work which the dispersal of published contributions to agricultural knowledge in all sorts of odd corners of literature makes increasingly important and even necessary. During 1931 two comprehensive bibliographies have been published. The first contains references to papers dealing with the biology of the fleece, a contribution prepared for the Imperial Wool Conference of 1930, and including works published up to 1929. In addition to the list arranged alphabetically according to authors, there is included a subject index, which forms a useful guide to the varied matter discussed. The second bibliography is more ambitious, and aims at bringing together the chief information upon the subject of fur-bearing animals. This compilation, which has had the advantage of many scientific collaborators, gives a summary classification of fur-bearing animals, and under each species groups the titles of relative papers. It is devised for the assistance of workers interested in the domestication of these useful animals, and includes references to papers on ecology in relation to conservation and utilisation of a natural resource, as well as to papers on the actual breeding of the animals in captivity. The first bibliography (32 pp.) is published by Messrs. Oliver and Boyd at 2*s.* 6*d.* net; the second (36 pp.) is duplicated typescript and may be obtained from the Bureau, price 1*s.*

A SECOND line of co-operative activity adopted by the Imperial Bureau of Animal Genetics is the publication of a *Quarterly Bulletin.* Its purpose, to judge by the three numbers of Vol. 2 which are before us, is to bring its readers in touch with current investigations, partly by the review of books bearing on genetics and relevant problems, and partly by short articles summarising the state of knowledge along different lines. In these numbers the chief summaries deal with lethal factors and live stock breeding, and fur production. The articles are far from exhaustive, but they suggest the scientific outlook, and in the case of fur-production a timely hint is given that the unskilled adventurer may lose much money in attempting to breed for marketable pelts under conditions of locality and climate which make profitable results impossible. It is announced that on the appointment of Mr. Eldon Moore to the editorship of the *Eugenics Review,* his place as Chief Officer of the Bureau has been taken by Dr. F. Fraser Darling.

IN an account of the birds in Mr. Whitley's private zoological garden at Paignton, now being published in the *Avicultural Magazine,* Dr. E. Hopkinson mentions (p. 245) five white specimens of the Australian zebra-finch (*Taeniopygia castanotis*) as having to be kept each in a separate compartment on account of their spitefulness. This is worth noting, as the species, though spirited and well able to look after itself in spite of its very small size, is not normally intolerant, even of its own kind in the breeding-season. It would seem, therefore, as if the white birds, which have only appeared recently, may have a different character from the normally coloured ones. This is certainly the case with a not distantly allied but much larger finch, the Java sparrow (*Munia oryzivora*), in which the white specimens are undoubtedly far more vicious than the normal birds. This may be, however, because the white birds are a domestic race and therefore at home in captivity, while practically all normal specimens are wild-caught and hence more apt to be nervous. In the case of the zebra-finch, however, normal birds are nowadays aviary-bred like the white ones, the species, long known as a free breeder in captivity, having been fully domesticated during this century. If whiteness and pugnacity are often correlated, this may be the reason why the giant fulmar (*Ossifraga gigantea*) is generally white in south polar latitudes and coloured farther north, for it is in polar conditions that the struggle for existence would be most severe among these powerful predatory sea-fowl.

A BREED of Mexican hairless swine has been studied by Elmer Roberts and W. E. Carroll (*Jour. of Heredity,* vol. 22, No. 4), who find that hairlessness is inherited as a simple Mendelian difference in crosses with Chester White. The skin is not entirely devoid of hairs, but they are sparse and the condition is therefore one of hypotrichosis. The heterozygotes have half as much hair as the normal. This condition is quite different from the type of hairless pigs prevalent in some parts of the United States, which is caused by a deficiency of iodine associated probably with goitre in the mother; the young are born dead or die shortly after birth, but the condition can be cured by administration of iodine. Hairless dogs, rats, mice, rabbits, and calves are known, as well as featherless fowls. Some of these factors are lethal. A vigorous naked sheep is, however, described by E. T. Popova-Wassina in the same journal (vol. 22, No. 3). It was born in a flock of black sheep, near Moscow, which had been intensely inbred. The skin was completely bare except for a few hairs on the hind legs and the tip of the tail. The skin was black instead of slate-blue, and the animal—a male—was of full vitality. It is probably a homozygous recessive, brought out by the close inbreeding which had been practised in the flock for twenty years.

WE have received from the British Drug Houses, Ltd., London, N.1, a number of leaflets describing different products issued by the firm. Acriflavine 'B.D.' was the first brand of British acriflavine used as an antiseptic wound dressing: it finds a use in a variety of septic conditions. Caprokol is a brand of hexylresorcinol: it is a urinary antiseptic which can be given by mouth. It is a highly active bactericide, and its action is enhanced by the fact that it reduces the surface tension of the urine so that it has a great penetrating power. It also acts as a soothing anodyne in urinary tract infections. Carotene B.D.H. has the growth-promoting power and anti-infective action of vitamin A, although it is not itself the vitamin. Recent research has suggested that carotene is converted into vitamin A in the animal body. It is issued in the form of pellets. Elixir Valibrom B.D.H. is a pleasant and safe hypnotic: it contains chloralamide, potassium bromide, and extract of valerian. A similar elixir is also issued containing 0·03 per cent morphine in addition. Liver Extract B.D.H. is used in the treatment of pernicious and certain other anæmias, such as that of pregnancy or sprue. It contains the liver fraction which stimulates the production of reticulocytes by the bone marrow. Livogen is a preparation of liver containing vitamins B_1 and B_2, to which has been added hæmoglobin and a yeast extract also containing vitamins B_1 and B_2. It is recommended as a general tonic and for the treatment of secondary anæmias. Manganese butyrate B.D.H. is of value in certain acute local conditions, especially those resulting from staphylococcal infections or in the complications of gonorrhœa. It is administered by intramuscular injection, a one per cent solution being used.

IN December 1930 the Central American Expedition of the University of Pennsylvania explored Yucatan in an aeroplane with the view of locating Maya ruins. A full account of the work of the expedition by Mr. P. C. Madeira appears in the *Museum Journal* (Pennsylvania) for June 1931. Several new sites were found and some were examined, but it is of interest to note that the leader of the expedition believes that the location of sites of ruins by aeroplane, in such a densely forested region as Yucatan, is of little scientific value owing to the difficulty of ground expeditions finding them again. Theoretically it is of course possible to fix the position on the map, but practically the mapped position may be, and probably is, a mile or two in error. This makes it impossible for an expedition cutting its way through the jungle to find the site without great loss of time and the use of many parties. Mr. Madeira suggests that the aeroplane might mark the site by dropping some destructive gas along lines forming a triangle with the site in the middle. Thus an exploring party could pick up the trail of the destroyed vegetation and so find the ruins. Another suggestion he makes is to drop, by parachute, on the ruins "a strongly constructed machine that would send out electrical waves for a considerable period" and so guide explorers to the spot. At any rate, until a sure method is devised of guiding a land party through the jungle to the site of ruins located only from the air, the discovery of further ruined cities by aeroplane seems to Mr. Madeira to be nothing but a fascinating and somewhat expensive sport.

PREVIOUS paragraphs in NATURE have noticed the operations conducted by the organisation known as "River Flow Records" on the rivers Moriston and Garry, in the Ness Basin, Inverness-shire. There has recently been issued a further series of quarterly reports, in two sets, by Capt. W. N. McClean, the director of the organisation, covering the six months from October 1930 to March 1931. These reports contain a detailed record of the rainfall within the basin during the period in question, with comments on the variations at the different gauging stations, and a statement of river-levels with the corresponding flow in cusecs set out in tabular form and the "Remaining Flow-off" from the catchment area in each case. The report on the River Garry also contains an examination of the rainfall records at Glenquoich Lodge on Loch Quoich, for the sixty years from 1870 to 1929, with a series of diagrams showing the annual rainfall, the deviation of the annual rainfall, and the aggregate rainfall to date, given as an excess or deficiency above or below 110 inches per annum. The Meteorological Office reckons the annual average for a period of 35 years (1881–1915) at 110·75 in. The report mentions that a striking characteristic of the record, which is found in those of other Scottish gauging stations, is the comparatively low rainfall of the twelve years, 1878–1889. At Glenquoich the following thirteen years gave a normal average and the twenty-seven years, 1903–1929, a much higher average. The mean of the records of thirty-five Scottish gauges gives similar conditions since 1889, though individual gauges differ very considerably. Copies of the reports can be obtained at the office of River Flow Records, Parliament Mansions, Victoria St., S.W.1.

THE Safety in Mines Research Board Paper No. 69, on the ignition of fire-damp by coal-mining explosives (Part 1, Gallery Experiments. H.M. Stationery Office, 1*s*. 6*d*.), by Grimshaw and Payman, deals with the causes of ignition of firedamp by permitted explosives, and gives suggestions as to the use of such explosives. The experiments show that it is really the conditions under which the explosives are used which determine whether they will ignite firedamp or not, and safety in their use depends as much, if not more, upon the care with which the operation is carried out than upon any specific property of the explosive. The experiments had in view an investigation of the conditions under which a given charge of a permitted explosive will cause ignition of firedamp underground. There is a long discussion of foreign theories of ignition and of the utility of tests. It is considered that the experiments rule out any possibility of utilising flame photography as a means of distinguishing explosives or methods of firing explosives. A shot-hole well placed, well loaded, and well stemmed is regarded as the best preventive of ignition of firedamp by explosives available to-day, and some simple rules which are likely to add to safety in the pit are given at the end of the paper.

THE Report of the Ordnance Survey for the year ending March 31, 1931, shows satisfactory progress in all departments, even if the staff and means available are far from adequate for all the cartographical and other work that is desirable. The Director-General notes the demand for revision of large scale plans of many areas which cannot be met by the Survey. Frequently the work is done by local surveyors employed by the municipality concerned, but the result seldom reaches the standard of accuracy of the Ordnance Survey. As regards small scale maps, a new quarter-inch series of England and Wales has now been published. A new feature of this series is the addition of town traffic diagrams on larger scales, showing the principal roads through the chief towns. They will be bound up with the folded editions, and are ready for sheet 11 of England and Wales and sheet 3 of Scotland. Another feature of interest is the proposal to produce a relief shaded edition of the one-inch map; after experiment, a satisfactory method has been found. The growing number of Ordnance maps printed annually shows that the popularity of these maps is rapidly increasing.

PART 18 of the "Catalogue of Indian Insects", issued by the Government of India, is devoted to the coleopterous family Carabidæ. The author, Mr. H. E. Andrews, has adopted a wide point of view, and the insects listed represent not only the Indian Empire but also the greater part of south-east Asia. The Catalogue is intended as a complete survey comprising all references to the Carabidæ inhabiting this territory. The classification followed is the recent one of T. G. Sloane, with certain adaptations. Thus, one new tribe (Idiomorphini) has been introduced and one tribe (Mormolycini) has been excluded. The arrangement of the Catalogue is alphabetical under genera, and each genus has its species arranged in a similar order, with synonymical and other references, and the areas wherein they are known to occur. Mr. Andrews's contribution, which extends to 389 pages of letterpress, represents the most extensive family so far dealt with in this Catalogue, and is likely to remain a standard for many years to come.

The Executive Council of the National Institute for the Blind has issued its annual report for the year ended March 31, 1931. A full account is given of the work and activities of the Institute with many illustrations. The output of braille books and periodicals was on the whole greater than for many years, and no less than 27,136 bound volumes were produced. The production of manuscript works and textbooks in braille for blind students has been continued by a band of volunteer writers, and this library now numbers 7000 volumes. The income of the Institute has been maintained, but the future naturally gives cause for anxiety, and emphasis is laid on the value of the annual subscription. The British " Wireless for the Blind " fund provided 13,000 wireless sets to date, and it is hoped that a further 7000 sets will soon be distributed, thus equipping with sets the estimated 20,000 blind persons without means of obtaining them.

A new oceanographical journal has appeared from Madrid in *Revista del Consejo Oceanografico Ibero-Americano*. The numbers that have so far appeared contain several important articles in oceanography by authorities in different countries, as well as bibliographical notes and the proceedings of the Council. The same body is responsible for a series of memoirs in oceanography, which includes papers by Dr. J. A. Fleming and J. P. Ault on the last cruise of the *Carnegie*, one by G. S. Huelin on gravimetric work at sea, and a useful list of oceanographical voyages of all countries by Prof. R. de Buen. This list omits few names of any significance.

The seventeenth of the series of lectures on " Physics in Industry ", arranged by the Institute of Physics, will be delivered by Mr. A. Whitaker, on " Physics in Sound Recording ", at the Royal Institution, on Nov. 26, at 5 p.m.

At a meeting of the London Mathematical Society on Nov. 12, the following officers and new members of council were elected: *President*, Prof. A. C. Dixon; *Vice-Presidents*, Prof. S. Chapman, Prof. H. Levy, Mr. T. L. Wren; *Treasurer*, Dr. A. E. Western; *Librarian*, Prof. H. Hilton; *Secretaries*, Prof. G. N. Watson, Mr. F. P. White; *New Members of the Council*, Mr. M. H. A. Newman and Mr. H. T. J. Norton.

It is announced by Science Service that Mr. Masani Nagata has been awarded the Donohoe Comet Medal by the Astronomical Society of the Pacific, for his discovery of the first new comet of 1931. The observation was recorded in Nature for Aug. 1, p. 192.

It is announced in *Science* for Oct. 23 that the John Fritz gold medal, conferred by the four American societies of civil, mining and metallurgical, mechanical, and electrical engineers, has been awarded for 1932 to Dr. Michael I. Pupin, professor of electro-mechanics and director of the Phœnix Research Laboratory at Columbia University, for his achievements as " scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils ".

The annual Congress of the Royal Institute of Public Health will be held in Belfast on May 10–15, 1932, under the presidency of the Marquess of Londonderry, chancellor of the Queen's University of Belfast. The inaugural meeting will be held on the morning of May 10, and the scientific work of the congress will be conducted in the following sections: Section 1, State Medicine and Municipal Hygiene (including Port Sanitation); Section 2, Industrial Hygiene; Section 3, Women and Children and the Public Health; Section 4, Tuberculosis; Section 5, Pathology, Bacteriology, and Biochemistry.

The latest catalogue of Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1, is No. 541, giving the titles of upwards of 1300 works dealing with Africa. It should be of interest to geographers and anthropologists.

Messrs. Baillière, Tindall and Cox, 7 and 8 Henrietta Street, W.C.2, have just issued a very useful classified catalogue of current books dealing, respectively, with animal husbandry and agriculture (including horticulture and forestry). The catalogue gives also the titles of certain periodicals relating to the subjects dealt with in the main list.

Applications are invited for the following appointments, on or before the dates mentioned:—A master at the Government Technical School, Kingston, Jamaica, for metal work and engineering subjects—C.A., The Secretary, Board of Education, Whitehall, S.W.1, or The Secretary, Scottish Education Department, Whitehall, S.W.1 (Nov. 23). A research student at the Institute of Pathology and Research, St. Mary's Hospital—The Secretary, Institute of Pathology and Research, St. Mary's Hospital, Paddington, W.2 (Nov. 23). A lecturer in mechanical engineering at the Northampton Polytechnic Institute—The Principal, Northampton Polytechnic Institute, St. John Street, E.C.1 (Nov. 25). A professor of pathology in the University of Sheffield—The Registrar, University, Sheffield (Nov. 27). A junior assistant pathologist at the Royal Sussex County Hospital—The Secretary-Superintendent, Royal Sussex County Hospital, Brighton (Nov. 28). A radium officer for the National Radium Regional Centre at Plymouth (South Devon and East Cornwall Hospital)—The General Superintendent and Secretary, South Devon and East Cornwall Hospital, Plymouth (Nov. 28). A pathologist at the Infants Hospital, Westminster—The Secretary, Infants Hospital, Vincent Square, S.W.1 (Nov. 30). A research fellow in bacteriology at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, S.W.1 (Dec. 5).

Erratum.—Nature, Nov. 14, p. 821, third paragraph of " News and Views ", last line but one: for " 1300 years " read " 1300 million years ".

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Representation of Crystal Structure.

The atomic structure of crystals is not an altogether simple matter to represent on paper. What is required, of course, is a portrait of a unit cell: that is, of any selected parallelopiped, with atoms at its corners and with just enough volume to include within itself a complete sample of the crystal pattern. A common device is to reproduce in picture form a three-dimensional model of such a cell. Another is to map out the contents of the cell upon one of its six faces. The rays employed for the purpose of projection must be parallel with that edge-direction of the cell which is inclined to the chosen face: thus in some cases the projection is orthogonal, and in others oblique.

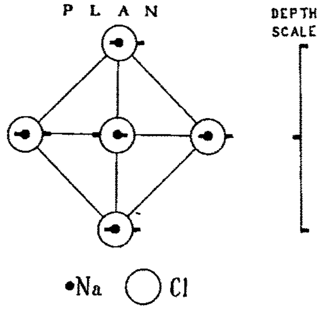

Fig. 1.—Atomic plan of sodium chloride on cube face (001). The symbols bear no relation to atomic volumes. Compare "Introduction to Crystal Analysis", Fig. 32.

Further, it is necessary to adopt a notation to indicate the depth of individual atoms represented on the plan. This depth is always stated as a fraction of the depth of the unit cell as a whole. Two conventions are in common use: (1) the depth of an atom may be shown by varying the depth of shading employed in the ornamentation of its symbol; or (2) it may be expressed by attaching an appropriate number, such as ¼ or 25, where 25 means 25 per cent. Both conventions become difficult at a very early stage of complexity.

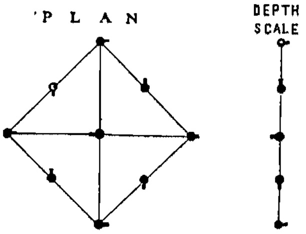

Fig. 2.—Atomic plan of diamond on cube face (001). Compare "Introduction to Crystal Analysis", Fig. 33.

The notation illustrated in Figs. 1-3, while equally simple in principle, admits of wider application. The depth of any atom is indicated in these figures by a pointer, which rotates in clock fashion. If the pointer is directed downwards, the atom lies in the lower half of the unit cell, and vice versa. A depth scale, vertical in the cases illustrated, but oblique where necessary, is added to complete the picture. It is drawn to the same scale as the plan, and its length can be stated in angstrom units.

It is easy with this notation to indicate depths of two or more atoms which happen to be superimposed in plan, even where these atoms belong to different chemical elements. It is also easy to proceed from one plan to another—in fact, to map out the crystal on any desired plane. For example, one can map diamond or calcite at right angles to its cleavage; in which case the origin of the cleavage becomes manifest in alternations of open and close spacing of the atoms.

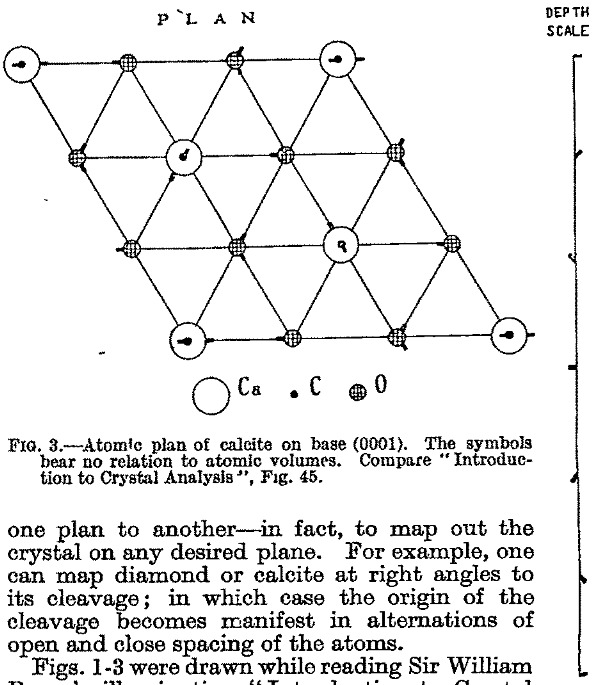

Fig. 3.—Atomic plan of calcite on base (0001). The symbols bear no relation to atomic volumes. Compare "Introduction to Crystal Analysis", Fig. 45.

Figs. 1-3 were drawn while reading Sir William Bragg's illuminating "Introduction to Crystal Analysis", and may be compared with the rather more complex originals, upon which they are based.

E. B. Bailey.

The University, Glasgow,
Oct. 21.

Effects of Inadequate Feeding on Insect Metamorphosis.

Mr. Dover in his communication on this subject[1] has confused the phenomenon of metamorphosis with that of moulting. These two phenomena are entirely distinct. It is well known that, whereas all insects periodically moult during their life-cycle, only certain groups undergo metamorphosis. Regarding moulting, his observations support the views to which I subscribed in my papers quoted by him. My conclusions[2] were that the number of moults is in proportion to the length of the larval life, and that moulting cannot be solely, and possibly is not mainly, correlated with growth but is primarily connected with metabolism. Mr. Dover observed that when the larvæ of *Orgyia turbata* completed their life-cycle sooner, they underwent a lesser number of moults than is normally the case. He concluded that the decreased number of moults was due to a lesser accumulation of waste nitrogenous matter. The only difference between our views seems to be that, whereas I connect moulting with general metabolism (which includes excretion), he connects it specifically with excretion, but without advancing evidence in support of his conclusions.

The question of the influence of inadequate feeding on metamorphosis, with regard to which there seems to be a radical difference between Mr. Dover's views and those of many other entomologists, including myself, is of far greater importance. Kellogg and Bell,[3] Northrop,[4] Tangl,[5] Kopec, and others, working on different groups of insects, showed that inadequate feeding, qualitatively or quantitatively, prolonged the larval life of the insect concerned. The observations of Krizenecky[6] and of Szwajsowna[7] on mealworms, however, did not seem to support this conclusion. Thereupon I carried out a series of experiments on mealworms, and found[8] (*a*) that the first essential for the metamorphosis is the full growth of the larva, which under normal conditions is attained a few days before actual pupation, and during these few days the larva does not require any food; and (*b*) that metamorphosis is delayed or accelerated according as the larva is inadequately fed before or after it is full grown.

It is evident that, whether metamorphosis is accelerated or retarded, the metabolic rhythm is disturbed; therefore Mr. Dover's explanation of my observations, namely, "that a comparatively lengthy period of starvation, followed by an equal period of normal feeding, disturbed the metabolic rhythm to the extent of retarding growth", is not very helpful. With regard to his own observations, we note that when larvæ of *Orgyia turbata* were reared on *Crotolaria*, a plant to which they were not accustomed, and which was apparently unpalatable, a heavy mortality occurred among them, and those which survived completed the larval period sooner. From this he concludes that inadequate feeding accelerates metamorphosis. This conclusion is based on the assumption that *Crotolaria* is less nutritious than the usual food plant, which may not be necessarily correct. Before sending this communication for publication, Mr. Dover was good enough to discuss the subject with me. He informed me that he had not ascertained by weighing or otherwise whether the larvæ fed on *Crotolaria* were smaller or bigger than those reared on the usual food plant, nor had he followed the complete history of the individuals fed on *Crotolaria* in order to determine their power of reproduction. Without applying these simple tests, to assume that *Crotolaria* provided inadequate food and to suggest that an insect which has once gained a foothold on the unusual plant may be more numerous than on the favoured ones appears scarcely justified. In this connexion the observations of Parfentev[9] on another species of *Orgyia* are of more value. This author studied the question by a series of carefully controlled experiments, and concluded that inadequate feeding retards metamorphosis and prolongs the larval life, a conclusion which is in consonance with the views of many entomologists, including myself, and is entirely opposed to Mr. Dover's interpretations.

HEM SINGH PRUTHI.

Zoological Survey of India,
Calcutta, Oct. 8.

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[1] NATURE, **128**, 303, Aug. 22, 1931.
[2] NATURE, **116**, 938, Dec. 26, 1925.
[3] Kellogg, V. L., and Bell, R. G., *Jour. Exp. Zool. and Science*, N.S., **18**; 1904.
[4] Northrop, J. H., *Jour. Biol. Chem.*, **30**; 1917.
[5] Tangl, F., *Arch. ges. Physiol*, **130**; 1909.
[6] Krizenecky, J, *Biol. Zentrbl.*, **34**; 1914.
[7] Szwajsowna, P., *C.R. Soc. Sci. Vars.*, **9**; 1916.
[8] Pruthi, H. S., *Brit. Jour. Exp Biol.*, **3**; 1925.
[9] Parfentev, I. A., "Défense des Plantes", Leningrad I.; 1925.

The Spin of the Photon.

RECENTLY a number of papers have appeared on the question as to whether the phenomena of polarisation of light can be explained by the assumption of a 'spin' of the photon.[1] Kastler and Frisch deduce from their experiments that the photon possesses no spin, and Kastler argues further that the phenomena of polarisation should be explained on statistical grounds. Raman and Bhagavantam, on the other hand, argue that the interesting results obtained by Bär and Hanle[2] on the reversal of the state of polarisation of Raman lines when observed in the direction of propagation of the primary beam can be explained only on the assumption that the photons possess spin. They seem to link circular polarisation definitely with a spin of the photon about the line of propagation.

The arguments of Frisch and Kastler are based upon the Sommerfeld-Rubinowicz explanation of the selection principle for the azimuthal quantum number (principle of conservation of angular momentum of atom plus photon), but applying the same principle, and the principle that the atom-magnet can orient itself in any direction making certain definite quantised angles with the external field (as proved by Stern and Gerlach's experiment), it can be shown that the absorption of Zeeman components can never disappear with reversal of the field, but it will be modified on passing through two fields, whether parallel or antiparallel. Hence the experiments of Frisch or Kastler cannot be interpreted in the way supposed by them and show no light on the question of the spin. Secondly, and this is more important, a discussion of the Zeeman effect of the π-components of the D_1 line, assuming that the principle of conservation of angular momentum holds during radiation, shows that there may be photons without any 'spin' whatsoever, although they may show polarisation. It therefore seems unjustifiable to describe polarisation with the aid of a 'spin'. It appears that Bar and Hanle's results should be explained in some other way than that proposed by Raman and Bhagavantam.

A full discussion will appear later.

M. N. SAHA.
Y. BHARGAVA.

Physical Laboratory,
Allahabad, India,
Oct. 14.

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[1] Frisch, *Zeit. fűr Physik*, vol. 61, p 626; Kastler, *Jour. de Physique*, May 1931; Raman and Bhagavantam, NATURE, **128**, July 18, 1931.
[2] *Naturwiss.*, vol. 19, p. 463, 375; 1931.

Light Scattering in Liquids.

As was pointed out by Raman and Krishnan,[1] the nebulosity or wings which appear accompanying the original lines of the mercury arc in the spectrum of the light transversely scattered by liquids consist of nearly completely unpolarised light. These wings arise from an unresolved rotational Raman scattering, their intensity depends on the optical anisotropy of the molecules concerned, and they contribute in a not negligible degree to the total scattering by the liquid. Owing to the fact that it consists mainly of unpolarised light, the existence of rotational scattering affects the observed depolarisation of the total scattered light to a notable extent. This is illustrated by the figures given in Table I., in which measurements with carbon disulphide, benzene, and toluene are shown. The first column of figures gives the depolarisation, as measured with a nicol and a spectroscope with a *very wide slit*, so that the Rayleigh and rotational Raman scattering are superposed.

TABLE I.

Substance.	Total scattering (observed value).	Rayleigh scattering (observed value)	Spin theory (quantum).	Classical theory (Maxwellian)
Carbon disulphide	64·0	56·0	55·5	36·4
Benzene . .	41·5	33·3	33·1	20·6
Toluene . .	45·0	37·0	35·1	22·0

In the second column are given the values obtained using *a very narrow slit*, so that only the Rayleigh scattering is recorded on the plate with the exposures given. The third column gives the theoretical value of the depolarisation calculated on the theory of spinning photons referred to in recent communications by Sir C. V. Raman and S. Bhagavantam. The fourth column gives the values calculated on the basis of the classical or Maxwellian theories of light-scattering. It will be seen that the agreement between the second and third columns of figures is very striking.

S. VENKATESWARAN.

210 Bowbazar Street,
Calcutta, India,
Oct. 12.

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[1] NATURE, 122, p. 882; 1928.

Photoelectrons and Negative Ions.

PROF. WELLISH's letter under this title[1] calls for some comment.

In a mixed current of electrons and negative ions traversing a gas, it is usual to assume that the proportion of free electrons will decrease exponentially with the distance covered parallel to the electric force, owing to the combination of electrons with neutral molecules. Thus, the number of photoelectrons surviving in a free state after travelling a distance d will be $N_d = N_0 \epsilon^{-\lambda d}$, where N_0 is the number starting from the electrode. J. J. Thomson[2] has shown that we may put $\lambda = \frac{U}{KX} \cdot \frac{1}{L} \cdot \frac{1}{\beta}$; where X is the field strength; K, L, and U the mobility, mean free path, and velocity of thermal agitation of the electrons; and $1/\beta$ the probability that any one encounter between an electron and a gas molecule will result in their combination. In theory, K and L are both inversely proportional to the gas pressure p, and Townsend[3] finds that K and U are also functions of X: so we may expect that λ will be a somewhat complicated function of X/p^2, even if we assume that β is a constant characteristic of the gas, and not in its turn a function of the electron energy.

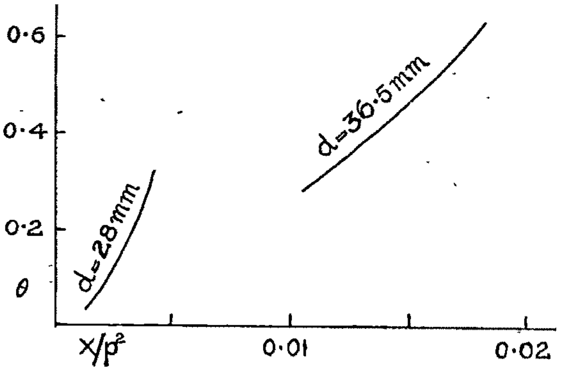

FIG. 1.

Wellish states that, in order to fit the theory to his experimental current/voltage curves, different values of λ are necessary for curves made with different frequencies of the alternating field. This is only to be expected, since the corresponding values of X will be different. The real question is whether a single value of β, not λ, can be found to fit all the curves.

With regard to the experimental procedure, there are serious practical objections to the use of current/voltage curves. The effects under consideration are functions of the field strength, and the actual magnitude of λ will therefore vary along the curves. The exact correlation of theory with experiment is not only very laborious, but also is subject to an unnecessarily wide margin of error. These complications can be avoided by keeping the voltage constant and varying the frequency of the alternating field cycle: the curves obtained in this way are much easier to interpret.

The effect can be studied in detail by my method,[4] in which, by means of two synchronised alternating fields separated by a grid, the current/*frequency* curves are resolved into two clear-cut horizontal 'steps'. From these the proportion of free electrons to total current (Wellish's θ, my N_d/N_0) can be read directly.

A crucial test of Wellish's theory lies in the effect of d, the distance between the electrodes. If no electron captures occur in the body of the gas, as he suggests, then, for given values of X and p, θ should be independent of the distance travelled by the free electrons. I am not at present in a position to make this experiment; but a re-examination of my published data[5] shows that θ can be expressed as a function of X/p^2, for a given value of d, and that when d is changed there is a complete discontinuity in the graph (see Fig. 1). This shows at least that an appreciable fraction of the electron capture must occur in the body of the gas.

J. L. HAMSHERE.

Leysin, Switzerland.

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[1] Wellish, NATURE, 128, 547; Sept. 26, 1931.

[2] J. J. and G. P. Thomson, "Conduction of Electricity through Gases", vol 1, 138; 1928.

[3] Townsend, "Motion of Electrons in Gases". Oxford, 1925.

[4] Hamshere, *Proc. Camb. Phil. Soc.*, 25, 205; 1928.

[5] Loc. cit., p. 217.

Change of Dielectric Polarisation of Carbon Disulphide with Temperature.

ONE of us (J. M.) has determined the changes of density D and dielectric constant E of carbon disulphide with temperature.

On the basis of these data we have computed the dielectric polarisation P, using the formula of Clausius Mossotti:

$$P = \frac{E-1}{E+2} \cdot \frac{1}{D}.$$

The accompanying curve (Fig. 1) represents the results of this computation for the temperature interval from − 60° up to − 112°.

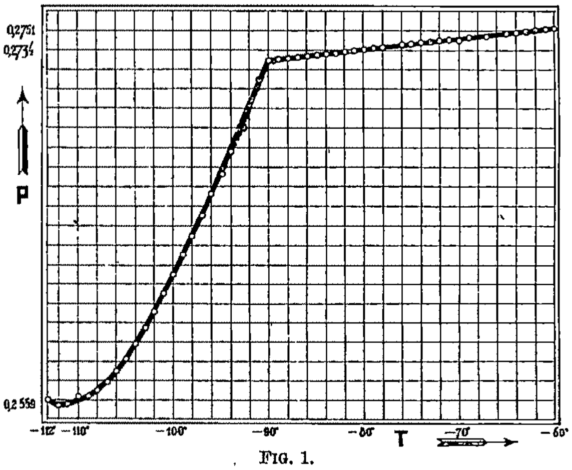


FIG. 1.

The value of P decreases gradually from 0·2751 at − 60° to 0·27372 at − 90° C. At − 90° there appears a sudden drop in the value of polarisation. It should be noted that at this point there appear also a jump in the value of the dielectric constant of carbon disulphide and a distinct change of slope in the density curve. Moreover, this is a point of change from one liquid modification of carbon disulphide into another one, also liquid.

The sudden change of the value of P at $-90°$ suggests that the structure of the carbon disulphide molecule undergoes a change at this point. We have already observed a similar effect with ethyl ether.[1]

M. WOLFKE.
J. MAZUR.

Physical Laboratory,
Technical Institute, Warsaw,
Sept. 22.

[1] NATURE, 126, 684; 1930: 127, 236; 1931.

Diamagnetism of Liquid Mixtures.

WE have been for the past year working on the diamagnetism of liquid mixtures. Our method was to determine the mass susceptibility by a Curie balance, using a powerful electromagnet of the Pye type. Several mixtures have been studied carefully. By careful adjustments we are confident that our error in susceptibility value is not more than half per cent. In all cases studied, straight lines have been obtained between the mass susceptibility and composition. It is thus clear that the additive law is generally obeyed by liquid mixtures. Our list includes mixtures of benzene with chlorobenzene, hexane, carbon tetrachloride, and nitrobenzene, mixtures of hexane with nitrobenzene, and mixtures of acetone with chloroform.

Density curves obtained in all these cases have shown a departure of nearly three per cent, the maximum being about five to six per cent in the cases of benzene-nitrobenzene and acetone-chloroform. We therefore agree with Ranganadham[1] that the results of Trew and Spencer[2] require correction, but so far we have not been able to obtain departures from the additive law when mass susceptibilities are considered. Work with many other liquid mixtures is in progress.

S. RAMACHANDRA RAO.
G. SIVARAMAKRISHNAN.

Annamalai University,
Annamalainagar, S. India,
Aug. 24.

[1] NATURE, 127, p. 975; 1931.
[2] *Proc. Roy. Soc.*, A, 131, p. 209.

Duration and Magnitude of a Lightning Discharge.

A SOMEWHAT unusual case of damage by lightning has recently been brought to the attention of the National Physical Laboratory by Capt. A. J. Mayne, Chief Electrical Adviser for the Aldershot Tattoo. An illuminated notice-board was supplied through fuses from a bare overhead line, by means of two cables, of the type used for house wiring, each having a conductor formed of three strands of tinned copper wire each about 0·75 mm. in diameter, insulated with pure and vulcanised india-rubber, a spiral covering of tape, and an outer braid, and suitable for currents up to 8 amperes: the diameter of each cable was about 5 mm. The two cables were taped together at intervals of about ten metres, and were supported by the creosoted wooden terminal pole of the overhead line and one other similar pole.

At a time when the circuit was not energised, a lightning discharge took place through the cable line, and passed to earth down the supporting poles, in each of which a spiral track was cut: the fuses protecting the cable line were shattered, but no damage to the overhead line was evident. As a result of this discharge, the rubber insulation and tape have been cleanly slit throughout their length and the conductor extracted; the outer braiding has been slit and hangs loose; and each copper conductor has been greatly deformed on one side. At certain points the two conductors have partially cohered. There is no evidence of melting of the copper, and, at most points, no burning of the insulation. At a few points, however, and particularly where the two cables were taped together and the conductor remained in contact with the insulation, burning or melting of the rubber and singeing of the braid have occurred.

It is evident that the lightning current was in the same direction in both cables, and gave rise to an attractive force, under the influence of which the conductors cut the insulation as scissors would do, and came violently into contact.

It is of interest to attempt to calculate very roughly the limiting duration and magnitude of the discharge. For this purpose it is necessary to know the temperature rise of the copper, and the force necessary to cut the insulation. The maximum temperature attained evidently lay between 1100° C., the melting point of copper, and 200° C., a temperature at which no damage to the insulation occurs in 1 minute. Some experiments in which a piece of the conductor was heated to a known temperature, placed in contact with the insulation, and allowed to cool naturally, suggest that 700° C. is a probable value for the temperature rise.

An approximate figure for the force necessary to cut the insulation was obtained by laying a piece of the three-strand conductor on a length of insulation resting on a copper plate, and applying pressure with a hydraulic press: the conductor was first run through a bath of solder to avoid spreading of the strands, since the tendency to spread would not be present during the actual lightning discharge. It was found that the insulation and braid were completely cut by a pressure of 150 kgm. per centimetre, the time of application being about 2 seconds, and were not cut by 100 kgm./cm. Taking a spacing of 0·5 cm., the minimum current in each conductor necessary to produce a force sufficient to cut the insulation is 60,000 amperes. This current must have supplied the energy required to raise the conductor temperature by 700° C., approximately 3000 joules per metre, in the duration of the lightning discharge. Hence it may be calculated that the maximum duration of the discharge was 20×10^{-6} seconds.

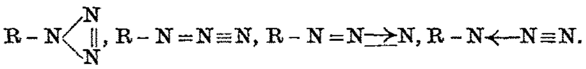
It may be noted that the average rate of energy input to each metre of conductor was at least 150,000 kilowatts.

R. S. J. SPILSBURY.

The National Physical Laboratory,
Teddington, Oct. 12.

Structure of the Azide Group.

L. E. SUTTON has given[1] measured values of the dipole moments of the *liquids* phenyl azide, *p*-chlorphenyl azide, and *p*-tolyl azide, and applies this evidence to discriminate between the structural formulæ below (1–4). The evidence is strongly in favour of the ring structure (1).

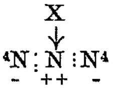


$$\mathrm{R-N}\begin{array}{l}\diagup\mathrm{N}\\ \;\;\|\\ \diagdown\mathrm{N}\end{array},\ \mathrm{R-N=N\equiv N},\ \mathrm{R-N=N}\underline{\longrightarrow}\mathrm{N},\ \mathrm{R-N}\longleftarrow\mathrm{N\equiv N}.$$

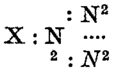
1 2 3 4

In contradistinction to this, in each of the *crystalline* azides for which structures have been obtained hitherto, the crystals of sodium, potassium, thallium, and cyanuric azides, (i) the azide group occurs as a short chain, and (ii) it is the central atom of the chain that carries the valence bond of the group.

These differences, in my opinion, are due to an instability inherent in the chain grouping under certain conditions.

(5) 

$${}^{4}\underset{-}{\mathrm{N}} : \overset{\overset{\mathrm{X}}{\downarrow}}{\underset{++}{\mathrm{N}}} : \underset{-}{\mathrm{N}}{}^{4}$$

(6) 

$$\mathrm{X} : \mathrm{N} \begin{matrix} : \mathrm{N}^{2} \\ \cdots \\ {}^{2} : N^{2} \end{matrix}$$

The electronic formula (5) represents a stable group of three nitrogen atoms, provided that one additional electron is supplied from outside so as to make a total of $3 \times 5 + 1 = 16$, for example by means of a polar linkage with an electro-positive radical X.

When, however, a non-polar linkage is formed between X and N, it is no longer possible for electrons to group themselves in octets about the nitrogens of the chain. The stability lost in this way can be regained only by disruption or by the formation of a ring, as, for example, at (6). This is the ring found by L. E. Sutton for the non-polar liquids he examined, and written by him as at (1), in accord with the chemical notation.

On this evidence, the grouping must take the ring form whenever it is bound into a molecule by a non-polar bond, but may take a chain form whenever it is either an electronegative ion or is bound into a molecule by a polar bond.

The dipole moment of (5) consists of (*a*) a moment due to the polar linkage acting along the valency X - N, and (*b*) two moments due to the semi-polar double bonds N - N, which are equal and act in opposite directions. The resulting dipole moment is, therefore, substantially that due to the bond X - N, and so is comparatively small. For (6), also, the dipole moment is small, since the distribution of electrons is balanced for each atom.

The calculated parachor values are nearly equal for the two groupings, being respectively

$$3 \times 12{\cdot}5 + 2 \times 23{\cdot}2 - 3 \times 1{\cdot}6 = 79{\cdot}1$$

and $$3 \times 12{\cdot}5 + 23{\cdot}2 + 16{\cdot}7 = 77{\cdot}4.$$

T. C. Sutton.

Research Department, Woolwich,
Oct. 14.

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[1] Nature, 128, 639, Oct. 10, 1931.

Slow Combustion of Hydrocarbons.

Two recent papers by S. Lenher[1] on the slow thermal oxidation of ethylene afford very striking confirmation of a modification of Bodenstein's mechanism[2] for the oxidation of acetylene, which I have developed to explain the proportions in which carbon monoxide, carbon dioxide, water, glyoxal, formaldehyde, and formic acid are formed in the reaction. Instead of Bodenstein's reaction

(5) $C_2H_2O_2' + O_2 \rightarrow CO_2 + HCOOH,$

which fails to explain the proportions in which carbon dioxide and formic acid are formed, the deactivating collisions with oxygen are assumed to occur in two ways in a ratio determined principally by steric factors thus:

(5*a*) $C_2H_2O_2' + O_2 \rightarrow CO + CO_2 + H_2O,$

(5*b*) $C_2H_2O_2' + O_2 \rightarrow 2CO + H_2O_2.$

With an additional but very minor reaction

(7) $2C_2H_2O_2' \rightarrow CO + CHO.CO.CH_2OH.$[3]

The scheme, with these modifications, accounts for all the observed phenomena within the limits of experimental error. It is now evident, from very careful analytical work by Lenher,[1] that hydrogen peroxide is produced in the oxidation of ethylene. This can be most readily accounted for by a reaction such as (5*b*) above,

$$C_2H_4O_2' + O_2 \rightarrow CO + H_2O_2 + HCHO,$$

rather than by the less probable deactivation by water suggested by Lenher, and conditions for the formation of dioxymethyl peroxide would be even more favourable. Lenher's kinetic measurements on ethylene, and also those of Thompson and Hinshelwood,[4] show a close parallelism with acetylene and indicate that the reaction proceeds by a similar mechanism. Lenher claims that the large yield of ethylene oxide obtained with short contact time, high temperature, and high ethylene concentration proves the chains to be short and discounts any theory postulating direct formation of carbon monoxide and carbon dioxide from the first collision complex as in (5*a*) and (5*b*). My experiments on acetylene using packed and open vessels,[5] and similar experiments by Lenher[1] on ethylene, show that the chain length in these reactions is at least of the order of 400, and such products as ethylene oxide and methyl alcohol[6] are to be regarded as the result of an alternative non-chain propagating deactivation by the hydrocarbon molecule, which only becomes of importance at high temperatures, high concentrations of hydrocarbon, or special conditions of surface. These views, with my results on acetylene oxidation, will shortly be published in a more extended form.

R. Spence.

Armstrong College,
University of Durham.

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[1] S. Lenher, *Jour. Am. Chem. Soc.*, **53**, 3737, 3752; 1931.
[2] M. Bodenstein, *Zeit. phys. Chem.*, B, **12**, 151; 1931.
[3] Norrish and Griffiths, *Jour. Chem. Soc.*, 2829; 1928.
[4] Thompson and Hinshelwood, *Proc. Roy. Soc.*, A, **125**, 277; 1929.
[5] R. Spence, Nature, **128**, 153; 1931.
[6] W. A. Bone, Nature, **127**, 481; 1931.

Occurrence of *Lithothamnion* in the South Indian Cretaceous.

In continuation of my note regarding the occurrence of *Lithothamnion* in certain Cretaceous rocks of the Trichinopoly area,[1] I write to state that I have further been able to recognise similar, or even identical, algæ in a limestone from the Cretaceous of the Pondicherry area. Some sections of this limestone reveal these algæ in such abundance that there is little or no hesitation in calling the rock an algal limestone. The discovery of these algæ in the rocks of the Pondicherry area must be considered as doubly interesting; first because it will now enable us to extend the statement made about the occurrence and importance of these algæ in the Trichinopoly area as being true of the whole South Indian Cretaceous, and secondly as revealing a new field for providing further material for detailed palæontological investigations of the South Indian Cretaceous algæ in general. The stratigraphical position of this algal limestone of the Pondicherry area, and the general facies of its associated fossils, suggest an age corresponding to the lower Ariyalurs (Senonian) of the Trichinopoly area; and hence we may reasonably conclude that, in this Pondicherry limestone, we have an occurrence of *Lithothamnion* even older than that which has been discovered in the Trichinopoly area.

L. Rama Rao.

Dept. of Geology,
Central College, Bangalore,
Oct. 14.

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[1] Nature, 128, 225, Aug. 8, 1931.

Research Items.

The Cult of the Bull in Scotland.—Mr. A. D. Lacaille, in *Folklore*, vol. 41, No. 3, brings together evidence from place-names, folklore, and archæology bearing upon the existence of a bull-cult in Scotland in prehistoric and protohistoric times. In the west, where Gaelic is still spoken, place-names are coupled with bovines; for example, a wood called 'Coille nan Tairbh' (Wood of the Bulls), near Kilmartin in Argyll. Nearby are several round cairns and other remains and sculptures on a granite outcrop; while a round cairn at Largie nearby yielded one of the most interesting sculptured stones of Scotland on which are figured eight axe-heads, suggesting work of the early bronze age. Names from bulls are given to rivers; for example, the 'Tarff' ('Tarbh', Gael., a bull) or 'Tarbhan', a little bull; 'Loy' from 'Laogh', a calf; for example, 'Alt Fionn Laoigh', 'the Burn of the White Calf'. Not only are antiquities present in the neighbourhood of places designated under an appellation incorporating a bovine name, but also there are legends associated with such features, as well as special practices observed by the people at certain times of the year. One of the most important places of pilgrimage in Scotland was an island on Loch Maree, where ancient rites survived long after the Reformation, associated with St. Mhaolrubh and a sacred well, where a bull was sacrificed on Aug. 25. Reginald of Coldingham records the sacrifice of a bull in honour of St. Cuthbert at Kirkcudbright; and the holy pool of St. Fillan at Strathfillan, Perthshire, effective in curing mental derangement, lost its virtue through the immersion of a mad bull. A legend of the combat between the Red Bull of England and the Black Bull of Scotland is associated with the Pulpit Rock of Ardlui. Representations of the bull are found on sculptured stones of prehistoric and early Christian times, but only in the east and north-east of Scotland.

The Fulani of Northern Nigeria.—Some notes on the Fulani of Northern Nigeria, collected by Mr. G. W. Webster during a residence of twenty-four years, are recorded in *Man* for November. Little can be learned from the settled Fulani, who have intermarried with native tribes and are under the influence of Islam, while the nomad Fulani are shy and inaccessible. A few families admitted the author to their intimate family life. They were startlingly white in appearance and of surprising mentality. They have slim and athletic figures, with beautiful hands and feet, oval faces, and straight or slightly wavy silken hair, usually worn in three to six plaits, but sometimes wound round the head in a single plait and fastened by a silver bodkin with a filigree head, or merely bundled up under a containing cap. Combings or horsehair are used by both sexes to increase the length of the hair. The men have straight or aquiline noses, the women short straight noses or long thin noses, sometimes tip-tilted. The lips are well chiselled, and fine, though often spoilt, according to our ideas, by tattooing of the lower lip, which thickens it and makes it pendulous. The ordinary dress for both sexes is a leather kilt, ornamented with tassels of cowry and shells or beads. It is frequently ornamented with patterns said to be heraldic. The older men wear, in addition, a sleeveless shirt of white cloth, the women a cloth wrap put round the body to form a dress from armpit to calf. The older men wear a phrygian cap or straw hat, as a protection from rain and sun when travelling. Women are usually bare-headed. Boys and girls herding cattle wear the kilt, a tanned skin over the shoulder, and the straw hat. The girls in addition have breastplates of copper, silver, or even calabash. On holidays and festivals, the kilts and jackets are brightly embroidered, and the girls wear necklaces of beads, said to be of great antiquity, with numerous pendants.

The Canada Goose and its Races.—The Canada goose is one of the favourite water-fowl of ornamental ponds in Great Britain, but in its native home it has been a source of annoyance, at any rate to the zoologists. *Branta canadensis* has several geographical races, and in the absence of investigation of the segregation of the races in their far northern breeding grounds, a satisfactory classification of material containing mixed migrants has been impossible. P. A. Tavener, having at hand new collections of breeding and summering specimens from Baffin's Land and elsewhere, has made a fresh attempt to solve the problem (*Ann. Rep.* for 1929, Nat. Mus. Canada, p. 28, 1931). He notes that the experienced sportsman often distinguishes, by habit, stance, action, or voice, races which to the taxonomist appear to be all but identical. As a result of his comparison of characters and sizes the author now groups under the specific name of *Branta canadensis*, three races—the honker or eastern form (*B. c. canadensis*), the western form (*occidentalis*), and the lesser form (*leucopareia*). But, partly on account of its breeding in juxtaposition with *leucopareia* without general hybridisation, he separates *B. minima* as a definite species, in which category he also places *B. hutchinsi*; the latter, apart from niceties of colour, appears to be a diminutive edition of *leucopareia* and *canadensis*.

Larval Freshwater Shrimps from Japan.—Dr. Zu Yokoya, in his paper "On the Metamorphosis of Two Japanese Freshwater Shrimps, *Paratya compressa* and *Leander paucidens*, with Reference to the Development of their Appendages" (*Journal of the College of Agriculture*, Imperial University of Tokyo, volume 11, No. 2; 1931), investigates these two freshwater crustaceans, one belonging to the Atyidæ and the other to the Palæmonidæ. Although describing briefly the various larval stages of each and figuring them, he pays special attention to the development of the appendages and of the muscles attached to them. Both species are found commonly in a pond in the grounds of the University of Tokyo, therefore abundant material was forthcoming, the larvæ also being hatched from the egg in aquaria and partially reared. The larvæ of *Paratya compressa* are rather like those of *Caridina wyckii* as described by von Daday, the larvæ of *Leander paucidens* somewhat resemble those of *Palæmonetes varians* as described by Gurney. *Leander paucidens* has an enormous fifth leg, specially large in the early stages. The author observed a larva in stage IV. catching a larval Ephemera with these precociously developed long legs. It is an interesting fact that these caridean larvæ should feed on insects. In the later stages the change in form of these legs is so great that one wonders whether the food is also changed. The paper is well illustrated by very careful drawings of the larvæ and of all the appendages in each stage, the latter occupying eight double plates. The whole is a valuable contribution to the study of decapod development, especially as little is known of these Japanese larvæ.

Entomogenous Fungi.—Mr. T. Petch has chosen the study of fungi which attack insects as his special branch of mycology. He has spent many years in Ceylon, and is now in England, pursuing his favourite hobby. His most recently published work is entitled "Notes on Entomogenous Fungi" (*Trans. British Mycological Society*, vol. 16, pt. 1, pp. 55-75, 1931). The species described therein are members of the genera *Beauveria, Sporotrichum, Rhinotrichum, Volutella, Hypocrella, Isaria, Nœmosphœrella, Oospora, Tilachlidium, Acremonium, Botrytis, Metarrhyzum, Cephalosporium, Sterigmatocystis, Penicillium,* and *Cordyceps.* Most of the descriptions refer to foreign species, and many of them have not been named before. A study of the genus *Cordyceps* revealed the presence of four species which had an atypical ascus. Instead of the characteristic cylindrical ascus with fusiform spores dividing into part-spores, these species have a clavate ascus with fusiform, non-dividing spores. The name of *Ophiocordyceps* is proposed for this genus.

Chromosomes and Constitution.—A. A. Moffett has a very interesting paper upon this difficult subject in reference to the Pomoideæ in the *Journal of Pomology and Horticultural Science*, vol. 9, June 1931. Earlier work from the John Innes Horticultural Institution has shown, for the cultivated apples, that these strains are polyploid, and that the greater productivity of certain strains can be traced to an even number of sets of chromosomes, whilst triploids are relatively infertile, as similar odd multiple polyploids have proved to be in *Prunus* and *Rubus.* At first sight the basic number of chromosomes in the apple seemed to be 17, with diploids 34 and triploids 51 in the gametes. But the curious secondary association of pairs of bivalents noticed in the pollen mother-cells, occurring after the normal pairing at prophase of nuclear division, has already suggested that these 17 chromosomes represent a complex grouping from an original set of seven, three of which were represented three times and four twice. Moffett has extended these observations through a number of the genera of the Pomoideæ, data being tabulated now for species in ten genera, including that variable North American genus *Cratægus.* Whilst the usual numbers of chromosomes in the gametes seem to be invariably 17 or a multiple of 17, the frequent occurrence of similar secondary pairing of the original bivalent pairs is regarded by Moffett as supporting the view that all the Pomoideæ are secondary polyploids founded on an original basic set of seven chromosomes. It is suggested that the common morphological characters of this group may be associated with this unusual cytological constitution.

Kaolin Minerals.—The results of a long-continued investigation of clay minerals by C. S. Ross and P. F. Kerr are presented in *Prof. Paper* 165 E of the U.S. Geol. Survey, 1931. The older methods of study have been supplemented by applying the X-ray powder-method, and tests of this kind have been effectively carried out on the same materials as those used in the chemical, dehydration, and optical investigations. Complete correlation of results is therefore attained. The conclusion is reached that instead of one kaolin mineral there are at least three distinct species. These are called *kaolinite, nacrite,* and *dickite,* the last being after A. B. Dick, who described the original material from Anglesey. All three have generally the accepted composition $2H_2O.Al_2O_3.2SiO_2$, but some kaolinite varies in the direction of higher SiO_2. Kaolinite is stable over the lowest temperature range; it is formed by the weathering of feldspathic rocks and by thermal carbonate-bearing waters. Dickite is stable at higher temperatures, and seems to have been formed by moderately heated hydrothermal solutions; it is not known as a product of weathering. Nacrite is the high temperature form, and is formed by hypogene processes. These results probably explain most of the current differences of opinion about the mode of formation of 'kaolin'.

Tide-gauge Measurements of Height Differences.—Among other interesting papers and reports included in the *Comptes Rendus* of the fifth meeting of the Baltic Geodetic Commission at Copenhagen, Oct. 13–18, 1930 (pp. 275: Ilmari Bonsdorff, Helsingfors, July 1931), is one by D. la Cour on the determination of differences of height by tide-gauge measurements in Denmark. Great difficulty has been found in levelling by the ordinary optical methods over the broad belts of water that separate the islands of Denmark from the mainland; large systematic errors have been found which render the results uncertain. La Cour has investigated the departures of the water surface in these belts from the horizontal, with the aim of avoiding the need for carrying an optical beam horizontally across the belts; this process of determining differences of height he calls 'quasi-levelling'. He has investigated the water-level by tide-gauges at certain Danish stations, and has found a considerable systematic variation of level, depending on the pressure gradients between Shetland and Aaland, and Calais and Cracow; extrapolating to zero pressure gradient, he finds that the corresponding water-level at Esbjerg is 28 cm. below mean water-level. He shows that changes in the mean water-level over a period of a few years can be deduced with a far smaller probable error when the correction to zero pressure gradient is made than when this is not done. He considers, also, the effect of the rotation of the earth in producing a difference of level across belts along which a current is flowing, and believes that this affords the most accurate means of estimating the difference of level. He finally suggests the experiment of laying a small lead pipe across the strait between Denmark and Sweden, in order to connect the levelling bases of the two countries.

An Effect of X-Rays on Matter.—A number of attempts, generally regarded as unsuccessful, have been made to affect the stability of atomic nuclei by non-radioactive methods. An elaboration of one due to Smits is described by G. I. Pokrowski in the *Physical Review* for Sept. 1. The effect consists in the supposed possession of radioactive properties by bodies when they have been exposed to X-rays. In Prof. Pokrowski's experiments, X-rays from tubes run at about 100 kilovolts were used. Light elements were not affected, but after heavy elements had been irradiated it was found that a new ionisation of gases was detectable in their presence, falling off in intensity with a period of half decay of the order of half an hour in the case cited. Another set of experiments was made which showed that a screen could be observed to scintillate in the same circumstances. By combining the two sets of observations, it was deduced that the energies of the particles correspond with those of weak α-particles, so that the phenomenon, if its reality can be maintained, would appear to be some stimulated form of disintegration of nuclei which are not normally radioactive.

Measurement of High Voltages.—A lecture given by Prof. W. M. Thornton to the Institution of Electrical Engineers and published in the October number of the *Journal*, discusses the possibility of making instruments for measuring very high voltages. This problem is an urgent one at the present time. The conclusion arrived at is that high voltage instruments can be made as simple in construction and as accurate and convenient to use as those for lower voltages. In the absolute form, when an ellipsoid instrument is used, the degree of precision approaches the highest physical accuracy. Using this instrument, Prof. Thornton finds very easily a value for the velocity of light which is in excellent agreement with the best of the standard determinations. Another type of instrument is the corona voltmeter, the action of which depends on the appearance of ionisation at the surface of the corona rod. The lack of an accepted theory of corona formation is a hindrance to the general acceptance of the formula which Prof. Thornton gives, but it is accurate, and he thinks the instrument will soon be developed so as to give very high accuracy. The constancy of hot wire ionisation and spark phenomena in gases leaves little doubt that the effects of ionisation are capable of repetition to a high degree of certainty. The electric wind is not at first sight a promising phenomenon to use for precision measurements, yet Chattock has shown that it is steady within one per cent, and further experiments have confirmed his results. Although not quite independent of the frequency, the ionic wind voltmeter is as accurate as any hot wire bridge can be made. It is necessary to work at voltages below that at which corona appears on the filament. Above this point the instrument may fluctuate several per cent above a mean value.

Optical Rotation and Atomic Dimension.—D. H. Brauns, in the *Bureau of Standards Journal of Research*, vol. 7, No. 3, refers to previous investigations which show that for the halogen acetyl derivates of the monosaccharides glucose, fructose, xylose, and arabinose the differences in specific rotations Cl–F, Br–Cl, and I–Br have the same ratio, 41 : 17 : 21, which is in close agreement with the ratio 41 : 16 : 21 for the distances of the carbon to the halogen atoms in homopolar compounds (mean of values of Arkel and de Boer and of Goldschmidt). The values for the mannose derivatives, however, give the abnormal ratio 41 : 25 : 35. The details for the preparation of the crystalline halogen derivatives of tetra-acetyl mannose, including the iodo-compound, are given in the paper. The behaviour of the mannose derivatives is then studied in relation to space models, and the conclusion is reached that the hydrogen of the first asymmetric carbon, to which the halogen is also attached, is influenced by the atoms of the second carbon acetyl group, whereas such an influence does not exist for the other halogenated monosaccharides. The results show that the study of the principle of optical superposition should be carried out in the light of these configurational peculiarities.

Isotopes of Lithium, Sodium, and Potassium.—The *Journal of the Franklin Institute* for September contains a detailed paper by K. T. Bainbridge on the above subject. Magnetic analysis of the positive rays of lithium from a heated spodumene source showed no change with temperature in the relative abundance of Li^6 and Li^7, in agreement with Aston and Morand. Different results of other observers are considered to be effects of space charge. Ions of the alkali metals were produced from heated natural silicates, the technique being described in considerable detail. Sodium and potassium were examined for the presence of small amounts of isotopes other than Na^{23}, K^{39}, and K^{41}. If Na^{21} or Na^{25} exist at all, they are present to less than 1 in 3000 of the main isotope and Na^{22} cannot be present to an extent greater than 1 in 800 of Na^{23}. From analysis of potassium it is concluded that there is less than 1 part in 1500 of K^{43}, less than 1 in 600 of K^{42}, and less than 1 in 300 of K^{40}, in reference to K^{39}, if they exist at all.

Astronomical Topics.

Comets.—Dr. Bower and Miss Miller found a markedly hyperbolic orbit for Ryves's comet from the August observations, but the October ones show that it does not differ much from a parabola; the following is a close approximation to it:

$$\begin{array}{rl} T & \text{1931 Aug. } 25{\cdot}9447 \text{ U.T.} \\ \left.\begin{array}{r} \omega \\ \Omega \\ i \end{array}\right. & \left.\begin{array}{l} 168^\circ\ 16' \\ 101\ \ 28 \\ 169\ \ 16 \end{array}\right\} 1931{\cdot}0 \\ \log q & 8{\cdot}8704 \end{array}$$

They give the following ephemeris for 0 h. U.T. in *Harvard Card* 184:

	R.A.	N. Decl
Nov. 24	$10^h\ 42^m\ 32^s$	1° 41′
Dec. 4	10 33 4	2 9
14	10 20 13	2 56
24	10 3 57	4 3

The comet is still within reach of moderate instruments, but is fading rapidly. It is important to follow the comet as long as possible in view of the near approach that it recently made to Jupiter; the elements given above indicate that it was nearest to Jupiter on Oct. 10, 1930, the distance being fourteen million miles; it remained within half a unit for more than two months.

Mr. F. E. Seagrave finds the following elements for Nagata's comet from observations made at Yerkes Observatory on July 23, Aug. 5 and 31:–

$$\begin{array}{rl} T & \text{1931 June } 10{\cdot}82188 \text{ U.T.} \\ \left.\begin{array}{r} \omega \\ \Omega \\ i \end{array}\right. & \left.\begin{array}{l} 318^\circ\ 45'\ 39{\cdot}31'' \\ 191\ \ 37\ \ 39{\cdot}20 \\ 42\ \ 27\ \ 28{\cdot}51 \end{array}\right\} 1931{\cdot}0 \\ \log e & 9{\cdot}9707006 \\ \log q & 0{\cdot}0137314 \\ \text{Period} & 62{\cdot}9261 \text{ years} \end{array}$$

The period is probably too short, but there is little doubt that the orbit is an ellipse of moderate period.

Mr. Durrad's announcement of a comet in the northern sky, Nov. 5–Nov. 9, proves to have been erroneous; the comet does not exist.

Mutual Eclipses of Jupiter's Satellites.—Before the time when these eclipses were predicted they were very seldom observed. The Rev. T. W. Webb in his well-known "Celestial Objects" (1881 edition) stated that there was only one recorded instance. The duration of the eclipses is brief and they are likely to be missed unless the observer is forewarned. The Computing Section of the British Astronomical Association undertook some years ago to predict these phenomena, and also those in Saturn's system; these predictions have led to many of these phenomena being observed; the results should be of value in improving the elements of the orbit planes; eclipses by Jupiter are of little use for this purpose. The seasons for such eclipses recur every six years, when the orbit-planes of the satellites pass through the sun; one of these seasons has just begun, and Major A. E. Levin, who is both president of the Association and Director of the Computing Section, devoted part of his presidential address on Oct. 28 to this subject. The geometry of the eclipses is somewhat intricate, but that of the mutual occultations, as seen from the earth, is still more so. The predictions are published in the British Astronomical Association Handbooks for 1931 and 1932. The next one that is visible in England at a convenient hour is the eclipse of II by I early on Nov. 23; it begins at $1^h\ 20^m$ A.M. and lasts 6 minutes. There are many visible ones in December, as Jupiter then rises earlier.

Educational Broadcasting.

AMONG the many discussions at the British Association centenary meetings which received comparatively little publicity was that which followed Prof. Winifred Cullis's paper on "Broadcasting in Adult Education". There are few more hopeful signs amid our present difficulties than the attempts which are being made to utilise for instructive purposes the new powers and forces which science has placed at our disposal in broadcasting and the cinema. It is generally admitted that progress in the exact or physical sciences, such as chemistry, physics, engineering, has far outstripped progress in the social sciences. Partly, no doubt, this is due to the disparity between the volume of research in these fields as compared with research in the physical sciences, but the prejudices and conservatism which are still widely prevalent in such fields as eugenics, education, and psychology are a contributing factor which is largely responsible for the absence of a true social science or sociology.

Progress in this field depends not only on research in biology and anthropology but also to a very large extent on the education of the community, if the results of scientific research are to find application. Prof. Cullis described the admirable experimental work which has been initiated in adult education since the establishment of the Central Council for Broadcast Adult Education in 1928. The series of pamphlets on "The Changing World", recently issued by the British Broadcasting Corporation as an introduction to a series of evening talks to be broadcast on Mondays to Fridays from Sept. 28, 1931, to March 25, 1932, illustrates the considerable progress which has already been made with the two main problems presented by the development of a specialised programme technique and of interesting the listening public.

These attractive pamphlets demonstrate the possibility of securing simple, informal, and continuous treatment of live subjects which are of wide general interest and related to experience in a way which appeals to a general audience. They are designed not only to arouse interest in the future talks but also to encourage the formation of study or discussion groups, and contain lists of books dealing with the various topics, which assist further reading and the attainment of a balanced and impartial view.

As its title indicates, the present series of pamphlets has as its main purpose the practical object of assisting the listening public to understand more fully the changes which are taking place in industry, art, and politics largely through the impact of science. This is fundamental work if the community is to have any real capacity to sort out the issues and to lend its continuous and intelligent support to policies which will enable civilisation to regain control over events.

The pamphlet by Prof. Henry Clay is introductory to twenty-four talks on industry and trade, and gives an outline of the ways in which changing wants have shifted prosperity from the basic industries or those supplying the necessaries of life to those that supply luxuries. Prof. Clay suggests that British industry is possibly losing trade because it persists in supplying goods that will last, when its customers chiefly desire variety and novelty. Into this picture, changing conditions in regard to population and emigration are fitted as a background to the factors of technical progress and mass production, upon which discussion is sometimes exclusively centred. Tendencies in industrial organisation and their economic effects, both in relation to the persistence of poverty and the relations of government and industry, are reviewed in an impartial way that opens up wide and fundamental questions.

It is all to the good that such questions as the relations between technical advance and the maldistribution of economic prosperity should be examined widely in this way. Too often the discussion is limited by prejudice or is characterised by an absence of perspective, and Prof. Levy's essay on science in perspective endeavours to place science in its rightful position in regard to the changing conditions under which we live. The rate at which scientific and technical development has proceeded in the last century is probably a prime reason why even yet the gap between scientific or technical advance and social, political, and economic developments is scarcely realised, still less the danger which confronts premature attempts at legislation with inadequate knowledge. Here, as well as in the demonstration that science has provided us with a fresh medium in which art can find expression and, above all, with the means and technique to plan our future, the series of talks which Prof. Levy introduces should greatly promote the interpretation of the true relations of science to society and culture.

Fundamental questions are also raised by the talks on the modern State to which J. A. Hobson writes an introduction. These, too, envisage the part which the specialist is called upon to play in the evolution of order and reasoned control in the sphere of politics if the modern State is to be adequate for the increasing demands made upon it. Existing parliamentary institutions are admittedly ill-adapted to deal with many of the problems, such as those of the relations between capital and labour, town industries and agriculture, manufacturing and distributive trades, key industries, transport, atmospheric pollution, etc., now confronting the State, and departmental action is frequently either ill-informed or unguided by a considered policy. The development of new methods cannot come without the help of scientific workers, and their help cannot be effective unless public opinion understands and appreciates the contribution they have to offer. So, too, in the international sphere, even yet society is slow to realise how imperative science has made the need for co-operation, and that both our material and international life needs replanning as an organic whole in which the co-operative effort of all classes of society and of all nations make their particular contribution to the common weal.

This is no Utopian ideal: it is a practical proposition. As Mr. John MacMurray points out in an introductory essay to the talks on education and leisure, the maintenance of an advanced civilisation depends upon the preparation of the minds which live in it and by it so that they can meet the demand for constant adaption to new conditions, for elasticity and versatility of mind. Primarily this is an educational problem, and the method of education by broadcasting offers a prospect of countering the inertia and mechanisation of mind for which our educational methods far more than our industrial conditions are responsible. If we can acquire the capacity to change our opinions continuously, in a balanced and controlled fashion, by a continuous testing of them against the changing facts of experience—which is only another name for a scientific outlook—we shall find that modern industrial conditions, and the wider services rendered by the modern State, so far from repressing or cramping individuality and personality, offer it wider opportunities. To learn the use of leisure is to learn how to live and to discover the way to control and transform the forces which, unchecked, threaten the existence of our civilisation.

Control of West Indian Insect Pests.

THE reduction of insect damage in all parts of the British Empire is a problem of primary importance. Adequate and reliable physico-chemical methods are available, yet in many parts of the world their cost, or the conditions governing their application, render them essentially unsuitable. Some other avenue of approach has to be opened up in these circumstances, and a method which shows evident promise is the practical utilisation of the parasitic and predaceous enemies of pests, or, in other words, biological control. In 1928, Dr. J. G. Myers, of the Imperial Institute of Entomology, was commissioned to devote two years' study to the possibilities afforded by biological methods of control in respect to the main insect pests of agriculture in the British colonies of tropical America. A preliminary report by Dr. Myers on his investigations has recently been published by the Empire Marketing Board.* In this report he discusses the main geographical, topographical, meteorological, biological, and agricultural conditions upon which the distribution and prevalence of insect pests presumably depend. At the same time there is reason to believe that such factors have a very direct bearing upon the prospects of applying biological control methods.

In carrying out his exploratory mission, Dr. Myers has visited most of the West Indian Islands and also parts of the mainland of South America. Notwithstanding the extensive area covered in these travels, he has been successful in assembling a large amount of practical information. Since sugar-cane is the most important crop in the British West Indies, the pests affecting it, naturally, received the most attention. The most important of these latter, in the region as a whole, is the small moth-borer (*Diatrœa* sp.). While this insect has numerous parasites, only two appear to be reasonably efficient. The most valuable of these seems to be *Lixophaga*, which has accordingly been introduced into Barbados and Antigua. As regards the notorious cane-froghopper of Trinidad, which still remains a pest of the first rank, no effective parasite has yet been discovered, though the possibility of its being found in the mainland remains for the future. The large moth-borer of cane (*Castnia licoides*) is now serious only in Trinidad; it is controlled by flooding the fields in British Guiana. Since it is increasing in Trinidad, an effective parasite is greatly needed. While no parasites are as yet known, the discovery of the original plant-host of this insect by Mrs. Myers is held to render the search more likely to prove successful. The cane root-borer (*Diaprepes abbreviatus*) is likewise a very serious pest in Barbados. The discovery of an effective egg-parasite of two allied species in Haiti and Montserrat has rendered the problem more hopeful, and its introduction into Barbados is being arranged for.

In addition to sugar-cane, the insect pests and their parasites of cacao, cotton, mahogany, banana, coffee, and so on, also come under consideration. In these connexions it needs to be pointed out that, for several of the pests, little hope is expressed that suitable parasitic enemies will be found within the confines of the West Indies or the adjacent mainland. Certain of the injurious species of insects are Old World pests which have become accidentally introduced, without their natural parasites or predators, into the West Indies. There are other cases in which the same pest, or closely allied species, is much more effectively parasitised in Africa or the Orient than in tropical America. Taking facts of this kind into account, the possibility of introducing suitable parasites into the West Indies from the Old World tropics is one which requires fullest consideration, since it may lead the way to the permanent control of the pests concerned. With the cacao thrips, for example, Dr. Myers suggests that a species of parasite from the Gold Coast may prove to be a useful introduction. Against cotton-stainers (*Dysdercus*) certain tachinid flies from Queensland or Nigeria are suggested, and for the banana-borer (*Cosmopolites sordidus*) it is recommended that a search for possible parasites should be made in New Guinea.

If the suggestions made in this report be translated into practice, they will lead to experiments of the utmost value in testing the soundness of the biological principles and ideas that are involved. Difficulties are likely to be encountered in the transit of living material of this kind over vast tracts of land and water. With the increase of aerial communications such troubles will become greatly reduced. The aeroplane, it may be added, has already been adopted by Dr. Myers in the transmission of moth-borer parasites from Cuba to Antigua, whence they were sent on in cold storage to Barbados.

This report should be read by all interested in the subject, and due credit must be given to the Empire Marketing Board, through the financial provision of which the investigations recorded therein were rendered possible.

A. D. IMMS.

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* Empire Marketing Board. A Preliminary Report on an Investigation into the Biological Control of West Indian Insect Pests. By Dr. J. G. Myers. (E M B 42.) Pp. 173. (London. H.M. Stationery Office, 1931.) 1*s*. net.

Measurement of Pressure and Temperature in the Upper Atmosphere.

DR. A. K. DAS, B. B. Ray, and D. N. Dasgupta, of Alipore Observatory, Calcutta, have sent a description of apparatus designed to yield measurements of atmospheric pressure and temperature at various heights. The advantages claimed over the ordinary meteorograph are that the required information is available within a very short time and at small expense.

For determining pressure, a small glass bulb drawn out at one end into a narrow spiral tube is used. A small pellet of strong sulphuric acid is introduced into the tube; the apparatus is then placed in a chamber with glass windows, the air of which can be gradually removed by a pump. The pressure is shown by a suitable manometer. Exhaustion is carried to the point when the pellet of acid is just reaching the open end of the tube, and the pressure at this moment is observed. The apparatus is then placed inside a light box packed with non-conducting material, the open end of the tube projecting beneath the box so as to overhang a small bowl containing a mixture of sugar and potassium chlorate. It is attached at some distance below a balloon, which carries it up until the pressure has fallen to that value which will allow the acid to emerge and explode the mixture in the bowl, the smoke of the explosion being observed from the ground in a theodolite. Measurement of the angle subtended by the line joining the balloon and the apparatus, and of the angular elevation of the latter, enables the height at which the explosion occurs to be measured.

A slight modification of the arrangement, illustrated by Fig. 1, allows temperature to be measured instead of pressure. As before, we start with air at surface temperature and pressure enclosed by the pellet of acid, but the explosive mixture is enclosed in a sealed copper vessel (*E*). The bulb is packed in non-conducting material, so that it is only the temperature of the explosion chamber that changes when the apparatus is carried up beneath a balloon. The fall of pressure due to the fall of temperature allows the pellet of acid to emerge from the spiral tube at a temperature that is determined by a special experiment on the same lines as that made for calibration of the apparatus for pressure measurement, the temperature in this case being varied.

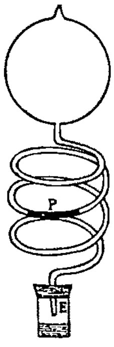

FIG. 1.

It will be seen that for every individual reading of pressure and temperature a special calibrating operation must be made in addition to the construction of a new apparatus. These drawbacks do not necessarily imply that the method is unworkable. A more serious objection is that the method of determining the height of the explosion is obviously liable to serious error unless the altitude is small compared with the highest altitudes attained by the balloon meteorograph for which this apparatus is proposed as a substitute. Its possibilities could be estimated if practically simultaneous sets of values of pressure and temperature were obtained, for the values of pressure could be calculated by Laplace's equation from the observed values of height and temperature, and could be compared with those found experimentally. The apparatus when used for measuring temperature must necessarily ignore inversions of the ordinary fall of temperature with height, and so could never give the thermal structure of the atmosphere in great detail.

Since the above communications were received, Dr. A. K. Das has forwarded a description of a modified form or extension of the device which he has specially designed to supply the missing information. It is shown in Fig. 2.

Glass is used throughout, except for the cork *c*. The vessel *V* contains a small quantity of potassium chlorate and sugar. The shaded parts contain strong sulphuric acid, the unshaded parts air. There is a constriction in the upper horizontal length of tube and a valve *v*, consisting of a glass tube drawn out at each end, which allows acid to travel from left to right only. The whole is packed in cotton-wool, except for the bulb *B* and a part of its stem, and is carried up by an ordinary pilot balloon. So long as temperature is decreasing, the valve is closed and acid is sucked up the stem of *B* owing to the fall of temperature and pressure in *B* through the capillary tube the open end of which is labelled t_1; but as soon as an inversion of temperature is encountered and the pressure in *B* is increased, the valve opens and a drop of acid emerges at t_2 so as to explode the mixture below it. The smoke of the explosion is observed through a theodolite, and its height, which is that of the inversion, is measured by the 'tail-method' described above. The partial filling of the apparatus with acid appears to offer no difficulty, the acid being sucked in through t_1; subsequently some acid is withdrawn from t_1.

Dr. Das does not say whether the apparatus has been tested. A difficulty that at once suggests itself is that of ensuring that the charge shall not be exploded prematurely by a rise of temperature at ground level. Sensitive thermograms show that the air near the ground is constantly varying in temperature whenever a wind is blowing, the effect being due largely to turbulence of the air. It would appear that the bulb *B* would need to be insensitive to these if a premature explosion is to be avoided; at the same time, the balloon that carries the apparatus up must rise quickly if the former is to remain visible to high elevations, and, if the bulb is not very sensitive, inversions may fail to be recorded unless they extend through a considerable height. Ingenious though the device may be, it seems very doubtful whether it or those formerly described will prove to be practical substitutes for apparatus of the type already in use with registering balloons.

E. V. NEWNHAM.

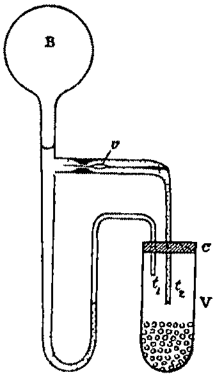

FIG. 2.

Prehistoric Society of East Anglia.

IN his presidential address before the Prehistoric Society of East Anglia on Oct. 7, Mr. J. P. T. Burchell took as his subject the relation of Neanthropic man to the ice age. Mr. Burchell pointed out that a convenient datum line in the quest for the correct geological horizons of the successive cultural stages is provided by the deposits of the 100 ft. terrace of the Thames, and the fact that north of the Thames the Acheulean and Mousterian cultures overlay the lower Boulder Clay. Recent work on the upper glacial deposits of the Yorkshire coast and the estuary of the Humber was correlated by Mr. Burchell with the discoveries made in the Brown Boulder Clay of Hunstanton by J. Reid Moir, and advanced in evidence of a late Pleistocene, Aurignacian-Upper Mousterian stage having been succeeded by climatic conditions which resulted in the formation of the Brown Boulder Clay of the Hunstanton and Lincolnshire coast and of the Coombe deposits (? Boulder Clay) of Yorkshire. Examination of the Lower Estuarine Clay of Northern Ireland had revealed a palæolithic industry of Magdalenian character which must predate the formation of that deposit.

At the same meeting, Mr. A. L. Armstrong described an open-air site at Scunthorpe, Lincolnshire, where an Azilian-Tardenoisian floor, covered by blown sand, was found to be superimposed upon a late Aurignacian deposit. This confirms the sequence already observed in the cave-floor deposits of Mother Grundy's Parlour, Cresswell Crags, Derbyshire, where excavations carried out by Mr. Armstrong in 1924 revealed the gradual development of Upper Aurignacian culture in England and established the fact that this development was of a distinctive character and practically free from Magdalenian influences, while it was found to be overlain by an Azilian-Tardenois culture—the microburin appearing in the last few inches.

Excavations in the Mendip caves and elsewhere have since confirmed these conclusions and it is now recognised that the latest phase of this developed Aurignacian culture is essentially an English one.

Hitherto, definite occupation sites have been confined to caves, but four years ago what appeared to be an open station was located on the North Lincolnshire Cliff Range, in the Scunthorpe district. This has since been consistently examined each year and the original conclusion proves to be correct. The site, though confined to a limited area, has yielded a typical series of developed Aurignacian tools, including long batter-backed blades, keeled scrapers, and burins of various types; also microlithic blades.

The Scunthorpe area has long been known as one of the type stations of the Azilio-Tardenoisian culture in England, and the Upper Aurignacian site forming the subject of this communication is situated within a few miles of one of the areas where pygmy tools are most abundant. The industry represented, however, is free from Tardenoisian influences. Pygmy tools are extremely scarce, and it is believed to be a representative site of the native culture upon which the Azilian and the Tardenoisian was engrafted. Tools which appear to belong to the same cultural epoch have been collected on the ridges southwards towards Lincoln, occurring upon the surface together with tools of later industries, and what is likely to prove a second definite occupation area has now been located in the vicinity of Willoughton and is under examination.

The Rubber Research Institute of Malaya.

THE annual report of the Rubber Research Institute of Malaya for 1930, covering the fourth year of active operations, shows that in spite of difficulties caused by shortage of staff, very considerable progress has been made. The Soils Division has continued its work on the manuring both of immature and mature rubber, and although the low price of rubber has induced caution in the application of artificial fertilisers, it has been possible to obtain valuable data regarding the effect of nitrogen, and nitrogen and potash together. A paper is to be published shortly, summarising our information on manuring the rubber tree, and the Soils Division is also co-operating with Imperial Chemical Industries, Ltd., and Malayan Fertilisers, Ltd., in similar experiments.

Other work has been concerned with practical methods of soil conservation and particularly the value of cover crops, and there is increasing realisation that the mere growth of a cover is not a universal remedy for trees in poor vegetative growth. Small fertiliser dressings, given individually to the young trees, seem a more economic way of inducing rapid growth without prejudice to future soil fertility.

In spite of the absence of a head of division, the Botanical Division has made considerable progress with its investigations on the improvement of *Hevea* planting material by vegetative means and on the response of the tree to different methods of tapping. This work, carried on not only at the experimental station but also in co-operation with various estates throughout Malaya, is providing information on the replanting of old areas which are becoming wasting assets through root disease in the old trees, as well as assisting the selection of new clones from high yielding trees or seedlings of known origin. Tapping experiments have indicated the existence of three or four very promising new Malayan clones.

The Chemical Division has continued its work on the separation and characterisation of latex constituents, particularly on the non-caoutchouc constituents which affect so largely the properties of raw and unvulcanised rubber. In addition, investigations have been carried out on the efficiency of sheet manufacture, the drying of crepe and sheet, the cause and elimination of defects in lower grade rubber, and the preservation and concentration of latex. Methods of spectrographic analysis are being developed by the Institute for soil investigations and for such problems as the effect of minute traces of certain metals on the properties of raw rubber.

University and Educational Intelligence.

CAMBRIDGE.—R. J. Pumphrey, of Trinity Hall, has been appointed University demonstrator in the Department of Zoology.

A grant of £125 has been made from the Balfour Fund to L. C. Beadle, of Pembroke College, for research on the biology of African lakes.

The managers of the Pinsent-Darwin studentship in mental pathology give notice that an election will be made in December. The studentship is of the annual value of not less than £200, and is tenable for three years. The student must engage in original research into any problem having a bearing on mental defects, diseases, or disorders; but may carry on educational work concurrently. Applications should be made before Dec. 5 to the Secretary, Pinsent-Darwin Studentship, Psychological Laboratory, Cambridge.

EDINBURGH.—The following appointments of lecturers have recently been made:—Mr. E. G. Dymond, in natural philosophy; Dr. E. L. Ince, in mathematics; Dr. R. A. R. Gresson, in zoology (cytology); Dr. Peter Gray, in zoology (vertebrate embryology); Lieut.-Col. S. Hunter Cowan, in forest engineering.

AMONG the honours approved by the King, arising out of the recent dissolution of parliament, is that conferred upon Sir W. Martin Conway, who has been made a baron. Sir Martin Conway was member of parliament for the Combined English Universities from 1918 until 1931.

THE Carnegie Foundation for the Advancement of Teaching has issued its twenty-fifth annual report, for the year ending June 30, 1930. Dr. Henry S. Pritchett, who was associated with Andrew Carnegie in organising the Foundation in 1905, presided over its administration from then until August 1930, when he made over charge to Dr. Henry Suzzallo. Starting with an endowment of ten million dollars, the Foundation has grown until its resources now amount to more than thirty-two million, whilst its annual expenditure, chiefly on pensions for University officers and teachers and their widows, is not far short of two millions. Among the topics of outstanding interest dealt with in the president's report is that of American college athletics. Dr. Pritchett exposes the too common exploitation of the student, his diversion from genuine college study and social life, his service under professional trainers in preparation for a commercial show before the public. As an indication of the importance of the rôle football plays in American university finances, he cites the fact that at Harvard the income from athletics (almost wholly from football) is one and a quarter million dollars, as compared with an income of three millions from tuition. In connexion with the study of the relations of secondary and higher education, which is being conducted by the Foundation jointly with the Pennsylvania State Department of Public Instruction, two comprehensive examinations have been administered in some fifty colleges and universities with the special object of measuring effective knowledge as distinguished from raw information. The results indicate that the American system of term courses with term examinations and credits fails lamentably as regards what is supposed to be the central purpose of the college, namely, teaching the student to think. Incidentally, they indicate better mental capacity in students of the sciences than in students of arts subjects.

Birthdays and Research Centres.

Nov. 22, 1875.—Prof. L. N. G. Filon, F.R.S., Goldsmid professor of applied mathematics and mechanics in the University of London and Director of the University Observatory.

Recent investigations have confirmed that double-refraction produced artificially by stress in transparent materials shows local anomalies of dispersion similar to those caused in ordinary refraction by the usual absorption bands. The present anomalies, however, do not seem to be connected with any absorption bands in the material, and their cause and the mechanism of their appearance is still a mystery. The first step towards the solution must be the collection of accurate data for a number of materials, particularly glasses or jellies of graded composition. For this purpose the collaboration of one or more manufacturing firms is essential; workers to carry out the observations, which are delicate and laborious, are also badly wanted.

The effect in question seems likely to throw a good deal of light upon the interaction of radiation and matter in the solid state, and, so far, has been studied only in a preliminary manner.

Nov. 23, 1864.—Sir Peter Chalmers Mitchell, C.B.E., F.R.S., secretary of the Zoological Society of London.

I fear that the increasing burden of administration will leave me no time even to work out certain anatomical investigations which I had to drop during the War. Indirectly I am continuing to study in London and at Whipsnade the relations of animals to light, heat, and fresh air.

A particular inquiry that ought to be taken up is the comparative study of the voices and sounds made by mammals, reptiles, and amphibians. I have no doubt that information interesting in itself and throwing light on systematic affinities could be got. As an example: kangaroos are habitually silent animals, but a kangaroo which is frightened or excited when it is being anæsthetised has a voice very like that of the marsupial wolf.

Nov. 26, 1889.—Prof. H. R. Robinson, F.R.S., professor of physics in the East London College, University of London.

With some of my colleagues at East London College, I am engaged in refining the methods of ‘ magnetic spectroscopy ’ for secondary cathode particles. We hope to elucidate some of the finer details of the interaction of X-rays and bound electrons, and we intend to increase the absolute accuracy of the measurements. Increased accuracy will enhance the utility of these methods in supplementing the data of X-ray spectroscopy, and will also remove some of our uncertainty as to how far discrepancies in the existing measurements may be ascribed to inconsistencies in the accepted values of the fundamental atomic constants.

Nov. 27, 1888.—Dr. Ezer Griffiths, F.R.S., principal assistant, Physics Department, National Physical Laboratory.

My work falls within the domain of physics applied to industry. The problems are largely determined by the wishes of various committees. A few of the investigations are: heat transmission to banks of piping such as are used for air cooling; hygrometry at temperatures below and above normal temperatures; the study of the thermophysical properties of refrigerants; determinations of the thermal resistivity of the soil throughout the year by a method utilising an electrically heated sphere buried in the ground; methods of measuring the amount of water in fogs; the measurement of the heat of formation of nitrous oxide.

Occasionally an investigation takes one far afield. The study of the variables causing loss of ‘ bloom ’ on frozen lamb necessitated a detailed study of the entire chain of processes from the killing floor in New Zealand to the London market.

Societies and Academies.

London.

Royal Society, Nov. 12.—**A. Fowler and J. S. Badami**: Spectrum of the hydrogen–nitrous oxide flame. Observations of the bright cap or cone which appears near the base of the hydrogen–nitrous oxide flame in a mixed jet have shown that the spectrum is closely similar to that of the ammonia–oxygen flame. It differs from the latter in the greater intensity of the HO and NO bands and the lower intensity of the NH_2 ? bands, the NH band at λ3360 being about the same in both.—**S. H. Bastow and F. P. Bowden**: On the contact of smooth surfaces. The experimental work has shown that it is very difficult to place surfaces together without dust or solid particles coming between them. When elaborate precautions were taken to eliminate dust and the surfaces were scrupulously clean there was no evidence for ‘ floating ’. A polished glass plate lowered on to a similar plate in air at atmospheric pressure sank down quickly to within a fraction of a micron of it. This small separation, which represents the limit of smoothness of the plates, was the same whether they were in high vacua, air, alcohol vapour, liquid alcohol, or water. The apparent ‘ floating ’ at a height of 4 microns is due to dust or solid particles between the plates.—**W. B. Mann and B. G. Dickens**: The thermal conductivities of saturated hydrocarbons in the gaseous state. Experiments have been carried out with methane, ethane, propane, and normal butane using the hot-wire method of investigation. The results obtained for the saturated hydrocarbons indicate a decrease of conductivity with each addition of a CH_2 group. Moreover, on plotting the thermal conductivity of the gas at 0° C. against the molecular weight ($O_2 = 32$) it was found that a smooth curve could be drawn through the four points obtained. This curve was found to be hyperbolic. A definite variation of the temperature coefficient with molecular weight is also indicated by the experimental results.

Edinburgh.

Royal Society, Nov. 2.—**G. W. Tyrrell and Martin A. Peacock**: The petrology of Iceland (2). The petrography of the acidic and intermediate intrusives and extrusives. The acidic and intermediate igneous intrusive rocks of Iceland were found to occur as relatively small stocks, and bosses, sills, dikes, and veins, together with extrusive domes and lava flows. They cover only one per cent of the total area of Iceland, and are thus very much inferior in bulk to the dominating basaltic lavas.—**Tudor Jones**: The primitive conducting mechanisms of the vertebrate heart. An introduction to the study of their appearance and development in *Lepidosiren paradoxa*. All the conducting mechanisms hitherto described are represented in *Lepidosiren*, in respect of their situation and connexions, by purely nervous structures. The mechanism consists of a nervous continuum comprising regions of the medulla oblongata and communications involving the sixth aortic arch, the ductus Botalli, the pulmonary artery, the sinus venosus, atria and ventricles of the heart and the pulmonary vein, with bilateral connexions at three (probably segmental) levels. The continuum—or cardiac neural primordium—precedes the general development of the cardiac musculature and forms a nodal nervous complex, to which it appears the whole development of the characteristic form of the heart may be referred as to an organic system of developmental foci.—**George W. McCrea**: An X-ray examination of *d*-mannitol and *d*-mannose. *d*-Mannitol: (see NATURE for Jan. 31, p. 162); *d*-Mannose: unit cell, $a = 5{\cdot}53$ A., $b = 17{\cdot}66$ A., $c = 7{\cdot}59$ A.; space-group, Q^4; calculated density, 1·602 gm. per c.c.; 4 molecules per cell. A manno-pyranose ring structure is probable in the *d*-mannose molecule, and the greatest length of the molecule is along the *c* axis.—**R. B. Mooney** and **H. G. Reid**: The absorption spectra of cyanogen and the cyanogen halides. Measurements are given of the band edges of the cyanogen absorption spectrum in the region 2380-1850 A. The influence of temperature on the relative intensities of the bands has been studied. The long wave-length limits of the regions of continuous absorption due to the cyanogen halides are: CNCl, 2240 A.; CNBr, 2540 A.; CNI, 3100 A. and 2150 A.—**W. O. Kermack** and **W. H. McCrea**: An operational method for the solution of linear partial differential equations. A general method has recently been given by Prof. E. T. Whittaker for the solution of differential equations by definite integrals. A closely related solution is now given, in which a differential operator appears in place of the integration. This may be regarded as a generalisation of Maclaurin's theorem. Certain applications of the theorem, including its application to the theory of generating functions, are discussed.—**H. S. Ruse**: On the definition of spatial distance in general relativity. A mathematical analysis of the problem of defining spatial distance (in a general Riemannian space-time) leads to a definition alternative to that recently obtained from astronomical considerations by E. T. Whittaker. Applied to a Galilean space-time and to the de Sitter world, the formula derived from the new definition yields the quantities hitherto regarded as representing 'spatial distance' in these particular cases.

PARIS.

Academy of Sciences, Oct. 12.—**A. Lacroix**: Obituary notice of Friedrich Becke.—**André Blondel**: Comparison between a cable with distributed constants and a circuit in *T*.—**W. Vernadsky** and **A. Vinogradoff**: The chemical composition of *Lemna* as characteristic of the species. Each species of *Lemna* collected in localities so far apart as the Ukraine and the Baltic region, and in different years, possesses a definite composition which characterises it.—**J. Schokalsky**: A new hypsometric map of the Soviet Union (European part) on the scale of 1/2,500,000.—**Léon Pomey**: New remarks relative to the last theorem of Fermat.—**E. O. Lovett**: A problem of Gambier in the deformation of surfaces.—**Hadamard**: Remarks on the preceding communication.—**B. Galerkin**: The elastic equilibrium of a thick rectangular plate.—**Kourensky**: The fundamental equation of exterior ballistics.—**J. Ph. Lagrula**: The inconvenience of using four stars in the local connexion of two photographs of large field, even when the distance of the centres is considerable.—**Th. V. Ionescu**: Ionised gases and the working of valves with positive grid. In a previous paper the author has shown that the velocity of propagation of waves in tubes containing ionised gas can be calculated, assuming for the gas a definite period of vibration. It is now shown that, taking these vibrations into account, the working of valves with positive grid can be explained, and the formula of Barkhausen obtained.—**F. Esclangon**: A method of measuring an alternating high-frequency magnetic field. The Foucault currents produced are measured by a mercury thermometer. It has been proved that the velocity of heating is proportional to the square of the field strength and to the square root of the frequency.—**B. Demetrović**: Some experiments concerning the reflection of X-rays. Description of experiments proving that the X-rays are strongly reflected by surfaces which form a bad mirror for visible light.—**F. Vlès** and **A. Simchen**: Remarks on the permanganate spectrum.—**J. Gilles**: Quintuplets and triplets of O III.—**E. Herzog** and **G. Chaudron**: The protection by cathode polarisation of iron dipped into aerated saline solutions. Depolarising deposits can be formed by simple aeration of metallic surfaces dipped into saline solutions. These experiments explain why certain metallic additions can exert a protective action on a metal being corroded.—**Georges Arditti**: The oxidation of paraffin oil. A study of the action of air in the presence of various catalysts on paraffin oil at 130° C.—**Mme. N. Demassieux** and **Victor Henri**: The ultra-violet absorption spectra of pure hydrochloric acid and bromine. Hydrochloric acid, prepared by methods commonly regarded as giving a pure product, gives an absorption spectrum in the ultra-violet which varies with different specimens. These differences have been traced to the presence of bromine: a trace of bromine in $10\,N$ hydrochloric acid gives an absorption which is several thousand times more intense than that produced by the same quantity of bromine in water. Whilst chemical methods fail to detect smaller proportions of bromine than 0·001 gm. per litre, the ultra-violet absorption spectrum can detect less than one-tenth of this.—**Augustin Boutaric** and **Raymond Amiot**: Experimental researches on the adhesion of lubricating layers to metals. Plates of various metals (copper, iron, aluminium, and rustless steel) were dipped in oil, allowed to drain for measured times, and the plate then centrifuged at 5000 rotations per minute. A relation between the oil on the plate (p) after a time of draining (t), and the limiting weight after centrifugation was established.—**Picon** and **Cogné**: The study of some sulphides of the rare earths. Description of the preparation and properties of the sulphides of yttrium, lanthanum, cerium, neodymium, and samarium.—**J. Bancelin**: Carbonates of the chromiammines.—**Raymond Paul**: Some pentenyl derivatives.—**C. Le Camus** and **F. de Saint-Just**: Magnetic and electrical observations in the Sahara. Measurements of the magnetic elements and of the atmospheric electrical field were made at Gao, Tanesrouft, and Camp Louis Marin (Hoggar), the two latter being new observation points.—**A. Maige**: Remarks on the subject of the physico-chemical mechanism of the amylogen condensation (in plants).—**O. Duboscq** and **P. Grassé**: The parabasal apparatus and the cytoplasmic constituents of zooflagellæ.—**F. Marceau** and **L. Acolat**: General considerations on the circulation of the arterial and venous blood in three-chambered hearts of vertebrates and the measurement of the degree of mixture.—**L. Lutz**: The soluble ferments secreted by the hymenomycete fungi. Comparison of the anti-oxygen power of tannin and the phenolic constituents of essential oils.—**J. Magrou**, **Mme. M. Magrou**, and **P. Reiss**: Action at a distance and the development of the egg of the sea-urchin. Attempt at an interpretation.—**E. Brumpt**: *Cercaria ocellata*, the cause of dermatitis in bathers, arises from a *Bilharzia* of the duck.—**Georges Bourguignon**: The interpretation of the variations of muscular chronaxy by repercussion, with and without functional troubles.

Official Publications Received.

British.

Proceedings of the Physical Society. Vol. 43, Part 5, No. 240, September 1. Pp. viii+416-648. (London.) 7s. net.

Sierra Leone. Annual Report of the Department of Agriculture for the Year 1930. Pp. ii+59. (Freetown: Government Printer.)

Natural Science and Archæology Society, Littlehampton. Reports of Proceedings, 1928–1930. Pp. 40. (Littlehampton.)

Philosophical Transactions of the Royal Society of London. Series A, Vol. 230, A668: Determination of the Yard in Wave-Lengths of Light. By Dr. A. E. H. Tutton. Pp. 293-322. (London: Harrison and Sons, Ltd.)

Journal of the Chemical Society. September. Pp. iv+2229-2508+x. (London.)

Eleventh Annual Report of the Research Council of Alberta, 1930. (Report No. 26.) Pp. 76. (Edmonton: W. D. McLean.) 35 cents.

Report of the Council of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, 28th October 1931. Pp. 40. (Newcastle-upon-Tyne.)

Proceedings of the Royal Society of Edinburgh, Session 1930–1931. Vol. 51, Part 2, No. 19: Photochemical Measurements of Light Intensity in two Common Vegetable Types in Tropical Africa, by means of the Improved Eder-Hecht Photometer. By Dr. John Phillips, J. D. Scott and J. Y. Moggridge. Pp. 150-161. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s.

Department of the Interior, Canada. Publications of the Dominion Observatory, Ottawa. Vol. 10: Bibliography of Seismology. No. 7: July, August, September 1930. By Ernest A. Hodgson. Pp. 101-118. 25 cents. No. 8: October, November, December 1930. By Ernest A. Hodgson. Pp. 119-138. 25 cents. No. 9: January, February, March 1931. By Ernest A. Hodgson. Pp. 139-156. 25 cents. No. 10: April, May, June 1931. By Ernest A. Hodgson. Pp. 157-174. 25 cents. (Ottawa: F. A. Acland.)

Proceedings of the Royal Irish Academy. Vol. 40, Section A, No. 2: Observations on Atmospheric Ionisation at Glencree, Co. Wicklow. By J. J. Nolan and P. J. Nolan. Pp. 11-59. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s. 6d.

Ministry of Agriculture and Fisheries. Fourth Progress Report of the Foot-and-Mouth Disease Research Committee. Pp. 375+12 plates. (London: H.M. Stationery Office.) 7s. 6d. net.

Aeronautical Research Committee. Report for the Year 1930–31. Pp. iv+89+4 plates. (London: H.M. Stationery Office.) 2s. net.

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), Part 5. By Dr. L. F Spath. Pp. 551-658+plates 103-124. 12.14 rupees; 21s. New Series, Vol. 19: Upper Carboniferous Fossils from Afghanistan. By Dr. F. R. Cowper Reed. Pp. iii+39+4 plates. 3.10 rupees; 6s. 3d. (Calcutta: Government of India Central Publication Branch.)

Bulletin of the Raffles Museum, Singapore, Straits Settlements. No. 5, August. Pp. ii+121+8 plates. (Singapore.) 1 dollar; 2s. 6d.

Report of the Botanical Survey of India for 1929–30 Pp. 10. (Calcutta.)

Quarterly Journal of the Royal Meteorological Society. Vol. 57, No. 242, October. Pp. 405-486. (London: Edward Stanford, Ltd.) 7s 6d.

University of London: University College. Calendar, Session 1931–1932. Pp. lxxxi+511+lxxxiii-ccxii+36. (London: Taylor and Francis.)

Report for 1930 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool. Edited by Prof. James Johnstone and Dr. R. J. Daniel. Pp. 115. (Liverpool: University Press of Liverpool.) 5s.

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 56, Part 2, September. Pp. 155-278+lv-clxxvii+xxii+28 plates. (London.) 7s. 6d.

Foreign.

U.S. Department of the Interior: Office of Education. Education Leaflet No. 4: Education in Porto Rico, 1920–1930. By Pedro A. Cebollero. Pp. ii+18. 5 cents. United States Publications on Education. Price List 1931. Pp. ii+49. Bulletin, 1931, No. 20: Biennial Survey of Education in the United States 1928–1930. Chapter 14: Professional Education of Teachers. By Benjamin W. Frazier. Pp 40. 10 cents. (Washington, D.C.: Government Printing Office.)

Bulletin of the American Museum of Natural History. Vol. 61, Art. 9: The Fourth Florida Whale Shark Rhineodon Typus, and the American Museum Model based on it. By E. W. Gudger. Pp. 613-637+plates 23-32. (New York City.)

Publications of the Wagner Free Institute of Science. Vol. 2: Studies of Evolution in the Genus Spirifer. By Carroll Lane Fenton. Pp. x+436 (50 plates). (Philadelphia.) 6 dollars net.

Vísindafélag Íslendinga (Societas Scientiarum Islandica) 9: Frequency Curves determined by Semi-Invariants. By Thorkell Thorkelsson. Pp. 50. (Reykjavík: Bókaverslun Sigfúsar Eymundssonar.) 3 00 kr.

Collection des travaux chimiques de Tchecoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 8-9, Août-Septembre. Pp. 379-464. (Prague: Regia Societas Scientiarum Bohemica.)

The Tôhoku Mathematical Journal. Vol. 34, Part 2 August. Pp. ii+187-396. (Sendai.)

University of Denver: Department of Anthropology. Archæological Survey of Eastern Colorado. By E. B. Renaud. Pp. 102. (Denver, Colo.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 15, No. 1: The Marine Lower Cretaceous Deposits of Japan, with Special Reference to the Ammonites-bearing Zones. By Saburô Shimizu. Pp. 40+4 plates. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Ministero dell' Agricultura, Egitto: Servizio Tecnico e Scientifico. Bollettino No. 92: Su di una grave infezione dei cani al Cairo. Note preliminari del Prof. Dott. Matteo Carpano. Pp. 23. (Cairo: Government Press.) 5 P.T.

U.S. Department of Agriculture. Circular No. 175: Experiments for the Control of the San Jose Scale with Lubricating-Oil Emulsions in the Pacific Northwest. By E. J. Newcomer and M. A. Yothers. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

Japanese Journal of Mathematics. Transactions and Abstracts, Vol. 8, No. 2, August. Pp. 65-112. (Tokyo: National Research Council of Japan.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 1: Mathematics, Astronomy, Physics, Chemistry. Vol. 2, Part 6: Über die Anzahl der Idealteiler. Von Zyoiti Suetuna. Pp. 155-177. 0.40 yen. Vol. 2, Part 7 Über die irreduzibelen Substitutionsgruppen, deren Grade Primzahl sind, von Kenjiro Shoda; Bemerkungen über vollständig reduzibele Gruppen, von Kenjiro Shoda. Pp. 179-209. 0.50 yen. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 3, Part 4: Neogene Shells from Karafto and the Hokkaido, by Matajiro Yokoyama; Tertiary Mollusca from Iwaki, by Matajiro Yokoyama. Pp. 185-204+plates 11-18. 0 60 yen. Section 3: Botany. Vol. 3, Part 2: Systematic and Anatomical Studies of some Japanese Plants, I. By Yoshisuke Satake. Pp. 485-513. 0.50 yen. (Tokyo: Maruzen Co, Ltd.)

U.S. Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 393: Reclaimed Rubber. By A. T. McPherson. Pp. 22. 10 cents. Research Paper No. 332: Measurement of Lenard Rays. By Lauriston S. Taylor. Pp. 57-72. 10 cents. Research Paper No. 334: Interpolation of the O.S.A. "Excitation" Data by the Fifth-Difference Osculatory Formula. By Deane B. Judd. Pp. 85-91. 5 cents. (Washington, D C.: Government Printing Office.)

The Bashford Dean Memorial Volume. Archaic Fishes. Edited by Eugene Willis Gudger. Article 3: The Genital System of the Myxinoidea; a Study based on Notes and Drawings of these Organs in *Bdellostoma* made by Bashford Dean. By Prof. J. Leroy Conel. Pp. 68-102+4 plates. (New York: American Museum of Natural History.)

Diary of Societies.

FRIDAY, November 20.

Royal Society of Medicine (Physical Medicine Section) (at British Red Cross Clinic, Peto Place, N.W.1), at 5.—A. Woodmansey: Catalysis in relation to Mineral Waters.

Physical Society (at Imperial College of Science), at 5.—Dr. F. Lowater: The Band Spectrum of Zirconium Oxide.—W. A. Wood: Lattice-distortion of Cold-drawn Constantan Wire.—Dr. F. Aughtie: (*a*) A Remote Electrically Recording Accelerometer with Particular Reference to Wheel-impact Measurements; (*b*) A Remote Electrically Recording Load-gauge for Wheel-impact Measurements.—Prof. E. V. Appleton and G. Builder: Wireless Echoes of Short Delay.—Prof. Kerr Grant: *Demonstrations:*—A Contrivance for Demonstrating the Law of Errors; a New Type of Surface-tension Meter; and a New Type of Static Electrometer.

Society of Chemical Industry (Liverpool Section) (at University, Liverpool), at 6.—Prof. I. M. Heilbron: Nature's Variations on the Isoprene Theme.

Institution of Mechanical Engineers, at 6.—Presentation of Sixth Report of the Marine Oil Engine Trials Committee.

Society of Dyers and Colourists (at 36 George Street, Manchester), at 7.—C. M. Whittaker: Random Leaves from a Viscose Yarn Dyer's Notebook.

Royal Photographic Society of Great Britain, at 7.—W. L. Shand: Pattern and Design in Pictorial Photography.

Society of Dyers and Colourists (Glasgow Section) (at George Hotel, Glasgow), at 7.15.—H. E. Potts: Patents.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry—South Wales Section) (at Mayfair Café, Cardiff), at 7.15.—Dr. J. H. Quastel: Dyestuffs and Biological Activity.

Society of Chemical Industry (Glasgow Section) (at St. Enoch Hotel, Glasgow), at 7.30.—Prof. J. C. Philip: The Abstracting of Chemical Literature.

Junior Institution of Engineers, at 7.30.—H. G. Brown: Modern Pressed Brick Manufacture.

Institute of British Foundrymen (Sheffield and District Branch) (at Albany Hotel, Sheffield), at 7.45.—J. E. Hurst: Further Experiments with Air and Oil-hardening Cast Irons.

South London Botanical Institute (323 Norwood Road), at 8.—J. E. Lousley: Plant Parasites (Lecture)

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.15.—Dr. Louisa Martindale: Recent Advances in Deep X-Ray Therapy in Gynæcological Conditions.—Dr. B. Solomons: Obstetric Methods at the Rotunda Hospital in 1909 and 1929.

Royal Society of Medicine (Radiology Section), at 8.30.—Discussion on X-ray Diagnosis of Diseases of the Chest.—Dr. S. Melville: Tuberculous and other Non-malignant Conditions.—Dr. P. Kerley: Malignant Conditions.

Royal Institution of Great Britain, at 9.—Prof C. H. Lander: Oil and Petrol from Coal.

Royal Aeronautical Society (Hull and Leeds Branch).—Lt.-Col. W. L. Marsh: Speed in Aviation and what it means.

SATURDAY, November 21.

Royal Institution of Great Britain, at 3.—W. Perrett: The Music of Ancient Greece (1): The Enharmonic Genus.

British Psychological Society (at King's College), at 3.—Rev. H. L. Philp: Frustration of Will Acts.—M. F. Lowe: Blood Distribution during Mental Activity.—*Demonstrations:*—A. G. Caws: Perception of Tachistoscopically Exposed Symbols.—R. Westgate: Effect of Affective Stimuli on Muscular Work.

Institute of British Foundrymen (Wales and Monmouth Branch) (at University College, Cardiff), at 6.30.—Prof. A. A. Read: The Microscope in Metallurgy.

Institute of British Foundrymen (Lancashire Branch—Junior Section) (at Manchester College of Technology), at 7.—A. Hopwood: Non-Ferrous Founding.

MONDAY, November 23.

Electrical Association for Women, at 6.15.—The Healing Effects of Electric Rays.

Institution of Mechanical Engineers (Graduates' Section—London) (jointly with Students' Section of Institution of Civil Engineers), at 6.45 —L. A. Beaufoy: Mechanical Solution of Rigid Frames.

Institution of Electrical Engineers (Informal Meeting), at 7.—R. Grierson and others. Discussion on The Electrical Heating of Buildings.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—E. A. Watson: Coil Ignition Systems.

Institute of Chemistry (Leeds Area Section) (Annual General Meeting) (at Great Northern Hotel, Leeds), at 7.15.—At 7.30.—A. R. Tankard and others: Discussion on The Food and Drugs Act, 1928.

Royal Society of Arts, at 8.—H. R. Ricardo: Diesel Engines (Howard Lectures) (1).

Royal Society of Medicine (Odontology Section), at 8.—Prof. L. S. Dudgeon: Vincent's Angina and Allied Affections of Mouth and Throat.

TUESDAY, November 24.

Royal Medico-Psychological Association (at B.M.A. House, Tavistock Square), at 3 —Sir Hubert Bond: Testimonied in his own Bringingsforth (Maudsley Lecture).

Royal Society of Arts (Dominions and Colonies Meeting), at 4.30.—M. Breton: Sericulture in the British Empire.

Royal Society of Medicine (Medicine Section), at 5 —Discussion on Nervous Dyspepsia.

Royal Institution of Great Britain, at 5.15.—Prof. J. B S. Haldane: New Light on the Origin of Species (2).

Institute of Marine Engineers, at 6.—A. E. L. Chorlton: The Work of Akroyd Stuart and the Development of the Oil Engine in which it is carried on (Akroyd Stuart Award Paper, 1930-31).

Institution of Electrical Engineers (London Students' Section), at 6 15.—H. S. Hind: The Recording and Reproduction of Talking Pictures.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—R. M. Charley: Recent Progress in Large Transformers.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. W. Dickinson and H. W. Grimmitt: The Design of a Distribution System in a Rural Area.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—A. J. Bull: How it works in Photography (4): Three Colour Photo-engraving.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.—Gossip Meeting.

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7.30.—H. T. Hildage: Works Progress.

Royal Anthropological Institute, at 8.30.—Dr. A. N. Tucker: Sudan Music.

Diesel Engine Users' Association (at Caxton Hall).—H. V. Stead: Diesel Engines for Overseas Work.

WEDNESDAY, November 25.

British Astronomical Association (at Sion College), at 5.

Royal Society of Medicine (Comparative Medicine Section), at 5.—Discussion on Active Immunisation in Virus Diseases.

Eugenics Society (at Linnean Society), at 5.30.—Prof. C. G. Seligman: Race and Temperament.

Newcomen Society for the Study of the History of Engineering and Technology (Annual General Meeting) (at Chartered Institute of Patent Agents, 1 Staple Inn Buildings), at 5.30.—T. B. Hennell: Men or Straw: An Account of Surviving Straw Handicraft.

Institution of Automobile Engineers (Manchester Centre) (at Engineers' Club, Manchester), at 7.—B. G. Robbins: The Training of Young Automobile Engineers.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Mining Institute, Newcastle-upon-Tyne), at 7.15. —Angus Watson: The Adventure of Life.

Leicester Literary and Philosophical Society (Chemistry Section) (at Museum, Leicester), at 7 30 —H. L. Long: Science in the Modern Laundry (Presidential Address).

Royal Society of Arts, at 8.—G. G. Blake: An Investigation throwing New Light upon Duplex Therapy and other Electro-medical Applications.

British Psychological Society (Industrial Section) (at Red Lion Restaurant, Red Lion Square), at 8.—J. Blackburn: Some Obstacles to the Determination of the Effect of Practice upon the Differences between Individual Performances.

British Psychological Society (Medical Section) (at 11 Chandos Street, W.1), at 8.30.—Dr. C. S. Read: Out-Patient Psychiatry.

THURSDAY, November 26.

Institute of Metals (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.—W. F. Brazener: The Casting of Tough Pitch Copper.

North-East Coast Institution of Engineers and Shipbuilders (Tees-Side Branch—Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7 30.—F. Whitfield and others: Discussion on Internal Combustion Engines.

Royal Society of Medicine (Urology Section), at 8.30.—Clinical Pathological Meeting.

British Psychological Society (at 55 Russell Square, W.C.1), at 8.30. —Prof. T. H. Pear: Suggested Parallels between Modern Speech and Clothing (Lecture).

Institute of Brewing (North of England Section) (at Midland Hotel, Manchester).—W. A. Riley: Problem of Bottling.

FRIDAY, November 27.

Andersonian Chemical Society (at Royal Technical College, Glasgow), at 8.15.—Prof. J. Kendall: Ionisation Theories: Old and New.

Royal Astronomical Society (Meeting for Geophysical Papers), at 4 30. —Dr. H. Jeffreys: On the Variation of Melting-Point within the Earth. —R. Stoneley: The Thickness of the Continental Layers of Europe.—A. W. Lee: The North Sea Earthquake of Jan. 24, 1927.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.—Dr. F. H. Todd: Some Measurements of Ship Vibration.

Manchester Literary and Philosophical Society (Chemical Section) (at 36 George Street, Manchester), at 7.—J. M. Preston: Textile Microscopy.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Dr. W. A. Scoble and others: Discussion on Wire Ropes, their Selection and Use.

Junior Institution of Engineers, at 7.30.—D. W. McJannet: Progress in the Design and Construction of Static Transformers.

Royal Institution of Great Britain, at 9.—Sir Alfred Ewing: The Work of Sir Charles Parsons.

SATURDAY, November 28.

Royal Institution of Great Britain, at 3.—W. Perrett: The Music of Ancient Greece: The "Orestes" Fragment.

PUBLIC LECTURES.

FRIDAY, November 20.

University College, Dundee, Scientific Society (at Dundee), at 4.30.—Prof. J. Read: An Organic Chemist looks at Australia.

Institute of Chemistry, at 8.—Dr. J. V. Eyre: Recent Advances in the Fermentation Industries (Streatfeild Memorial Lecture).

SATURDAY, November 21.

Horniman Museum (Forest Hill), at 3.30.—H. St. George Gray: The Romans in the South of England.

MONDAY, November 23.

University College, at 5.30.—Prof. G. Dawes Hicks: The Philosophy of Religion (Hibbert Trust Lectures). (Succeeding Lectures on Nov. 30, Dec. 7 and 14.)

St. Leonard's School, St. Andrews, at 8.—Prof. J. Read: Alchemy and the Alchemists.

TUESDAY, November 24.

Goldsmiths' Hall, E.C., at 4.30.—Dr. H. H. Dale: Biology and Civilisation (Norman Lockyer Lecture).

University College Hospital Medical School.—Dr. R. T. Grant: The Pathology of Endocarditis. (Succeeding Lectures on Dec. 1 and 8.)

WEDNESDAY, November 25.

Royal Institute of Public Health, at 4.—D. Lees: Venereal Diseases in City Life.

King's College, London (at 40 Torrington Square, W.C.1), at 5.30.—Dr. W. Borowy: Poland and its Civilisation in the Middle Ages.

Imperial College of Science and Technology, at 5.30.—Prof. E. A. Milne: The Theory of Stellar Structure. (Succeeding Lectures on Nov. 26 and 27.)

London School of Economics and Political Science, at 6.—P. T. Lloyd: The Form *versus* the Machine in Office Records.

Belfast Museum and Art Gallery, at 8.—Dr. K. G. Emeléus: Atoms, Electrons, and X-Rays

THURSDAY, November 26.

Science Museum, South Kensington (in connexion with Exhibition of Modern Glasses), at 4 45.—R. W Clark: The Supreme Glass: Fused Silica.

Royal Institution, at 5.—A. Whitaker: Physics in Sound Recording (Institute of Physics Lectures on Physics in Industry)

Bedford College for Women, at 5.15.—Sir William Beveridge: The Meaning of Purchasing Power (Stevenson Lecture).

Institution of Civil Engineers, at 6.—Prof. C. E. Inglis: Vibrations in Railway Bridges and Impact Allowances (Armourers' and Brasiers' Company Lectures). (Succeeding Lectures on Dec. 3 and 10.)

Battersea Polytechnic, at 7.—Dr. H. Phillips: The Walden Inversion: The Mechanism of the Substitution of Groups in Saturated Organic Compounds (2).

FRIDAY, November 27.

London School of Economics and Political Science, at 5.—Prof. L. Hogben: Genetic Principles in Medicine and Social Science. (Succeeding Weekly Lectures in Michaelmas Term and in Lent Term beginning on Jan. 15.)

SATURDAY, November 28.

Horniman Museum (Forest Hill), at 3.30.—Miss I. D. Thornley: Pilgrims of Medieval England.

CONGRESS.

Friday and Saturday, November 20 and 21.

Public Works, Roads, and Transport Congress (at Royal Agricultural Hall).

Friday, Nov 20, at 11 a.m —H. R. Lintern: A Philosophy of Civil Engineering Training.
H. R. Lintern: Considerations affecting Highway Department Organisation.
At 3.—F. H. Osmond-Smith: Suicide in Agriculture.
H. T. Tate: Statutory Small Holdings.
T. G. Ellis: The Economic Principles which should govern the Equipment of Small Holdings.
H. Davis: Street Lighting in relation to Transport

Saturday, Nov. 21.—S. C. Baggott: The Collection and Disposal of House Refuse.

EXHIBITION.

Thursday and Friday, November 26 and 27.

Scientific Exhibition (at 16 Royal Terrace, Edinburgh), 5.30 to 9.

SATURDAY, NOVEMBER 28, 1931.

CONTENTS.

	PAGE
Geological Survey of India	885
The Internal Combustion Engine	886
Studies in Immunity. By Prof. J. M. Beattie	888
Ore-Minerals and the Microscope. By C. G. C.	889
Short Reviews	891
Oxygen and Everest. By Raymond Greene	893
The Principles of Evolution Revealed by Palæontology. By Prof. Henry Fairfield Osborn, For.Mem.R.S.	894
Biology and Civilisation	897
Obituary:	
Dr. John Sampson	898
News and Views	899
Letters to the Editor:	
Light of Glow-worms.—Dr. Michael Perkins	905
Mercury Line Spectrum in Fluorescence.—The Right Hon. Lord Rayleigh, F.R.S.	905
A Connexion between Fluorescence and Free Neutral Radicals.—Dr. W. A. Waters	905
Matter: Life: Mind.—Albert Eagle; W. W. L.; Dr. W. D. Lighthall	906
A Two-Dimensional Space Lattice?—Dr. R. C. Menzies	907
Coagulation of Colloids by Electrolytes.—Dr. B. N. Desai and P. M. Barve	907
Application of the Simonis Reaction to Monohydric Phenols.—A. Robertson	908
Aitken Condensation Nuclei.—A. R. Hogg	908
The Relativistic Opacity Coefficient.—R. C. Majumdar and D. S. Kothari	908
National Needs.—Louis Anderson Fenn	909
Derived Early Mousterian (Levalloisian) Implements in the Melt-water Gravels of the Coombe Rock Glaciation.—J. P. T. Burchell	909
Research Items	910
Astronomical Topics	912
The Hakemite Tables of Ebn Jounis. By J. H. Reynolds	913
Forest Gardens	915
Insect Relations of Plant Virus Diseases	915
University and Educational Intelligence	916
Birthdays and Research Centres	916
Societies and Academies	917
Diary of Societies	919
Official Publications Received	920
Recent Scientific and Technical Books	Supp. v

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Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Geological Survey of India.

THE Geological Survey of India has won a well-deserved reputation as one of the leading surveys of its kind in the world. An unusually high proportion of its officers, past and present, have attained international fame as geologists, and in keeping with this fact its publications rank amongst the most important of those which make genuine contributions to the advance of geological knowledge. It is therefore both surprising and alarming to find, in connexion with the financial retrenchment imposed upon the Government of India by the necessity of balancing its budget, that serious proposals have been put forward to reduce the staff and salary scales of the Survey to an extent that would be nothing short of disastrous.

In our issue of Nov. 14 we commented on the retrenchment proposals which affect the Zoological Survey of India, relative to which Sir C. V. Raman has issued a timely Memorandum. In a similar Memorandum on the Geological Survey of India, Sir C. V. Raman discloses the fact that it has even been urged that the Survey could be permanently or temporarily closed down. Another proposal would reduce the personnel to a nucleus of eight members. The Retrenchment Advisory Committee, however, has finally recommended the retention of the director, three superintendents, and ten assistants; three superintendents and twelve assistants being dispensed with.

All of these disturbing proposals seem to be based on the extraordinary assumption that as the Survey has already been in existence for eighty years it has begun to outlive its usefulness. Nothing could be further from the truth. Sir C. V. Raman clearly shows in his Memorandum that the need for intensive geological investigation is steadily increasing and that the present activities of the Survey are actually insufficient to meet the demands of a territory so vast as that of the Indian Empire. He claims with justice that many of the mineral and associated manufacturing industries of India owe their present status to the discoveries of the Survey, and he points out that the royalties and income-tax derived from these sources can legitimately be claimed as a direct financial return for the money spent on its maintenance. It is also shown that the advisory work of the Survey results in the saving of large sums every year and in the prevention of waste and the avoidance of disaster to life and property that would otherwise be, for the most part, inevitable.

An alternative scheme of reorganisation suggested by Sir C. V. Raman involves considerable reductions in salaries on an increased staff of one director, forty geologists (superintendents being regarded as unnecessary), one chemist, one artist, and six museum assistants. It must not be overlooked, however, that the traditionally high standard of the Survey is in no small measure attributable to the attractive conditions offered by the service. Hitherto the Survey has recruited its officers from the most promising of our post-graduate geologists. At present a geologist enters at Rs. 400 and rises in sixteen years to Rs. 1200, with a reasonable chance of promotion to the grade of superintendent at Rs. 1500 to Rs. 2000. On the proposed scale a geologist would enter at Rs. 300 and, after passing an efficiency bar at Rs. 750, rise to Rs. 1000 in eighteen years. It cannot be anticipated that a scale so drastically reduced will continue to maintain the Survey at its wonted level of achievement.

Sir C. V. Raman makes a very good point in directing attention to the cost of other leading geological surveys. The United States and Canada, countries comparable with India in the nature and magnitude of the problems requiring attention, expended respectively in 1929–30, 4,212,294 dollars and 705,325 dollars. We may add that the U.S.S.R. in 1928–29 devoted £1,359,000 to the activities of the Russian Geological Committee. That the results have justified this unprecedented expenditure and that geology is appreciated at its true worth in that much criticised land would appear to be shown by the official announcement that in 1932–33 more than three thousand field workers will take part in some eighteen hundred expeditions at a budgeted cost of £5,918,000.

Can it be seriously pretended that India can afford to dispense with an efficient geological service? Sir Albert Kitson stated the case unanswerably in his presidential address in 1929 to Section C (Geology) of the British Association on "The Utility of Geological Surveys to Colonies and Protectorates of the British Empire". Unfortunately, recent events have driven home the bitter truth of his comment that such surveys have benefited the British Dominions "immeasurably more than is yet realised by them".

We have discussed the position as regards the Zoological and Geological Surveys of India. Drastic proposals have also been made by the Retrenchment Advisory Committee for reducing the expenditure of other scientific departments. Accepting the fact that the Government of India, like most other governments, is faced with a grave financial crisis, we may take exception to the steps which have been adopted to secure recommendations for economies. When a business firm is faced with such a situation, the usual procedure is to call a conference of departmental heads and ask them to prepare a scheme to enable the firm to carry on over the crisis with the least possible damage to the efficiency of the organisation. The Government of India has sought advice from an able body of men who, however, know little or nothing of the highly specialised activities of the scientific departments of the Indian Empire. This raises again the problem to which we have repeatedly referred in these columns, namely, the alleged incompetence of scientific workers in administration. It is safe to say that, had anyone familiar with the methods and achievements of science been included in the personnel of the General Purposes Sub-Committee of the Retrenchment Advisory Committee, its present report would never have been published unchallenged.

The Internal Combustion Engine.

(1) *Power and the Internal Combustion Engine.* By Prof. W. E. Dalby. Pp. viii + 280. (London: Edward Arnold and Co., 1931.) 18*s*. net.

(2) *The High-Speed Internal-Combustion Engine.* By Harry R. Ricardo. New edition. Pp. vi + 435. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1931.) 30*s*. net.

WITH two newly issued volumes on the internal combustion engine lying on the table, one by Prof. Dalby and the other by Mr. Ricardo, the reviewer expected new light on a subject at once important, interesting, and strangely elusive. The new light is rather disappointing. Where one hoped to find a general illumination on an ordered scene, one finds in the former book much attention given to the author's special interests, and in the latter just as good a presentation of modern knowledge as a very busy investigator, with a somewhat less easy command of English than the best, can give time to produce. Perhaps it would be fair to add that a few years ago books of this kind would have been read with minds less critical than those of to-day, and that if one man more than another is responsible for this, the 'blame' may be put on Sir James Jeans, who, whether in the simple "Stars in their Courses" or the comprehensive "Astronomy and Cosmogony", has shown us how lucidly and forcefully information on natural phenomena of great complexity may be presented.

(1) In Prof. Dalby's book, with the broad title of "Power and the Internal Combustion Engine",

one expects to find a unitary conception of the engine and its path of development to date. This, however, is scarcely attained. The general scheme adopted is to proceed from the ' working agent ' to mixtures and fuels, thence to the engine itself and the ' Dalby diagram ', followed by the suction gas plant, the petrol engine in detail, and finally heat flow in its effect on design. The author has a curious way of giving authority for his statements and figures : thus, in his first chapter the number of molecules in the cubic centimetre is given on the unexpected authority of the "Encyclopædia Britannica" —scarcely an original source ; and a few pages later he includes, without a smile, under the heading of " some gases whose molecular weights are given " elsewhere, " the Liverpool Gas Company ". The author endeavours to state all measurements in engineers' units even when dealing with the work of chemists and physicists. This makes the reading somewhat heavy, and it does not help the student when he has to refer to books on chemistry and physics.

As an occasion for desultory—but pleasant—wandering there is much to be said in the book's favour, and in fairness to the author it should be mentioned that the preface contains the warning that " to read Chapter i. involves knowledge of Chapter iii.", though somewhat unexpectedly it explains also that " to read Chapter iii. involves some knowledge of Chapter i." Such a book is scarcely for the training of students. What would a student make, for example, of the information that " the weight of vapour or gas which will enter a given volume at a given temperature is the same whether the space be a vacuum or contains other gases " ? Is he to measure the temperature of a vacuum, and if so, how ? In another place the author seeks to explain the simple ratio " 1/4 per cent by volume " by the elucidation that it is " less than half a fluid ounce per gallon ".

The author sums up towards the end of the book that " probably no invention in the history of man has at one and the same time so much increased his comfort and so much increased his anxieties, as this small, light and efficient prime mover—the petrol engine ". It is evident that these anxieties are shared by the engineer, for the last sentence in the book gives warning of the danger of " cracked liners, cracked pistons and cracked cylinder heads ".

The book contains, or gives references to, much of the best work which has been done on this subject in the last twenty years, and one cannot but be grateful to any author who helps, as Prof. Dalby does, to make such work more readily accessible to the investigator.

(2) Mr. Ricardo's book is in very interesting contrast to Prof. Dalby's. It is written by a man with a synthetic brain, and if he were not so occupied with his important research work he could probably write the best book on this subject that has ever been written. The present volume is, however, a reissue, after eight years, of an earlier book now partly out of date. In the first edition there were errors common to most first editions, and it was to be expected that the issue of a new edition would have afforded an opportunity to correct them, but this expectation is not entirely fulfilled ; nor has the chance been taken to correct certain statements and definitions which contain so much scientific error, as presented, as make it impossible to pass them by. Examples are seen in the author's strange use of ' internal energy ' and his loose way of speaking of heat energy in fuels. Certainly the definition of ' total internal energy '—on p. 21 —is wrong and should be deleted. In the same chapter the reader is told that the heat value of a volatile fluid has no relation to the power output—again quite untrue and the blue pencil needed. The reader may know what the author means, but that is no excuse for the use of incorrect language ; and those who do understand the meaning will scarcely be those who need to read the book. Nor is it wise to mix both Centigrade and Fahrenheit scales of temperature. Indeed, in a book not intended for popular consumption there can be little excuse for using the latter at all.

The author's remark on p. 40 that the reaction velocity is trebled by a three per cent rise in temperature for all hydrocarbon fuels, probably refers to the work of Tizard and Pye. If it does, is the figure ' three ' correct, and was it shown by them to apply to all hydrocarbon fuels ?

As regards the new sections on detonation, it is fair to state that a general result which has emerged in recent years is that detonation is mainly a chemical problem which cannot well be explained by treating the explosive mixture in bulk ; there is no mention, however, in Ricardo's treatment of detonation of Callendar's and Egerton's theories and the idea of chain reactions. Mention of these is, it is true, made later when the author deals with the action of metallic dopes, but this rather suggests that these theories do not apply to the initiation of detonation in general but are only of interest in connexion with ' dopes '.

Nevertheless, the reviewer considers the book the best there is in the English language on the present position of research work on the internal combustion engine. At the moment this research work is proceeding on healthy lines. It is chiefly guided in Great Britain by the Engine Sub-Committee of the Aeronautical Research Committee, the Air Ministry providing most of the funds for such researches, whether undertaken at the aero engine builders' works, at the Government research establishments, or in the research laboratory of Mr. Ricardo himself. All this research work is published, when it has reached a suitable stage, in the Reports and Memoranda Series of the Aeronautical Research Committee. So much work is now in hand in Great Britain alone on compression ignition types, two-stroke cycles, sleeve-valve operation, fuel injection, supercharging, and 'boosting', that any summary of it all issued to-day must speedily become out of date. It is too much to expect, therefore, that Mr. Ricardo's volume can give an entirely synchronous account of the present position, but it certainly comes much nearer to doing so than does the writing of any single author in Great Britain or elsewhere.

Studies in Immunity.

Medical Research Council. A System of Bacteriology in relation to Medicine. Vol. 6. By J. A. Arkwright, S. P. Bedson, C. H. Browning, H. R. Dean, A. T. Glenny, P. Hartley, J. C. G. Ledingham, H. B. Maitland, R. Muir, H. L. Schütze, W. M. Scott, D. B. Steabben, J. W. Trevan. Pp. 538. (London: H.M. Stationery Office, 1931.) 21*s.* net.

THE literature on immunity has almost got beyond the limit of the capacity of any one worker, and this volume on the "System of Bacteriology" will be welcomed not only by laboratory workers, but also by all interested in this difficult but fascinating subject. The volume stands out as one of the best in the "System", and each chapter is written by a worker who has an intimate experimental knowledge of his subject. There is an adequate summary of most of the important papers which have been published, and the writers have given their own views, based largely on their own experimental work, but have, at the same time, dealt very fairly with the writings of other experimenters in the same field.

Chap. i., on "Bacteria in Relation to Disease", is a necessary introduction, and is concise, well written, and accurate. A subject such as immunity, which is still based to a considerable extent on theory, has had associated with it various terms which were useful but the meanings of which were not at all definite. We are glad to see in this chapter a suggestion that some of these, such as endotoxin, leucocidin, aggressin, have served their purpose, but have lost their usefulness and should be avoided. This will be a difficult task to accomplish, and it is significant that the succeeding writers have not followed, even one step, in this suggested path. A brief account is given of the very important and difficult subject of the virulence and antigenic complexity of bacteria in its bearing on the genesis and extinction of epidemics.

Chap. ii., on "Natural Immunity", by Prof. Ledingham, is very detailed, but so well written that the detail does not in any way detract from its interest. There are many points of great importance not merely mentioned but discussed. In the first place, he deals with the normal defence mechanisms, such as bactericidal and hæmolytic action, opsonins, leukins, etc. He emphasises the fundamental importance of phagocytosis, and then he discusses the modifications which may be induced on these normal and 'non-specific' substances found in the body by the parenteral injections of proteins, etc., and by various physical and chemical agents, such as ultra-violet light, fatigue, and certain reflexes, such as sound. The bearing of nutritional factors is discussed, especially in relation to the antibody-forming mechanism and the resistance to spontaneous and induced infection. The natural resistance to various infections, the problem of local immunity, and much of the recent work on the reticulo-endothelial system are dealt with very thoroughly. The whole chapter bristles with interesting facts.

Chap. iii., on the "Production of Active Immunity to Bacterial and Virus Infections", is by Ledingham and Schütze. They deal with the work of Jenner, the early work of Pasteur, and the modification of their methods, and follow this up with the whole subject of bacterial vaccines, dealing with the work on typhoid, cholera, plague, etc., and the virus diseases, such as rabies, foot-and-mouth disease, distemper. A very interesting discussion is given on immunity as influenced by recent knowledge of bacterial antigens, and it is shown how our views have been modified by the investigations on the subject of the flagellar and somatic antigens.

Chaps. iv. and v. deal with toxins, and relate largely to chemical and physical problems. They are written by experts on the subject, and will prove of great value to laboratory workers, but their interest will be mainly for such.

In Chap. vi., by Prof. Browning, the antigens and antibodies are discussed. Among the many interesting points there are some which are perhaps not sufficiently recognised by vaccine therapists.

We are told that, as a rule, antigens introduced into the stomach are either destroyed by the digestive ferments or fail to be absorbed. Thus, the oral administration, though not rejected altogether, is regarded as generally useless. The transference of antibodies from mother to fœtus occurs, apparently, only in some species of animals and not in others. The whole chapter will repay careful reading, and may be regarded as a standard work on the subjects.

Chap. vii., by Dr. Hartley, gives a very full account of the effect of physical and chemical agents on the properties of antigens and antibodies. This study of the chemistry of bacterial cells and bacterial products is still very imperfect, though the work of Hartley himself and those whose investigations are recorded in this chapter have done something to clear up doubts and difficulties.

Chaps. viii., ix., and xi., on "Anti-bacterial Sera, Hæmolytic Action, and Opsonic Action", are by Prof. Muir, with certain minor sections by other authors. These chapters, with Chap. x., by Browning, and xii., by Arkwright, are, we think, the most important and valuable in the volume. They cover the whole ground with great success. They are well written, and are clearly the work of men who not only have an intimate working knowledge of the subjects with which they deal, but also have the faculty of conveying their knowledge to others. There are many points to which one would like to refer, but space will not permit.

In Chap. xiii., Dean deals with the precipitin reaction in considerable detail; discusses the source of the precipitate, its specificity and practical application, and its relation to other serum reactions. This chapter will, we hope, have the effect of clarifying the somewhat hazy views which are held by many people on precipitins. It is a chapter of very great value.

Chap. xiv. is a brief critical survey of antiferments and defensive ferments, by Prof. Browning, in which he emphasises the fact that many of the observations on these subjects have not led very far in the investigation of disease.

Chap. xv. is an excellent and fairly exhaustive review of the work on anaphylaxis and serum sickness and allergy. There are many practical points concerning the therapeutic uses of serum, and Dr. Scott emphasises the dangers and uncertainties, especially of desensitisation. This is an extremely useful contribution both to the laboratory worker and the clinician.

Miss Steabben in Chap. xvi. gives a short survey of immunological problems in their relation to colloid chemistry, and in Chap. xvii. Prof. Browning has given a very clear summary of the value of chemo-therapy particularly in protozoal infections, though he also deals with antiseptics in a limited field in bacterial infections.

We heartily welcome this volume as a really valuable and up-to-date contribution. It should find a place in every bacteriological laboratory and in the library of every medical practitioner.

J. M. Beattie.

Ore-Minerals and the Microscope.

Lehrbuch der Erzmikroskopie. Von Prof. Dr. Hans Schneiderhöhn und Prof. Dr. Paul Ramdohr. Band 2. Pp. xii + 714. (Berlin: Gebrüder Borntraeger, 1931.) 72 gold marks.

Erzmikroskopische Bestimmungstafeln: Anhang zum Lehrbuch der Erzmikroskopie. Von Prof. Dr. H. Schneiderhöhn und Prof. Dr. P. Ramdohr. Pp. 47. (Berlin: Gebrüder Borntraeger, 1931.) 3·80 gold marks.

It would be difficult to over-estimate the value of the contributions to our knowledge of rocks and rock-forming minerals that have resulted from the adaptation of the microscope to petrographical research. The technique of rock examination with the polarising microscope, evolved since the pioneer work of H. C. Sorby, has long been so effective as to make the instrument indispensable to the petrographer.

Naturally, this technique has been focused in the main upon the examination of the transparent minerals—principally silicates—that are the chief constituents of ordinary rocks. Of late years, however, with a growth in the study of mining geology, and especially in view of the remarkable results that have been obtained in the investigation of polished surfaces of metals with the metallographic microscope, increased attention has been paid to the opaque minerals which, while frequently occurring as minor components of common rocks, enter so largely into the constitution of those highly specialised rocks, the metalliferous ores.

As a result a new mineralogical technique, involving the systematised use of reflected instead of transmitted light, is being rapidly developed, and promises eventually to be as serviceable in the study of ores as the old has been in that of rocks. This technique, similar to that of metallography, is variously known as mineralography, mineragraphy, chalcography, and ore-microscopy, but still awaits an appropriate designation.

The application of metallographic methods to the study of opaque minerals began in America soon after the opening of this century, the names of

Campbell, Murdoch, Davy, and Farnham being especially associated with early publications. Good progress was made by these workers both in the methods of preparing polished surfaces of the complex mineral aggregates so often presented by ore-specimens, and in the optical identification of a wide range of opaque minerals difficult to distinguish from one another microscopically. In the course of time the possibilities of work along these lines were realised by mineralogists of other nationalities, and during the last decade contributions of great value have been made by Schneiderhöhn, van der Veen, Orcel, and others in Europe. There have also been numerous recruits in the United States and Canada, and in most laboratories in which ore research is undertaken, investigation by this method is becoming standard practice.

At first the microscope employed differed in no essential from that of the metallographer. Ordinary, that is, unpolarised, light was used, the determination of mineral species being based upon such simple criteria as colour, hardness, cleavage, and so on; and upon micro-chemical reactions obtained with a selected series of etch-reagents. While the data so obtained were in many cases satisfactory, they often proved insufficient for unequivocal identifications, and the need was felt for additional means of diagnosis. The principal innovations of recent years have been designed to provide such extra data, and have consisted of ingenious modifications in the ore-microscope to permit of the accurate measurement of the reflecting power of the various opaque minerals, and of the examination of polished surfaces in polarised as well as in ordinary light.

These refinements have added greatly to the effectiveness of ore-microscopy and to the amount of information it is able to supply. The reflecting power, observed either visually or by means of a photoelectric cell, promises to provide a quantitative factor of great discriminative value. The examination in polarised light, besides giving characteristic reflection-pleochroism in many cases, yields interference effects—reminiscent of the polarisation colours and extinctions shown between crossed nicols by transparent minerals—from which important diagnostic data as to crystallisation, twinning, and so forth may be deduced. As adapted for these additional observations, the ore-microscope is rapidly acquiring distinctive peculiarities, and there can be little doubt that further modifications, making for still greater effectiveness, will be introduced in the near future.

Pre-eminent among those who have helped in the building up of this new branch of mineralogical research is Dr. Hans Schneiderhöhn, formerly of Giessen, now of Freiburg i. Br., who first became interested in it while engaged on the ore-fields of south-west Africa. After returning to Germany, Schneiderhöhn published, in 1922, his "Anleitung zur mikroskopischen Bestimmung und Untersuchung von Erzen und Aufbereitungsprodukten"—an admirable treatise which has since been a standard work of reference. The rapid developments of the last decade, however, have made a fuller and up-to-date presentation of the subject desirable, and this, under the simplified title, "Lehrbuch der Erzmikroskopie", he is now producing in collaboration with Dr. Paul Ramdohr of Aachen. This much-enlarged work is to consist of two volumes and a supplement. The second volume and its supplement have already appeared and are now under review, while the first volume of the complete work, the authors hope, will be available shortly.

The first volume will deal with general principles, apparatus, and technical procedure. The second is descriptive of the minerals met with in ores, no fewer than two hundred species being considered in detail. These are classified on a chemical basis, and include besides the ore-minerals, whether opaque or not, most of the common gangue-minerals also. A uniform system of description is adopted covering composition, physical characters, polishing properties, colour, reflecting power, polarisation effects, etch-reactions, occurrence and genesis, etc. There are nearly 250 admirable reproductions of photomicrographs, and an indication of colour effects observable with or without polarised light is given in a number of beautifully reproduced colour-prints. The supplement—"Erzmikroskopiche Bestimmungstafeln"—consists of an ingenious set of tables for the practical identification of the minerals described by a comparatively simple system of physical, optical, and chemical tests applicable under the microscope. It is put up in the form of a booklet convenient for use in the laboratory.

The preparation of this ambitious publication has obviously entailed much time and labour. The authors state that they have been engaged upon it for eight years, and that in the course of their work they have made and investigated some six thousand polished surfaces of ores from all parts of the world. The volumes when finished will constitute the most complete treatment of the subject ever attempted, and will be invaluable to all who have to investigate ores with the microscope. C. G. C.

Short Reviews.

A Hand-Book to the Flora of Ceylon: containing Descriptions of all the Species of Flowering Plants indigenous to the Island, and Notes on their History, Distribution, and Uses. By Henry Trimen. Published under the Authority of the Government of Ceylon. Part 6: *Supplement.* By A. H. G. Alston. Pp. vi + 350. (London: Dulau and Co., Ltd., 1931.) 30*s.* net.

PENDING a complete revision of the flora of Ceylon, Mr. Alston, lately systematic botanist in the Agricultural Department in that island, has done valuable service in publishing the volume under review. His aim has been twofold: first, to bring in additional matter with regard to a few new species and a number of known species which had been omitted, for one reason or another, from Trimen's "Hand-Book to the Flora of Ceylon", with the appropriate additions to the keys to the families and genera; secondly, to bring to notice nomenclatural changes due to research and to altering concepts of generic and specific limitations.

In connexion with the latter aspect, it is not obvious why the author has rejected certain views of other botanists; for example, the substitution of *Nervilia* for *Pogonia* and *Platanthera* for a section of *Habenaria*, both of which have been accepted by Schlechter, among other authors. Further, it is not permissible, as apparently Mr. Alston thought at the time (the introduction is dated March 20, 1928), to substitute *zeylanicus* where an author has used the form *ceylanicus*; the original spelling must be respected. Nor can these two orthographic variants be valid in the same genus, as the reference to them seems to indicate. A number of typographical errors have escaped detection.

Tamil names taken from the "Flora of the Presidency of Madras" have been incorporated. It is not stated whether these names have been tested in Ceylon. Vernacular names are often very local and Tamil names are apt to vary from district to district in the Tamil country; thus, so widespread and well-known a tree as *Dalbergia latifolia* Roxb. is known as *Iti* in Coimbatore and is called *Eravadi* in Madura and Tinnevelly.

The work will be of great assistance in the revision of the flora of Ceylon which, we believe, is contemplated in the near future.

We Indians: the Passing of a Great Race. Being the Recollections of the last of the Great Indian Chiefs, Big Chief White Horse Eagle, as told to Edgar von Schmidt-Pauli. Translated by Christopher Turner. Pp. 256. (London: Thornton Butterworth, Ltd., 1931.) 10*s.* 6*d.* net.

THIS interesting document is transcribed from the narrative of a great chief of the Osage tribe of Colorado, who it is claimed, not without some sort of corroboration, had attained the age of one hundred and seven years at the time of his narrative. It sketches the life of the Indian of the south-western United States in the earlier half of the nineteenth century, before the buffalo had disappeared and white settlement had restricted the Indian hunting grounds. It also outlines the events which later led up to the defeat of Custer in 1876 and the great peace treaty which, in the view of the narrator, was the death-blow to the Indian.

The Big Chief's claim to the memory of posterity will rest almost equally on the facts that he, as representative of the Indians, buried the hatchet under the steps of the White House at Washington, and as a young man rescued from a massacred emigrant train and brought up with his own children an infant who afterwards became 'Colonel' William Cody, better known as 'Buffalo Bill'. The narrative, which is not without naïveté, has a certain importance as giving the Indian point of view on a number of historical events, though, not unnaturally perhaps, little stress is laid on Indian aggression. The Bureau of Indian Affairs is criticised in strong terms and not without cause.

A History of Surnames of the British Isles: a Concise Account of their Origin, Evolution, Etymology, and Legal Status. By C. L'Estrange Ewen. Pp. xx + 508. (London: Kegan Paul and Co., Ltd., 1931.) 25*s.* net.

THERE is perhaps room for a new history of British surnames since Bardsley and Harrison published their works on the subject. Mr. Ewen has given his history a wider scope than Bardsley and has brought into use much new material. Obviously the "History" has been a labour of love, and there is an inclination to overload it with matter, industriously collected, which has not much direct bearing on the subject in hand and is not always culled from the best authorities. Apart from this criticism, however, Mr. Ewen has given us a work which will be of considerable value to the genealogist and to a lesser extent to the anthropologist. Although the history of personal names has not the scientific value of its sister study of place names, yet much can be learnt by a cautious use of it to show the migrations of races and the settlements of groups of immigrants from other lands, the prevalence of industries in particular districts and the distribution of dialect. But the mobility of the human race and the change of surnames necessitate the greatest care in its use for these purposes. Mr. Ewen has recognised this difficulty and so has wisely emphasised the genealogical value of his study. Of not the least importance is the bibliography given at the end of the volume, which appears to be most comprehensive.

The Spore Ornamentation of the Russulas. By Richard Crawshay. Pp. 185 + 48 plates. (London: Baillière, Tindall and Cox, 1930.) 12*s.* 6*d.* net.

Russula is one of the more easy genera of Hymenomycetes to recognise, but one of the more difficult to classify into species. The spores of *Russula* are ornamented with minute tubercles or warts, sometimes joined together by lines, and the disposition of this ornamentation is used by Mr. Crawshay as an accessory character in the specific classification of the genus. The spores themselves, however, are only a few micromillimetres in length, and the differences in the surface markings are so slight that it would, in many cases, need an experience as intensive as that of the author himself to distinguish them.

The book seems to be directed to the serious amateur possessing a compound microscope, and the first four chapters contain somewhat elementary accounts of microscopic optics, photomicrography, and micrometry. The main portion of the book consists of a useful dichotomous key to the genus, notes on certain species, and forty-six plates of spore drawings, as well as colour charts for spore-deposits and gills. There is an introduction by Bataille.

Apart from its value as a guide to the genus *Russula*, the work is important as marking a step in the endeavours of systematic mycologists to base the specific classification of Hymenomycetes upon something more objective than colour, feel, taste, and smell. W. B. B.

Edward Carpenter: in Appreciation. Edited by Gilbert Beith. Pp. 246 + 2 plates. (London: George Allen and Unwin, Ltd., 1931.) 7*s.* 6*d.* net.

A Heathen's Thoughts on Christianity. By E. Upasaka. Pp. 92. (London: The Pioneer Press, 1930.) 1*s.*

A BRIEF notice may cover various books either by reason of their sympathy or their mutual antagonism. So, in the present instance, in the late Edward Carpenter was encountered a man of strong individuality who grew into a life of practical socialism, surrendering for its attainment a curacy and holy orders, but by no means surrendering the essentials of a religious life. He was, peculiarly, one with many friends and no enemies, though not everyone could approve his views. This "Appreciation" contributed by a few friends bears eloquent testimony to his sterling qualities; his own farewell (written some years prior to his death, to be read from the graveside) is a fitting conclusion. His views upon "A Heathen's Thoughts" would have been welcome as an antidote against its virus. The author has obviously a right to his opinions, nor can he properly be charged with blasphemy where he has no religious belief. But it is a grievous error wilfully to shock the religious beliefs of others, and this book is one which, whilst it can do no good, may conceivably do harm. The 'higher critics' may note that biblical history is worthily championed to-day by those who support their arguments on logical foundations. P. L. M.

Die Nordsudetische Dyas: eine stratigraphisch-paläogeographische Untersuchung. Von Prof. Dr. Hans Scupin. (*Fortschritte der Geologie und Paläontologie,* Band 9, Heft 27.) Pp. viii + 246 + 4 Tafeln. (Berlin: Gebrüder Borntraeger, 1931.) 30 gold marks.

THIS memoir contains the results of a detailed stratigraphical and palæogeographical investigation of the Permian of the region to the north of the Riesengebirge in Silesia. The succession, reaching from the Middle Rothliegendes to the Upper Zechstein, is subdivided on palæoclimatic evidence. The history of the struggle between deepening and filling-up at the margins of the sinking Variscan land provides an interesting study in palæogeography. The memoir closes with an account of the Zechstein copper ore of the district, which is shown to be stratigraphically and mineralogically distinct from the famous Mansfeld Kupferschiefer. It is considered to have been formed by the action of copper sulphate solutions, derived from the weathering of basic igneous rocks, on the calcium carbonate of the Zechstein sea—a conclusion showing the importance of palæogeography in the elucidation of syngenetic ore-deposits.

Mental Nursing (Simplified). By O. P. Napier Pearn. Pp. viii + 304. (London: Baillière, Tindall and Cox, 1931.) 5*s.* net.

DURING the last decade great progress has been made in the nursing of the mentally afflicted. This most difficult branch of nursing in many ways requires more attention and training than its sister branches, due to the fact that the mental side is the more important and is a really difficult subject to understand. Dr. Pearn in his "Mental Nursing (Simplified)" has in many ways made the path of the mental nurse easy. He gives many interesting little artifices for remembering difficult things, and the nurse who knows this book well before he or she begins the familiar "Red Book" of the Royal Medico-Psychological Association will find the latter book a much easier proposition than is usually the case. The subject matter throughout is extraordinarily well set out, following the general plan of the "Red Book". Dr. Pearn has earned the gratitude of that large body of excellent men and women who, although at times subject to criticism, spend their time in a very arduous but nevertheless fascinating vocation.

A Bibliography of Sex Rites and Customs: an Annotated Record of Books, Articles and Illustrations in all Languages. By Roger Goodland. Pp. v + 752. (London: George Routledge and Sons, Ltd., 1931.) 63*s.* net.

MR. GOODLAND'S bibliography of sex rites and customs is a monumental work of 9000 entries, which have taken, we gather, between fifteen and twenty years to compile. The entries are arranged alphabetically under authors' names. The place of a subject-catalogue, which is essential in a work of this kind if it is to be of any practical use, is taken by a copious subject-index. In view of the present cost of printing, this is perhaps the best solution of a difficulty which confronts every bibliographer. Mr. Goodland, however, has added greatly to the value of his work by the inclusion under each entry of a brief indication of the precise subject or subjects with which the book or paper deals, giving the page reference for each topic. A high standard of accuracy is maintained, and a careful scrutiny of the entries has not revealed any serious omission or error. Such omissions as have been noted would seem to be due to Mr. Goodland's interpretation of what is to be regarded as ritual.

Oxygen and Everest.

By RAYMOND GREENE.

THE recent success of the British Himalayan Expedition in climbing, without the use of oxygen, ten of the greater Himalayan peaks, including Kamet (25,447 feet), the highest summit yet attained, has brought once more into prominence the question of the use of oxygen on Everest. It is a question on which both climbers and physiologists are divided. It is possible that an attempt to sum up the present position may be of use in future discussion.

The problem to be solved is whether or not oxygen can be regarded as a helpful factor in high climbing. One school of thought claims that, in the face of theoretical considerations and practical experience, it is impossible to deny its usefulness. The special difficulties of Everest are due chiefly not to terrain or climate but to want of oxygen. To supply this want can scarcely fail to reduce the difficulties of the ascent. Moreover, Prof. J. Barcroft has shown by direct experiment that, under laboratory conditions, it is possible to do by means of oxygen what is certainly impossible without it—to climb at a rate of a thousand feet an hour, without previous acclimatisation, at a barometric pressure equal to that of the summit of Everest. Much practical experience points in the same direction. Of the ascent of the Rapiu La (21,000 feet), Prof. G. I. Finch wrote: "Colonel Strutt and Doctor Wakefield, unoxygenated, accompanied us on this little expedition, and oxygen at once proved its value, so easily did Bruce and I outpace them". Later, writing of May 22, 1922, he recorded that "There had been a considerable amount of step-cutting, but even so, oxygen had made a brief alpine ascent of what is otherwise a strenuous day's work". Of May 24 he wrote: "No longer did the porters regard oxygen as a foolish man's whim. One and all appreciated the advantages of what they naïvely chose to call 'English air'." As to its use in emergency, I will again quote Finch. He and Geoffrey Bruce had spent a miserable night at a height of 25,500 feet, about the height of Kamet. The weather was cold and windy but they decided to spend a second night at this camp. He wrote: "a dead, numbing cold was creeping up my limbs, a thing I had only once before felt. . . . Something had to be done. Like an inspiration came the thought of trying the effect of oxygen. . . . A few minutes later, after the first deep breath, I felt the tingling sensation of returning life and warmth to my limbs. We connected up the apparatus in such a way that we could breathe a small quantity of oxygen throughout the night. The result was marvellous. We slept well and warmly. Whenever the tube delivering the gas fell out of Bruce's mouth as he slept, I could see him stir uneasily in the uric, greenish light of the moon as it filtered through the canvas. Then, half unconsciously replacing the tube, he would fall once more into a peaceful slumber. There is little doubt that it was the use of oxygen which saved our lives during this second night in our high camp." On the next day, the two climbers climbed a further 1800 feet at an average speed of nine hundred feet an hour. An earlier party, using no oxygen, a stronger party from a mountaineering point of view, in better weather and after only one night in the high camp, covered roughly the same zone of altitude at a speed of only 330 feet an hour. It is on such data, derived from theoretical considerations, laboratory experiment, and practical experience, that the oxygen school bases its conclusions.

The no-oxygen school claims, on the other hand, that the conclusions are unsound because, both in the Barcroft steel chamber experiment and on Everest, the 'subjects' were either unacclimatised or only partially acclimatised. Acclimatisation appears to occur in three different ways. In the well-trained person, oxygen secretion by the lung epithelium increases the oxygen supply to the blood at a very early stage of an ascent. The existence of oxygen secretion is denied by some physiologists. In this battle of the giants I do not propose to take a part. It does not affect our main issue, because it does not occur to a sufficient extent to affect the question of whether or not oxygen should be carried on Everest. A great increase in the hæmoglobin percentage of the blood undoubtedly occurs, but this increase will not make possible the continuance of life at very great altitudes, unless supported by an actual increase in the pressure of oxygen in the lung alveoli. This increase is attained by deep breathing.

The first deep breathing of the ascending climber is caused by the effect of oxygen want, which increases the susceptibility of the respiratory centre to an increase in the carbon dioxide of the blood. The 'subject' responds to oxygen want by breathing more deeply. In so doing he washes carbon dioxide out of his blood and so lowers the acidity of the latter, and the tendency towards deep breathing. He may even show the periodic type of breathing known as 'Cheyne-Stokes breathing'. The most important element of acclimatisation is the overcoming of this 'alkalosis', and the breaking of the vicious circle. This compensation is brought about by an increased excretion of alkali by the kidneys. Thus a compensation towards acidosis is produced and permanent deep breathing with increased oxygen tension follows. Now the exponents of oxygen point out that although it is obvious that the supply of oxygen to an unacclimatised person would increase his working capacity, the acclimatised person would be unaffected. His deep breathing keeps his oxygen tension as high as he wants it.

The no-oxygen school can also quote from practical experience, for the evidence of the 1924 Everest Expedition was less favourable than that of the 1922 Expedition. There is, it is true, a record of a quick oxygen-assisted climb between Camps III. and IV. by Mallory and Irvine, and there is a note by Mallory, written from Camp VI., telling Noel to be on the look-out with his cinema at 8 A.M., when he expected to be at the foot of the final pyramid. This suggests that Mallory expected to make, with oxygen, very rapid progress. On the other hand, Geoffrey Bruce and Odell both reported that they obtained little or no benefit from its use. The first such occasion was up to 23,000 feet, where its use could scarcely be expected to produce dramatic results in acclimatised climbers. The second occasion was at 27,000 feet, when Odell discarded oxygen and felt better without it. With the deference due from one who was not actually present, I suggest that the fault may have rested with the apparatus, and that the improvement in Odell's condition may have been due to the discarding of useless weight and partly possibly to the euphoria usually associated with anoxæmia. We know that the apparatus was cumbersome, inefficient, and leaky. We do not know to what extent Irvine's improvements and corrections, carried out without proper equipment and under the most difficult of conditions, may have broken down in use. The appearance of Mallory and Irvine, still below the final pyramid at 12.50, four and a half hours late, may have been due to a breakdown of the apparatus.

If, then, the oxygen school believes in the usefulness of oxygen for high climbers, whether acclimatised or not, and the no-oxygen school believes in its usefulness for the unacclimatised, a method of attack in conformity with both points of view appears at first sight to be obvious. It should be possible to eliminate the necessity for acclimatisation by using oxygen from a low level on the mountain and climbing it at alpine speed. But here two great problems present themselves. It is very difficult to construct an apparatus which will without waste deliver the required quantity of oxygen while the climber is eating and sleeping; and it is impossible at the moment to find an apparatus which can be trusted never to go wrong. The failure of his oxygen apparatus near the top of Everest would mean death to the unacclimatised mountaineer.

The other extreme view has also been presented, but never by anyone with experience of Himalayan climbing—the view that Everest should be attacked by a party prepared, if necessary, to spend a year upon the mountain. To rush a mountain is folly, unsound in theory and disastrous in practice. Siege tactics have been proved sound. But there must be moderation even in slowness. The weather of the great peaks allows only a limited time in which to make the ascent, and many months upon a mountain undermine the health of the climbing party. It is possible that before sufficient acclimatisation for an oxygenless assault on the summit of Everest has been attained, altitude deterioration may have set in. If by relying on oxygen for the last few thousand feet of Everest it is possible to reduce the time on the mountain and thus the danger of deterioration, the chances of a successful attempt will be increased. Whether this can be done will be determined by direct experiment in a steel decompression chamber.

The practical difficulties of oxygen are serious. The apparatus in use in 1924 was so heavy that, in the opinion of some, its weight outbalanced its advantages. Valves tend to freeze or leak, and complicated taps are difficult to work under trying conditions. Many improvements have been made in the last five years, but there is room for more. There should be produced a light, simple, and efficient apparatus, thoroughly tested in refrigerators and mid-tunnels and on the mountains of Europe. This task has been undertaken by a committee of the British Association. If such an apparatus can be designed it should, as soon as permission can be obtained, be placed in the hands of a young, well-drilled, and well-organised party. Such a party will, in my opinion, climb Everest. It will at any rate show us whether or not oxygen can be of service to the unacclimatised man.

The Principles of Evolution Revealed by Palæontology.*

By Prof. Henry Fairfield Osborn, For.Mem.R.S.

In honour of Darwin our first thought is that natural selection is the sole survivor of the age-long theories and hypotheses clustering about evolution. Selection alone has stood the test of survival of the fittest, yet we must severely limit the powers of selection as Darwin imagined them in his earlier and more sanguine frame of mind, and glean the elements of truth pervading all the other hypotheses and theories. It is a striking fact that the zoologists, experimentalists, and geneticists who, a quarter century ago, were stoutly combating Wallace, Weismann, and other super selectionists, have, one after another, returned to the Darwinian fold and are now almost unanimously teaching their students, as if it were a demonstrated fact, that evolution progresses by the survival of fortuitously adaptive mutations.

To the mind of the palæontologist these teachings are pure Darwinism camouflaged in new language. Bateson, founder of the genetic school, was the only one to confess frankly his utter failure to explain the origin of species; few have displayed similar courage.

When we consider the youthful zoology and the infantile palæontology of Darwin's time (1809–82), our admiration for his genius and marvellous powers of generalisation constantly increases. What would his generalisations have risen to with our present knowledge? He foresaw the promised land of palæontology, but did not live to enter it. The ratio of the 8767 vertebrate species known in his time to the 65,939 species known in 1925, nearly 8 to 1, is about the measure of the biological progress of the first century of evolution. The 'biochemical' adaptations underlying coloration, as well as the 'biophysical' adaptations controlling many of the animal instincts, are beyond the ken of the palæontologist who is bounded by his biomechanical fossils.

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* Paper read before Section D (Zoology) of the British Association, following Prof. E. B. Poulton's presidential address, entitled "A Century of Evolution", on Sept. 24. This is the sixth of a series of papers by the author on the origin of species

Far from marking any real progress toward the eternal question of the origin of co-ordinated mechanical adaptations, the experimental zoologist and geneticist are making little progress along the biochemical line. In order to ascertain the state of current observation and opinion on the mutational origin of species, sub-species, or adaptive mutations, as well as on the experimental results of biochemical, biophysical, and endocrine action, the following questionnaire (slightly modified) was sent out on July 17, 1931, to forty-one leading zoologists:

1. Do you know of a single concrete case of the origin of a species, of a sub-species, of an adaptive mutation of De Vries, or of a single adaptive character, arising suddenly by mutation or saltation either under natural or experimental conditions?
2. Granted that permanent hereditary sports, mutations, and modifications of existing characters are being produced by biochemical and biophysical means, has a single adaptive character been produced by such means by experiment in your laboratories?
3. Granted that profound changes in colouring, in form, in somatic proportion, in the developmental acceleration or retardation of characters, may be produced by glandular action, is there sufficient evidence that Nature has ever proceeded in this way except in producing immunity and non-immunity?

Up to the present time (Aug. 13) seventeen replies have been received. To Questions 1 and 2 the prevailing answers are negative as indicated by the reply "No". More or less positive or affirmative replies were also received to Question 1, but analysis of most of these replies indicates that the crucial element in Question 1 is evaded, namely, *the origin of adaptive characters*. No doubt certain mutations do survive; many of them are recorded in the answers to the questionnaire; Crampton has discovered mutations in his monographic researches on the mollusc *Partula*; Chapman in the avian genus *Buarremon*; the short-legged Ancon sheep is a classic; certain biomechanical mutations in the pelagic Ciliata, such as the spiral shelf of *Xystonella scandens* observed by Kofoid, may be of sudden or mutational origin although this is not proved. The answers of seventeen zoologists to Question 2, namely, to adaptive biochemical origins by experiment, are uniformly negative; new and hereditarily permanent mutations may be aroused by more or less violent chemical or physical means, but not a single one is known to be adaptive. The answers to Question 3 are five negative and five affirmative; the negative squarely meeting the question, the positive reaffirming the granted postulate that endocrine secretions profoundly modify all existing characters and processes of development, but not a single case can be cited wherein a new biomechanical character has arisen through endocrine action.

In this struggle for existence of bygone theories and of new hypotheses, it seems that palæontology, with its world of new and wholly undreamt of evidence as to the *origin of adaptive biomechanical characters*, serves as the two-edged sword of biology; it cuts hypotheses unfit to survive; it strengthens hypotheses fit to survive. It calls for conceptions of a new and synthetic physicochemical order to supplant outworn hypotheses dating back to Empedocles (600 B.C.). Palæontology disestablishes the entelechy hypothesis of Aristotle (300 B.C.) and of all his 'vitalistic' followers like Driesch and Bergson. It substitutes for Aristotle's 'internal perfecting tendency' the idea of adaptive reaction and interaction of internal with external energies which has been formulated (Osborn, 1912–1929) into a new *tetraplastic* principle of the 'four inseparable energetic factors of evolution', namely: (1) physical environment, (2) ontogeny including habit, (3) living environment, the biota, (4) the germ plasm. The above energetic complex is subject to the non-energetic selection—survival of the fittest.

This tetraplastic principle which seeks to combine the elements of truth in preceding hypotheses and theories has, thus far, won no acceptance.

In causation of the origin of species and subspecies, palæontology unites with modern field zoology in firmly establishing the direct action of environment (Buffon, 1755–Wagner, 1870) on the germ plasm as a causative factor. It disestablishes the habit-inheritance law of Erasmus Darwin and of Lamarck (1790–1809); through auto-adaptation it establishes habit as a *guiding* principle in evolution, but not in the Lamarckian sense. Palæontology eliminates selection from the energetic complex; it establishes the non-energetic selection as a universal and outstanding guide and principle of progress from the beginning of time; it disestablishes the third and fourth principles of Charles Darwin (1859), namely, of the origin of adaptations through the survival of the fortuitously adaptive. It firmly establishes the inconspicuous adaptive origins of new characters first observed by Waagen (1869), which may be distinguished as *W.* mutations when compared with the fortuitous *D.* mutations of De Vries (1911). At least from biomechanical evolution it excludes entirely the fortuitous *D.* mutations of De Vries. It helps to disestablish the 'pangenesis' of Darwin and all similar theories of the somatic origin of adaptive characters; it accordingly disestablishes the 'inheritance of acquired characters' and establishes the complementary principle of the 'continuity of germ plasm' of Weismann (1880). It disestablishes the super-selection theories of Weismann and other neo-Darwinians. In its earliest (1806), as well as its latest phases (1931), palæontology undermines the primitive idea of 'created evolution'; of recent years it tends to establish the wholly different idea of 'creative evolution', which may be provisionally termed *aristogenesis*. Finally, palæontology unites with systematic and experimental zoology in compelling us to concentrate research on the origin and co-ordination of bio-characters, in the lower animals and in man, as the outstanding problem of the second century of evolution.

Although primarily an original observer rather than a collator of other people's ideas, Darwin was more or less familiar with ten of the principles of ' biomechanical ' adaptation which had been observed in the hard parts of animals from the time of the earliest Greek anatomists and philosophers. Throughout his frequent discussions of the biomechanical evolution of animals, are included the bony and muscular adaptations brought about through processes of (1) degeneration, (2) development, (3) compensation, (4) economy, (5) change of proportion, (6) co-adaptation, (7 and 8) acceleration or retardation, (9) self-adaptation, and (10) sports and discontinuities. One great principle remained to be established after his time, namely, (11) continuity of the germ plasm, in antithesis to all pangenetic hypotheses of the origin of hereditary characters. Note that all these ten pre-Darwin principles of adaptation relate not to the *origins of organs*, but to the *modification of existing organs*, as of the wings of the duck, the neck of the giraffe, the speed of the wolf. Darwin realised that the weak point in his theory was in the matter of origins ; he could, and did, largely explain the survival value of organs once established, but was hard put to place a survival value on fortuitous variations.

Palæontology (1869–1931) has changed all this through a succession of discoveries revealing nine principles of *adaptive biomechanical origin in the germ plasm*. Thus, up to the present time, we have established through zoology and palæontology no less than twenty more or less distinct but invariably co-operative principles of bio-mechanical adaptation, as follows :

Modification of Existing Organs, Ontogeny.

Discovered in Anatomy and Embryology.
Known to Darwin.

1. Biomechanical *onto-retrogression* (Aristotle), degeneration, atrophy of organs.
2. ,, ,, *-progression* (Aristotle), development, hypertrophy of organs.
3. ,, ,, *-compensation* (Aristotle), metatrophy and eutrophy of organs.
4. ,, ,, *-economy* (Aristotle), metatrophy and eutrophy of organs.
5. ,, ,, *-allometry* (Lamarck-Darwin), allometrons, changes of proportion in organs.
6. ,, *co-adaptation* (St. Hilaire), co-ordination, correlation of organs.
7. ,, *onto-acceleration* (v. Baer) into earlier growth stages of organs.
8. ,, ,, *-retardation* (v. Baer) into later growth stages of organs.
9. ,, *auto-adaptation* (Goethe) through principles 1-8.
10. ,, *onto-saltation* (St. Hilaire), sports, discontinuities.
11. ,, ,, *-continuity of germ plasm in the perpetuation of organs* (Weismann).

Origin of New Characters, Phylogeny.

Discovered in Palæontology.
Not known to Darwin.

12. Biomechanical *phylo-mutation* (Waagen, 1869), orthogenesis in new characters.
13. ,, *-trend* ' mutations-richtung ' (Neumayr) in new characters.
14. ,, *-acceleration* (Hyatt, 1880) in the evolution of characters.
15. ,, *-retardation* (Hyatt, 1880) in the evolution of characters.
16. ,, *-continuity* (Osborn, 1889–1931) vs. discontinuity in characters.
17. ,, *-potentiality* (Osborn, 1889–1931) in the origin of new characters.
18. ,, *-predetermination* (Osborn, 1889–1931) in the origin of new characters.
19. ,, *-rectigradation* (Osborn, 1889–1931) in the origin of single characters.
20. ,, *-aristogenesis* (Osborn, 1889–1931) in the rise of characters.

Of the nine principles of biomechanical origin discovered in phylogeny since Darwin's " Origin of Species " (1859), the first three were observed in fossil invertebrates, namely : (12) the *D.* mutations of Waagen (1869), in which is involved (13) the ' trend ' or ' mutations richtung ' of Neumayr (1875); (14-15) the ' acceleration and retardation ' of Hyatt (1880), principles which Darwin could not clearly comprehend. In the year 1889, Osborn, at the time a convinced neo-Lamarckian, began his extremely intensive observations upon the origin and development of single adaptive characters, aided by unprecedented fossil material first in the primates and then in five independent divisions of the ungulates, wherein were revealed five previously undiscovered principles of biomechanical adaptation, namely : (16) germinal continuity versus discontinuity, and *W.* mutations ascending and descending ; (17) germinal potentiality, as a basis of Lankester's principle of *homogeny* ; (18) germinal predetermination, as distinguished from indeterminate origins ; (19) germinal rectigradations, as distinguished from fortuitous or chance origins. Finally, in the synthesis of the orthogenetic origin of new adaptive characters in all the mammals, including man, there was reached (20) the principle now provisionally termed *aristogenesis* for the want of a more appropriate word to express continuously creative adaptation.

A very important distinction is observed between *rectigradations* which are predetermined, and changes in proportion, as in the elongation of the neck of the giraffe, technically known as *allometrons*, which are not predetermined. Rectigradations are relatively rare, while allometrons, or changes of proportion in the teeth, skull, and limbs, are constantly in progress and make up a larger part of the definition of species. Similar rectigradations arise through community of descent. Similar allometrons are constantly arising in animals of dissimilar ascent.

Whereas the zoologist, comparative anatomist, and geneticist by the very nature of the evidence at their command, find difficulty in distinguishing between the accidental, fortuitous, and temporary variations, fluctuations, and *D.* mutations, the palæontologist is absolutely sure of his footing as soon as he is enabled to observe the ascending geological mutations of animal mechanisms, whether invertebrate or vertebrate. He advances solely by inductive means, after the manner of Darwin. If he is not sure of the adaptive trend of a certain rectigradation in its feeble, incipient stage, he may observe it a hundred thousand or a million years later as the dominant and commanding character of the entire organism. As Weismann spoke of the immortality of the germ plasm, the palæontologist may speak of the secular immortality of thousands of characters which he is enabled to observe through the whole cycle from potentiality and predetermination in the germ plasm until, after æons of use and service, they may subside again into the mysterious germinal substance—mysterious because utterly inexplicable. The biomechanism of the titanothere and of the elephant is due to a complex of energetic factors which is entirely beyond our present comprehension.

The palæontologist concludes that the origin of species, so far as species are defined by various stages of biomechanical adaptation, has long ceased to be a problem; the manner by which sub-species, species, genera, families, and orders arise through divergence, acceleration, retardation, and rectigradation is also perfectly clear.

Selection acts incessantly, but it originates nothing, and it does not control either the origin of characters or their rate of evolution after they arise.

We can affirm that it is the essential living principle of biomechanical reaction which calls forth the adaptive biomechanical response, whether in ontogeny or in phylogeny.

While we know infinitely more about the principles of evolution than did Charles Darwin, and while we can demonstrate beyond refutation the prevailing twenty principles of biomechanical adaptation discovered in ontogeny and phylogeny, *we are more at a loss than ever before to understand the causes of evolution.* One after another the Buffonian, Lamarckian, Darwinian, Weismannian, and De Vriesian theories of causation have collapsed; each, however, contains elements of truth. All that we can say at present is that Nature does not waste time or effort with chance or fortuity or experiment, but that she proceeds directly and creatively to her marvellous adaptive ends of biomechanism.

Biology and Civilisation.

IN his Norman Lockyer lecture, delivered to the British Science Guild on Nov. 24, Dr. H. H. Dale dealt with the part which biology and biologists should play in modern civilisation. It is a commonplace that physical science and mechanical inventions have probably made greater changes in the conditions under which human beings live in the past hundred and fifty years than in the preceding twenty centuries. But this progress has led to many thinking of it in quantitative rather than qualitative terms, and forgetting that machinery was made for man and not man for machinery. It is possible that the imposing achievements of physical science have already, in the thoughts and interests of men at large, in our educational and public policy, as well as in technical and industrial development, overshadowed those of biology to an extent which threatens a one-sided development of science itself, and of the civilisation which we hope to see based on science.

Dr. Dale illustrated his argument by a reference to the physiological problems involved in flying. At the beginning of the War, physiologists were consulted on the subject of the difficulty of breathing at high altitudes. They sought permission to take small quantities of blood for investigation, and were asked by the authorities, what had blood to do with breathing? The question was not easy to answer with polite brevity, since British physiologists had, for several hundred years, been attempting to describe what blood has to do with breathing, and how it does it. To-day physiology has a proper place in the research organisation of the Royal Air Force; and with the development of machines capable of flying at several hundred miles an hour, has come the realisation that the reactions of the human organism to the stresses occasioned by these great speeds will play an important part in any further advances and may well prove to be the limiting factor.

Although biology and physical science have supplemented each other in our modern civilisation in such directions as the provision of pure water supplies and the disposal of sewage, in other directions there has been a lamentable divergence. The pollution of the atmosphere by smoke involves not only a direct waste of fuel and destruction of other materials, but also a very definite increase in ill-health from the absence of direct sunshine, which may be indicated indirectly by the stifled and stunted plant life in our northern cities and directly by the presence of rickets—the 'English disease' of German medical writings—among the growing children.

Dr. Dale described in some detail how our present knowledge of the etiology of this disease has come about. It is now certain that it is due to the absence from the body of a compound which is known as vitamin D, which can be supplied either in the food or by exposure of the surface of the body to the sun's rays, or to some artificial source of light. The vitamin is formed from a compound known as ergosterol, under the action of the rays in the shorter wave-length region of the solar spectrum, either in the skin or in any food material containing its precursor. In practice, for its manufacture, an artificial source of light is used, which emits more of the shorter wave-lengths than reach the earth's surface from the sun. Recent work by Bourdillon and his colleagues in Great Britain, and by Windaus in Germany, has led to the preparation of a pure crystalline compound, of very great activity, which is probably the vitamin itself. In spite of our knowledge of the necessity of supplying vitamins to growing children, margarine still too frequently replaces butter in their diet. Surely a community which respects human life should insist on the production of margarines biologically equivalent to, as well as physically like, butter.

Looking further afield and considering the problem of the qualitative and quantitative dietary needs of men of different races of civilisation, in all varieties of climate, it appears that only the fringe of this great problem of human nutrition has begun to be touched by science. It is very probable that a large proportion of the human race is living at a nutritional level which prevents them from achieving more than a small part of the physical and mental efficiency of which they are racially capable.

Even the bodily well-being of man demands more than food. We have not properly begun to use the available resources of physical science to provide for other factors of a healthy environment, nor have we properly applied the botanical and zoological knowledge which bears on the problems of disease, or made the fullest efforts to extend it. In cold or temperate climates, the white races can only exist in winter with the aid of artificial heat; in the tropics no attempt has so far been made to supply artificially cooled houses. Again, we are only beginning to realise the dimensions of such problems as those presented by the tsetse flies, by the plagues of locusts, and by the hosts of external and internal parasites which prey upon the higher animals and plants.

Dr. Dale referred to the recent work on virus diseases, pointing out that it is probable that biological research has here reached a point at which progress is delayed, because it is trying to advance beyond the range of the methods which physical science has yet made available. There are other points at which functional biology finds itself halting for want of physical methods of the required delicacy and precision. The work requires a partnership between biology and physics, of which there is little sign at present. The lack of it is connected with the tendency, referred to above, to a one-sided development of civilisation.

The causes of this are complex. They are partly due to the increasing specialisation which accompanies increased knowledge, partly to the fact that biology, in its observational and systematic stage, was considered to demand a smaller intellectual effort than the sciences of chemistry and physics. To-day, biology calls to its aid the resources provided by the latter sciences, as seen, for example, in the work carried out on the processes accompanying a simple muscular contraction. It is making a bold approach to the task of analysing vital processes into sequences of associated chemical reactions. The problems differ from those with which the ordinary chemist deals only in their complexity and difficulty. The reactions proceed with extraordinary rapidity, and the substances concerned are very unstable and are present in only minute amounts. Organic chemistry, which started as the chemistry of living organisms, has been prone to forsake its original objective for the fascinating pursuit of making unnatural substances by artificial synthesis, for practical use in industry or medicine, or for their theoretical interest. Similar complexities face the physicist who may interest himself in biological problems; in fact, although the cleavage between the physical and chemical sciences and biology may have been inevitable when the problems of biology seemed too superficial and too easy, it is of the utmost importance to the future that this cleavage should not persist unnaturally, because the problems of biology are now becoming too complex and too difficult.

The widespread desire to know something of the achievements of science is concerned almost solely with those of physical or chemical science, and the unequal concentration of this interest, reflected in our educational and administrative systems, may become a real danger to our civilisation. An intelligent appreciation of the fundamental facts of biology is not regarded as a necessary part of the equipment of an educated man. Even an eminent physicist may preserve his aloofness from biological knowledge to a degree quite impossible to the normally educated biologist in relation to physics and chemistry. This anomaly in our education is part of a vicious circle: it arises in response to a one-sided demand of our civilisation, which, in turn, it tends to confirm in its asymmetry.

The problem of the improvement of the human race is ultimately biological and demands a biological outlook for its investigation. Thus it involves the application of genetics to the production without conflict with the existing social order of desirable human types. The problem is difficult, but this does not justify us in ignoring it; on the contrary, it makes more urgent the need for the most complete scientific knowledge that can be obtained. Such biological knowledge may make the human race capable of a civilisation beyond any that we can imagine at the present day.

Obituary.

DR. JOHN SAMPSON.

BY the death on Nov. 8 of John Sampson, D.Litt., for many years librarian of the University of Liverpool, England loses its most eminent Gypsy scholar. He became interested in Gypsies, more particularly on the linguistic side, as a young man; and after exhausting the possibilities of English Romani, which indeed is a poor, broken-down dialect, he turned to the fully inflected speech of the Welsh Gypsies descended from Abram Wood. That was in 1894, prior to which its existence had barely been proved. Thirty-two years later, there appeared from the Oxford University Press his massive, scholarly, and, for a philological work, intensely human, "Dialect of the Gypsies of Wales", the 660 closely printed quarto pages of which provide, not only the best account yet published of any Romani dialect, but also, despite a few omissions imposed by the nature of his subject, the fullest and most accurate exposition available of the phonetics and morphology of the Gypsy language as a whole.

This imposing book, and the series of Welsh Gypsy folk-tales Dr. Sampson published in the *Journal of the Gypsy Lore Society* at intervals during the past twenty-five years, may be regarded as his life work. But he also contributed numerous other papers to the pages of that journal. One of them, read before the British Association in 1923, is a very original and largely successful attempt, based mainly on phonological data, to trace the migrations of the Gypsies on Asiatic soil prior to the date of their first appearance in Europe. In another, written more than forty years ago, he solved the riddle presented by Shelta, the jargon of the Irish tinkers often met with on the English roads; an ancient jargon, invented, as his friend Prof. Kuno Meyer proceeded to show, by the Irish bards.

WE regret to record the death of the Rev. F. Smith, formerly a chaplain in the Royal Navy, which took place at Nottingham, where he had lived since his retirement in 1917. Mr. Smith was best known to archæologists for his advocacy of the existence of early man in Scotland during the interglacial periods of the Ice Age. With the late Dr. Gemmell, of Drummers, Wigtownshire, he had made a large collection of specimens, some of enormous size and of rocks other than flint, which he held showed evidence of man's handiwork and supported his contention. His conclusions and a summary of the evidence on which they were based were embodied in his "The Stone Ages in North Britain and Ireland", published in 1909. A close student of the technique of stone implements, he maintained that the readiness with which the hand adapted itself to the grip of a doubtful artefact was a sure test of genuineness—a view he applied in his "Prehistoric Man and the Cambridge Gravels", published in 1926, in dealing with specimens of which the human origin had not generally been accepted. This winter a part of the collection made by Mr. Smith and Dr. Gemmell is being exhibited in Glasgow.

News and Views.

THE weekly meeting of the Linnean Society held on Nov. 19 was devoted to a series of papers commemorative of Robert Brown, the eminent nineteenth century botanist. In November 1831 he announced to the Linnean Society his discovery of the nucleus of the vegetable cell. The authors of the papers presented were: Prof. F. E. Weiss (president), Mr. J. Ramsbottom, Mr. S. Savage, and Lieut.-Col. J. Stephenson. A number of interesting original documents and prints illustrative of Brown's career were on view. Also, a portrait and a bust of the botanist belonging to the Society were placed, for the occasion, close to the presidential chair. Robert Brown was the son of an Episcopalian minister, and was born at Montrose, on Dec. 21, 1773. Educated there at the Grammar School, he proceeded in 1787 to Marischal College, Aberdeen, entering afterwards the medical faculty of the University of Edinburgh. He was strongly interested in the studies of the pioneer botanists of his time. Visiting London in 1798, he met Sir Joseph Banks, and henceforth botanical research work and allied interests dominated his energies. The recommendation of Banks, in 1801, secured his appointment as naturalist to H.M.S. *Investigator*, commissioned under Capt. Matthew Flinders to conduct a survey of the coasts of Australia. After nearly four years' absence, Brown returned with a collection of some four thousand species of plants, mostly new to science. He did not, however, overlook the demands of zoology.

IN 1805 Brown was appointed librarian to the Linnean Society, thereafter devoting himself in his hours of leisure to the working out of his collections, contributing largely thereby to perfecting the natural method of classification. In 1810 he published the first instalment of his famous "Prodromus Floræ Novæ Hollandiæ". He assisted also in the accounts of various scientific expeditions; for example: Salt's "Travels in Abyssinia", Clapperton's "Expedition to Central Africa", and Strutt's "Expedition to Central Australia". In 1810 Brown became librarian to Sir Joseph Banks and keeper of the collections at his house in Soho Square; afterwards (1827), when the collections were transferred to the British Museum, Brown followed thither in charge of the botanical sections. Brown was president of the Linnean Society from 1849 until 1853. Residing in Banks's old home in Soho, he died there on June 10, 1858, at the age of eighty-five years. At the meeting of the British Association at Oxford in 1832, honorary degrees were conferred by Convocation on Robert Brown, Sir David Brewster, John Dalton, and Michael Faraday. In Brown's case the distinction was that of D.C.L. It was this little group which prompted Keble's allusion to a "hodge-podge of philosophers" as being present in the city. Elected a fellow of the Royal Society in 1811 (Banks, as president, was, likely enough, chief sponsor), Brown was awarded the Copley Medal in 1839 for his discoveries on vegetable impregnation.

ON Dec. 5 occurs the centenary of the birth of Hans Heinrich Landolt, the eminent Swiss chemist whose work formed a connecting link with that of Mitscherlich, Rose, and Bunsen, and who counted among his contemporaries and friends Lothar Meyer, Beilstein, Kekulé, and Quincke. Born at Zurich, he was a descendant of an old patrician family of Switzerland. He entered the University of Zurich and wrote his first paper at the age of nineteen years, and his labours as a chemist did not cease until a week before his death, which occurred on Mar. 15, 1910, when he was in his seventy-ninth year. Leaving Zurich at the age of twenty-two, he studied at Breslau, and thence entered the laboratory of Bunsen at Heidelberg. For twelve years, 1857–69, he was associated with Hofmann and Kekulé at Bonn, and in 1869 he was made head of a new technical institute at Aix-la-Chapelle. From 1880 until 1891 he directed the newly founded Agricultural College at Berlin and was next appointed to succeed Rammelsburg in the University of Berlin. At Heidelberg, Landolt carried out researches on the electrolytic production of calcium and lithium, and on the gases produced in the newly invented Bunsen burner. At Bonn he studied the influence of the atomic composition of liquids on the transmission of light, at Aix-la-Chapelle he carried out his important work on polarised light, while at Berlin he turned his attention to the determination of melting points, the crystalline structure of substances, and, between 1893 and 1908, carried out his well-known series of experiments on the conservation of mass during chemical reactions. A man of placid disposition, Landolt possessed infinite patience, and in his old age was regarded as a patriarch of physical chemistry. His death took place at Berlin, but he was buried at Bonn, where he had spent some of the happiest years of his life.

SIR CHARLES PEERS, in his address to the annual Congress of Archæological Societies, which was held in the rooms of the Society of Antiquaries on Nov. 17, directed attention to the first session of the Congrès International des Sciences Préhistoriques et Protohistoriques to be held in London in August 1932. He reviewed briefly the circumstances leading up to the decision, taken by representatives of a number of countries meeting at Berne in May last, to found a new Congress after the failure of protracted negotiations for placing the Congress organised by the Institut International of Paris on an international basis. Sir Charles also pointed out that the old International Congress of Prehistoric Anthropology and Archæology, which first met at Spezia in 1865 and held its last session at Geneva in 1912, met in London in 1868, but no congress of prehistoric studies has been held there since that date. The invitation to hold the Congress in London tendered by the Society of Antiquaries and the Royal Anthropological Institute, acting in conjunction with its Joint Committee for Research and Teaching, has received the support of the Royal Archæological Institute and a number of other bodies engaged in cognate studies. The need for an international gathering of this character at regular intervals—the congress will meet normally once every four years—has been felt with increasing urgency for some time; and this movement towards international co-operation in prehistoric studies, therefore, merits the strongest support among the many circles of widely varied interests with which the local archæological societies are in touch. The range of subjects —geology, palæontology of plants and animals, anthropology, ethnography, folk-lore, and archæology—ensures ample material to occupy a membership of the most diverse character.

ON several occasions the local archæological societies of Great Britain have been invited, through their annual congress, to co-operate in the collection and study of material which, either because it is too widely extended geographically or because it requires local knowledge, is beyond the range of the individual. The work of the Committee on Earthworks is a case in point. At the last Congress, Mr. H. J. E. Peake appealed on behalf of the British National Committee on Folk-Arts and Crafts for information relating to arts and crafts still practised among the people in the countryside, while Dr. G. Herbert Fowler asked the societies to promote a survey of parish documents. Both these matters unquestionably require the attention of local societies, although in the case of parish documents it was pointed out with justice that some county councils already have done much to arouse local interest in these records and thus to ensure their preservation. The urgency of Mr Peake's request must be measured by the fact that it comes almost too late. Although a number of folk-arts and crafts are still practised even now, and some, owing to local circumstances or their special adaptability to local needs, are quite likely to survive for some time, yet the last few years have witnessed rapid strides towards the extinction of many traditional industries and methods. When an attempt was made to institute an ethnographic survey of the British Isles without success some thirty years ago or more, an opportunity was lost which cannot recur.

INDIGNATION is being freely expressed in Australia at the action of the Commonwealth Government in imposing a primage duty of 10 per cent on books imported from abroad, and a further sales-tax of 6 per cent. Almost all importation is from Great Britain, and, apart altogether from direct taxation, the purchaser suffers from an adverse exchange rate of 30 per cent in converting Australian currency into sterling. To educational institutions and scientific societies, and also, of course, to individuals (particularly students), these imposts are a very serious matter indeed. Federal labour ministers have so far shown scant sympathy towards the representations made by universities and other bodies. They plead that the need for revenue outweighs considerations of the burden upon scholarship and knowledge in general, a view which is deplorably short-sighted in any community, but especially so in a country so dependent upon outside sources for its literature as Australia is. Nor is the revenue contention finding justification in experience. In 1929 imports of books and other reading matter from Great Britain and Northern Ireland totalled well over one million pounds in value. For 1931 the indications are that the figure will not reach half a million. The taxes are defeating their own purpose by destroying the source of revenue; but, apart altogether from that side of the matter, they impose a serious handicap upon literary and scientific development.

THE Friday evening discourse at the Royal Institution on Nov. 20 was delivered by Dr. C. H. Lander, who took as his subject, "Oil and Petrol from Coal". In Great Britain, where there are no appreciable deposits of natural oil, but where coal is plentiful, the possibility of manufacturing oil and petrol from coal has obvious attractions. Liquid fuels were first made commercially from coal as a by-product in the manufacture of gas or coke. The total yield of motor spirit by such processes, however, cannot be pushed beyond some six or seven gallons per ton of coal carbonised. Coal, as compared with oil, is deficient in hydrogen; the problem therefore suggests itself of adding extra hydrogen to the coal substance in order to make up this deficiency, and then, by some means or other, inducing the molecules of the mixture to reshuffle themselves into oil molecules. Some fifteen years ago, Dr. Bergius, in Germany, succeeded in liquefying coal by direct hydrogenation.

SOON after the War, experimental work on the hydrogenation of coal was taken up at the Fuel Research Station, Greenwich, and at a later stage close collaboration was established with the German group. By 1927, Imperial Chemical Industries, Ltd., thought it worth while to explore the possibilities of its commercial exploitation, and a plant capable of dealing with about fifteen tons of coal a day is now in action at its Billingham Works and is producing some 160 gallons of motor spirit from the treatment of a ton of suitable coal. Extra coal is required for hydrogen manufacture and power generation, but, taking all the costs into account, the cost of petrol from the works is of the order of only *7d.* or *8d.* a gallon. The complete gasification of coal to hydrogen and carbon monoxide, and the subsequent synthesis of these gases for the production of alcohol and hydrocarbons, was also briefly referred to. Although such processes cannot at present compete with carbonisation or hydrogenation for the manufacture of liquid fuel, they have already become the basis of a large industry for the production of alcohol for solvents.

SPAIN will be the host of chemists from all parts of the world in April 1932, when the ninth International Congress of Pure and Applied Chemistry meets in Madrid. The occasion is one of distinction, for the Congress is the first to be held since the War, and the first to be held under the auspices of the International Union for Chemistry. The seventh Congress of Applied Chemistry was held in London in 1909, and the eighth in Washington and New York in 1912; the ninth congress at Madrid will also be associated with the eleventh Conference of the International Union of Chemistry. While the latter is a delegate conference, the Congress itself offers membership to anyone professing interest in any of its objects, namely, the advancement of chemistry and its applications, and the strengthening of relations between chemists of every nation. Additional importance is lent to the occasion by its official character, the assembly having been placed under the patronage of the Government of the Spanish Republic.

THE three subjects which have been chosen for discussion at the International Congress of Pure and Applied Chemistry are: the Raman effect in connexion with chemical constitution; the high polymers in chemistry; and the chemistry of high temperatures. Invitations to take part in the discussions have been extended to the following: Sir C. V. Raman (Calcutta), Prof. K. W. F. Kohlrausch (Graz), Prof. J. Cabannes (Montpellier), Prof. K. H. Meyer (Ludwigshafen), Prof. A. Staudinger (Freiburg), Prof. W. L. Bragg (Manchester), Prof. C. Matignon (Paris), Prof. O. Ruff (Breslau), Prof. A. Day (Washington). The proceedings will commence with a reception on April 3, and will terminate on April 9, although April 10 is reserved for trips; the principal discussions will take place on April 4, 6, and 8, whilst excursions and other social functions will be held on other days in that week. Meetings of the International Union for Chemistry will be held on April 8 and 9. Incidentally, the congress week will coincide with the holding of interesting festivals and fairs. Applications for membership of the Congress must be sent to the general secretary, Prof. E. Moles, San Bernardo 49, Madrid (8), before Jan. 1, 1932.

PRAGMATISM was the keynote of Mr. Olaf Bloch's presidential address, "The Faith of a Technical Man", delivered to the Royal Photographic Society on Oct. 20. The man of science believes in a real world, and to mix metaphysics and experimental science is fatal. The realisation of his comparative ignorance is characteristic of the modern man of science, and produces a mental attitude which, coupled with logic, imagination, and intuition, is largely responsible for our rapid technical progress. It is important to develop the attitude of fearless inquiry, of freedom from conventional shackles, which enables us to look at facts and problems from the outside. In this educational problem the man of science must play his part. Our political and social organisation has only permitted a tithe of the influence which scientific and technical advances have exercised in industry. The numerous factors involved should not deter the technician from attempting to deal with politics, economics, and public affairs in the abstract and logical way he applies in his own work. Production is already passing rapidly under his control, followed by distribution. In various directions, scientific methods have already been applied to human affairs to some extent, and the successful use of such methods in this field calls for great qualities, and in particular requires an internationalism which does not yet exist. Science, both pure and applied, is a great destroyer of barriers, and the international economic agreements already in force may be the beginnings of far-reaching developments.

MR. BLOCH stated that whether or not human nature can be changed, its outlook can certainly be modified by education, public opinion, or by the application of technical achievements to life so that human nature would have all the appearance of having been changed. Thus the technical advances which have so completely transformed and mechanised the production and even the distribution aspects of industry and agriculture are producing a type of mind which reacts more quickly, is less insular, and more open and willing to face problems in the light of facts rather than of tradition. Fundamentally, technical progress is only justified when accompanied by social, economic, and political progress—amelioration and increased amenities of life, greater security and more widespread education, knowledge, recreation, etc. At present, the coexistence of a highly organised and increasingly complex productive system with an inert and more or less antiquated social and political system tends to great instability, which can only be removed as we extend our organising powers from production, distribution, and consumption to the social and legislative problems at present so largely unco-ordinated. A wise administration would deliberately and unostentatiously plan to construct a true educational ladder, building up a higher average brain capacity. Race quality cannot be improved by statesmanship alone; the technical man must bring his scientific methods, insist upon their increasing application to the material concerns of life, and manifest his profound faith in the power of mind to compose, arrange, create, and cope with the difficulties and complexities of human affairs.

SIR ARNOLD WILSON contributed an interesting paper on "The Epic and the Tragedies of Civilisation" to the recent Modern Churchmen's Conference, and it has now been reprinted by Basil Blackwell, of Oxford, as a pamphlet. He quotes and criticises Spengler and Houston Chamberlain with good effect, and adds some wise warnings as to the durability and strengthening of civilisation, both in the past and the present, which historians and social reformers would do well to take to heart. Of the former, the most valuable is that we are coming to see that the pervading rule is that the old does not disappear in a cataclysm, as one is apt to think when reviewing the whole process after its completion. The barbarians, for example, did not sweep away the Roman Empire, but partly absorbed it and partly were absorbed. The change is mutual and continuous rather than catastrophic. With regard to the present and the future, Sir Arnold rightly dwells on the supreme importance of the use of leisure, on which, as he says, with the growth of wealth, "mainly depends the maintenance of a civilisation". Following on this he has a weighty passage, suggested by Mr. H. W. Nevinson, on the fundamental importance of the skilled manual worker as the creator of civilisation. It is a view which fits in well with the gospel which Dr. Jacks is never tired of preaching—of salvation by 'making'.

ONE grave omission, however, cannot fail to strike the reader of the brochure, an omission which it shares in common with most of the criticisms and prophecies of the delay of civilisations. Sir Arnold Wilson does not see, or at least does not mention, the transformation effected in the world by the scientific organisation of society in modern times. Wherever science, both as a method of thought and as an agent of mechanical adjustments, is established, society acquires a stability and a power of resistance quite unknown in earlier times. Lord Balfour pointed this out years ago in his presidential address to the British Association, but the literary historian goes on talking as if nothing of the sort had happened. Yet the War, which came after Balfour's address, gave the most striking confirmation. Scientifically organised communities, of which Germany was the leading example, have survived, and Germany is at present the leading country in the world in export trade, and her intellectual life seems as keen as ever. Man might conceivably destroy his present civilisation by persistent internecine warfare, but the task becomes increasingly difficult.

IN the presence of representatives of the Italian Government, an official demonstration took place on Nov. 20 in Italy between Santa Margherita Ligure and Levanto—a distance of 25 miles—of the new Marconi quasi-optical, ultra-short wave radio-telephone system. The wave-length used was only 50 cm., the same as that employed in the previous demonstration recently carried out between Santa Margherita Ligure and Sestri Levante over a distance of 11 miles, corresponding to a frequency of six hundred million cycles per second. The success of the demonstration was all the more complete because, although the range had been increased from 11 miles to 25 miles, the margin in the signal strength was such as clearly to indicate that the apparatus was capable of covering a considerably greater distance. This demonstration is a test of a new practical and commercial radio system which will very shortly be used for public services in Italy. Owing to its simplicity the new system is very moderate in price and in running costs: it will thus soon afford to the inhabitants of many small islands scattered in the Mediterranean a reliable telephone service, with a range at present of about a hundred miles, which they could not, heretofore, enjoy in consequence of the high cost of the submarine cable telephone installation.

THE progressive extension of the grid by the Central Electricity Board has led many dwellers in rural districts of Great Britain to hope that in the near future they may be able to get the electric light at a reasonable cost. In a paper by E. W. Dickinson and H. W. Grimmitt read to the Institution of Electrical Engineers on Nov. 19, the problem of rural electrification was thoroughly discussed. They conclude that if the density of the population in a rural district of about 400 square miles in area be not much less than a hundred, then there is no financial or technical reason why this supply should not be given. Under average conditions, they see no reason why the price should exceed a flat rate of about sixpence per unit, but they advise charging a fixed annual sum and a small charge a unit for the load consumed. If the population be scattered uniformly over the area, electric energy would be more expensive than coal, paraffin, or wood. Fortunately, in Great Britain most of the population is congregated in villages and hamlets. The remainder is located in country residences, institutions, farms, factories, etc., of sufficient size to warrant the capital expenditure needed to form an interlinked system of supply for the whole area. The authors' study of statistics has brought out the interesting fact that any lowering of the price to the consumer results in an increase of revenue. At the higher rates of charge, a given percentage drop in the price produces only a small percentage increase in the revenue; but at the lower prices the same percentage drop produces a remarkable increase.

The rapidity with which the number of high-power broadcasting stations is increasing in Europe is causing anxiety to radio engineers. In the spring of 1929 there was only one transmitter in Europe having a power of 50 kilowatts. There are now nearly thirty. Although it is only two years since the European Postal and Telegraph Administration met at Prague and formulated the wave-length plan known as the Prague Plan, based on a nine kilocycles separation between stations, it is now obvious that it needs alteration. It will be remembered that at the opening of the Stuttgart-Mühlacker Station in November 1930 the interference between it and London Regional was very serious. Fortunately it has been possible by experiment to make certain slight modifications in the frequencies of several British stations so as to avoid interference in certain specific cases. In some instances the bands of frequency have been separated by eleven kilocycles. It is obvious that if no limit is fixed to the power radiated from a broadcasting station, several of the channels of communication allotted to countries internationally must be sacrificed. It is because certain nations refuse to consider such sacrifices that no decisive action was taken at the meeting of the International Broadcasting Union (U.I.R.) at Rome in October. We learn from *World Radio* for November that the B.B.C. has carried out a large number of experiments, both in the laboratory and under practical reception conditions, at its receiving station at Tatsfield, to ascertain how interference can be remedied. It appears clear that, beyond a certain point, improving selectivity decreases the quality of the reproduction. Similar results have been obtained by Dr. Van der Pol in Holland. There is little chance of any step being taken in the direction of establishing a new wave plan before the international meeting at Madrid in the autumn of 1932.

An attempt is shortly to be made by the State Radiological Institute at Prague to evaluate the radioactivity of the atmosphere in different parts of Czechoslovakia. The object of these investigations, which have the support of the Czechoslovak Ministry of Health, is to discover whether there is any noteworthy difference between the radioactivity shown by the atmosphere in the neighbourhood of the spas such as Karlsbad, Marienbad, Poděbrady, Jáchymov (where there are extensive uranium mines and the ore is worked up for radium preparations, etc.) and that of the general countryside and town air. The radioactivity of the atmosphere at the climatic resorts in the Giants' Mountains and the High Tatras will also be studied for comparison. It is suggested that the radium emanation in the atmosphere must exert some therapeutic action, perhaps comparable with that of sunlight or warmth. Indeed, Prof. J. Stoklasa has gone so far as to declare that this radioactivity may play an important rôle in connexion with metabolism, since animal organisms show a distinct radioactive content. The 60-80 gm. of potassium present in an adult exert a feeble β-and γ-radiation. Preliminary measurements, using Gerdien's apparatus, have indicated that the conductivity of the atmosphere at Prague is $0{\cdot}4\text{-}1{\cdot}2 \times 10^{-4}$ electrostatic units, whilst around the west Bohemian thermal spas it varies between $1{\cdot}0$ and $1{\cdot}2 \times 10^{-4}$. At Jáchymov (St. Joachimsthal), in the neighbourhood of the radium extraction laboratories, it is $2{\cdot}4\text{-}2{\cdot}6 \times 10^{-4}$.

On Dec. 3, 1929, at the invitation of Sir Harold Boulton and Sir James Calder, a meeting was held at the Hotel Metropole, London, for the purpose of inaugurating a Wood Preserving Association. The Association came into being, and the first number of the *Journal of the British Wood Preserving Association* marks the end of the first year of the Association's life. As is to be expected, there is not, for the expert, much original matter in the number; but it is hoped that in the future the scope of the journal will be enlarged to include original articles, reviews of current literature, and an account of the numerous other activities by which the Association is endeavouring to fulfil the purpose for which it has been formed. With Sir Harold Boulton as president, Lord Clinton and Sir James Calder, vice-presidents, and a strong council, the Association should be able to look forward to a very useful future. In addition to the editorial and description of the inaugural meeting, the journal has articles on the preservation of timber by R. S. Pearson, insects injurious to timber by Prof. J. W. Munro, and records of general discussions in the Association on the preservation of estate timber and the preservative treatment of building timber. Perhaps one of the most promising sides of the Association's future possibilities, from the practical point of view, is the setting up of the Technical Committee. This Committee has already had to deal with numerous and varied inquiries. Particularly gratifying, it is said, has been the interest taken in the Association abroad, in the Dominions and Colonies, which has led to several important bodies taking up membership.

We are informed by Dr. Félix F. Outes, Director of the Museum of Anthropology and Ethnography, Buenos Aires, who is well known to students of the prehistory of America for his writings on the stone age and other aspects of the anthropology of South America, that the Council of the Faculty of Philosophy and Letters in the National University, Buenos Aires, has sanctioned the reorganisation of the Museum, which was formerly known as the Ethnographical Museum, in accordance with a scheme submitted by him at the time of his recent appointment as director. The Museum will now consist of four departments: a Department of Anthropogeography, which will be in the charge of Prof. Romualdo Ardissone; a Department of Physical Anthropology and Human Palæontology, of which a director has still to be appointed; a Department of Archæology, of which the head will be Prof. Francisco de Aparicio; and a Department of Ethnography and Folk-lore, to be entrusted to Dr. Alfred Métraux. The incorporation in the Museum of the Institute of Geographical Research will enhance its standing and at the same time place it in charge of a large amount of extremely valuable material. The publications of the Museum are also to be reorganised. In future they will be classified into four categories, of which two will be strictly scientific; one will be devoted to 'diffusion' and one to popularisation in the broadest sense of the term.

THE *Veterinary Journal* for October is a special veterinary physiology number and is also of interest from the aspect of comparative medicine. Articles are contributed by Dr. A. S. Parkes on "The Co-ordination of the Reproductive Processes", by Dr. F. W. Lamb on "The Regulation of the Acid-Base Balance of the Body", and by Prof. J. Barcroft on "Stores of Blood". Dr. Piney writes on the reticulo-endothelial system, and Messrs. Crew, Miller, and Anderson contribute a note on the diagnosis of pregnancy in the mare by the Ascheim-Zondek test, which in man is claimed to give correct results in 97 per cent of cases. A total of 390 equine samples have been examined, of which in three cases only the biological diagnosis did not agree with the clinical evidence.

ONE of the largest of the giant redwood trees (*Sequoia sempervirens*) of California is the so-called Palo Alto tree at the town of that name near the south of San Francisco Bay. It is the subject of a brief historical monograph by Miss A. I. Weymouth ("The Palo Alto Tree": Oxford University Press). The author traces the earliest records of the tree back to the first Spanish explorers of California. In 1769, Gaspar de Portola camped beneath it on his discovery of San Francisco Bay, and there are several later records of the tree. Its age is not known, but in 1777 it was already a large tree with a recorded height of 137·5 feet and a ground circumference of the trunk of 15·1 feet. At present the circumference is 23 feet. Miss Weymouth believes it to be the oldest of surviving trees.

A REPORT of Science Service, Washington, D.C., states that a new method of identification has been suggested by Dr. Thomas Poole, of Washington, which may form a useful supplement to finger print and similar methods. The method makes use of X-ray photographs of the bony cavities or sinuses in connexion with the nose. Examination of thousands of pictures of these sinuses shows that in no two persons are the shapes exactly alike, and that once formed, the bony partitions of the sinus cavities never change. The tissues of the body quickly degenerate and disintegrate after death, but bones do not, so if X-ray pictures of the sinuses have been taken during life, identification would be possible long after death.

THE National Research Council of the United States has reprinted from the July issue of the *Journal of the Acoustical Society of America* the "Bibliography of Acoustics of Buildings" prepared under the auspices of the Committee of the Council in charge of the subject, by the chairman of that Committee, Mr. F. R. Watson. It extends to twenty-nine pages, and the great majority of the papers referred to have appeared in the last five years. In many cases a brief statement as to the contents of a paper is made, which is of great assistance to those who use the "Bibliography". The references are classified under the heads: general, acoustics of rooms, and sound insulation.

THROUGH the generosity of Dr. Henry S. Wellcome, a gold medal has been founded to be awarded annually by the Royal Anthropological Institute for the best anthropological research essay. It is hoped that the first award will be made in 1932. Competition will be open to candidates of any nationality.

THE Third International Congress of Sanitary Technique and Urban Hygiene will be held at Lyons on March 6–9, 1932. As on the two previous occasions, when congresses were held at Prague and Milan, the Congress will be associated with an international exhibition which will be open on March 7–20 during, and in the buildings of, the Lyons Fair. Further information can be obtained from the General Commissary of the Congress, Dr. Garin, Rue Ménestrier, Lyons.

THE British Institute of Radiology, incorporated with the Rontgen Society, will hold its Annual Conference on Dec. 2–4, at the Central Hall, Westminster. In connexion with the Conference there will be an exhibition of apparatus, organised by the Associated Manufacturers. The Conference will be opened by the Right Hon. Lord Rutherford, and Dr. A. E. Barclay will deliver the presidential address. Besides several technical papers, two lectures have been arranged—the fourteenth Silvanus Thompson Memorial Lecture by Sir James Jeans, on radiation, and the twelfth Mackenzie Davidson Memorial Lecture by Prof. Dr. Hans Holfelder, on medical, surgical, and radiological treatments of disease. Cinematograph films illustrating experiments on the inflammability of films (Prof. F. Haenisch) and the effects of radium on living cultivated tissues (Dr. R. G. Canti) will be exhibited. Two discussions have been arranged for the last day of the Conference.

MESSRS. W. Dawson and Sons, Ltd. (Rare Book Department), Pilgrim Street, E.C.4, have just issued a new part (N.S. No. 5) of their catalogue of scientific books and serials. It contains many rarities and should be seen by collectors and librarians desirous of adding to their libraries.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A sub-editor of the *British Journal of Radiology*—The General Secretary, British Institute of Radiology, 32 Welbeck Street, W.1 (Dec. 8). An assistant in zoology at the Queen's University of Belfast—The Secretary, Queen's University, Belfast (Dec. 10). A Geoffrey Duveen Travelling Student in Oto-Rhino-Laryngology—The Academic Registrar, University of London, South Kensington, S.W.7 (Dec. 31). A professor of mathematics at King's College, Strand—The Academic Registrar, University of London, South Kensington, S.W.7 (Jan. 4). A professor of philosophy at the University College of Wales, Aberystwyth—The Secretary, University College of Wales, Aberystwyth (Feb. 1). A professor of zoology in the University of Calcutta—The Registrar, University, Calcutta (March 31).

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Light of Glow-worms.

THE letter by Dr. Ramdas and Dr. Venkiteshwaran[1] on the "Spectrum of Glow-worm" will surely arouse interest in the fascinating subject of animal luminescence and stimulate photophysical research on the phenomenon. The writers note that their worm glowed only by night, could be stimulated by shaking, and that the light was apparently under voluntary control. These details I am able to supplement by other observations, which may be of value to research workers who wish to take up the subject.

In June–July 1919 I had an abundant supply of female *Lampyris noctiluca* L. from Looseley Row, Bucks. Their light was eclipsed immediately in sudden disturbance, presumably causing alarm, but could often be enhanced by concussion and always by nipping the luminous organ; though these displays were relatively transient, being succeeded by the negativism characteristic of 'alarm'. The light emitted by larvæ was more readily extinguished and less easily aroused than that of females.

Dissecting out the ventral nerve-cord, I found that crude chemical stimuli (sodium chloride, caustic soda, common acids) were without effect, but that momentary flashes could sometimes be produced by the mechanical stimulus of nipping the cord. Single induction coil shocks, if sufficiently strong, would produce momentary flashes of light, 'break' seeming more efficient than 'make'. Continuous faradisation produced a brilliant light, but my terminals were impromptu makeshifts without attempt at screening, so that I could not be absolutely sure the luminous organ had been affected by nerve-impulse and not by the current directly. Certainly, an even more vivid effect could be obtained by plunging the terminals into the tail of the insect, near or on the organ. It was possible to suspend the tail in fixative (Zenker's fluid, alcohol, formaldehyde, 5-10 per cent), and to keep the organs glowing by faradisation while fixation gradually took place. This was a very astonishing sight, and I have always hoped for an opportunity to extend these preliminary observations into a serious research. The light of isolated and crushed luminous organs could also be observed under the microscope, perhaps as a result of mechanical stimulation of residual nerves and end-organs, but sometimes in such thin smears that the effect seemed purely biochemical.

I also made up three batches to be kept—(1) in absolute dark, (2) with a little diffuse light during the day, (3) in the fullest light that could be applied at all times, namely, full diffuse daylight all day and a 60 candle-power electric light at about 3 yards at night. There were a dozen worms in each batch. At first all three batches kept the hours then current in the field, beginning to glow at 10–11.0 P.M. and ceasing at 1–4.0 A.M. After about the third day the habits of the illuminated batch began to be deranged, and after four or five days they would only glow at irregular intervals or on stimulus by shaking, which, however, was more uncertain than with normal worms. The other two batches kept their hours well until after about a fortnight, when senility and perhaps starvation began to produce their effects, the totally dark batch being the earlier deranged and producing light by day as well as night. I concluded that external light was probably not needed for storage on the lines of chemical phosphorescence, but necessary to simulate natural conditions; at the same time, there was a remarkable automatic regulation of the hours of light which was not primarily dependent on external illumination, but could be upset by unusual conditions of environment.

MICHAEL PERKINS.

5 Little Cloisters, Westminster Abbey,
London, S.W.1,
Oct. 27.

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[1] NATURE, 128, 726, Oct. 24, 1931

Mercury Line Spectrum in Fluorescence.

IT was found by Füchtbauer[1] that mercury vapour of low density, illuminated by the radiation of a mercury arc, emits all the chief lines of the mercury spectrum in fluorescence. These experiments were extended by R. W. Wood,[2] who found, in accordance with the views of Füchtbauer, that the process is one of stepwise excitation, the mercury atom being raised in the first instance to the $2\,{}^3P_1$ state by absorption of the resonance line, and next to, for example, the $2\,{}^3S_1$ state by absorption of 4358. Emission of the visual triplet $2\,{}^3P_{012} - 2\,{}^3S_1$ then follows. Wood was able to verify this explanation by using an independent source to supply 4358.

No doubt is here expressed that this is in the main a correct account of what happens under the conditions used by these experimenters. I find, however, that when excitation is *by the resonance line alone*, and the other lines from the original source are suppressed by appropriate filters, it is still possible to observe the emission of these other lines in mercury vapour of, say, 2 mm. pressure. Thus a chlorine filter of 40 cm. thickness is absolutely opaque to the lines 3650, 3126, and 2967. Yet these lines are emitted when the vapour is excited through such a filter. Whatever the process may be by which the vapour is raised to the $3\,{}^3D_{321}$ state, it cannot be stepwise absorption, because the appropriate frequencies are not there to be absorbed. It is remarkable that the atom is raised to a level of 8·8 volts, whereas the excitation directly applied is only 4 86 volts.

I find, further, that in a rapid current of vapour the emission of these lines continues, even when the vapour has passed out of the region directly illuminated.

Much further work will doubtless be required to interpret these results. They are probably to be connected with the known ionisation of the vapour by the resonance line.

RAYLEIGH.

Terling Place, Chelmsford,
Nov. 17.

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[1] *Phys. Zeit.*, 21, 635; 1920.

[2] *Proc. Roy. Soc*, A, 106, 679; 1924.

A Connexion between Fluorescence and Free Neutral Radicals.

MODERN physical theories[1] treat the fluorescence of all substances as the re-emission of previously absorbed radiation during the return of a chemical molecule to a stable form from an activated form, possessing a mean free life of 10^{-8} to 10^{-9} second. Since it has been shown that, in any atom, only the outermost, or valency, electrons are concerned in the absorption or emission of light waves of the visible order of frequency, it follows that fluorescent emission is necessarily concerned with the *re-formation of stable valency bonds* (or possibly stable 'lone-pairs' of electrons) from previously activated molecules.

Now, the photochemical activation of such simple molecules as the halogens has been *thought*, by Bodenstein, Franck, and others, to consist in the separation of the diatomic molecule into free neutral atoms of sufficient energy content either to enter into direct chemical combinations with other free atoms or radicals, or alternatively to initiate 'chain reactions'. The halogen atoms are considered to have an exceedingly short mean free life, comparable in duration with that of a molecule which can absorb light energy and re-emit it as fluorescent radiation. Further, energy of an amount approximately equal to that available on the recombination of atoms to molecules (for example, $2I \rightarrow I_2 + h\nu$) is actually emitted as fluorescence by the halogens under favourable pressure and temperature conditions.

It seems reasonable therefore to suppose that this light-energy emission might be associated with the chemical action of recombination of the neutral free atoms to the diatomic molecules. This speculation may be extended to other cases of fluorescence, and perhaps absorption of light by molecules followed by fluorescent emission might in general be concerned with the dissociation of a covalent bond into free neutral radicals, followed by recombination of these radicals once more. The emission of a fluorescence might then indicate that the dissociation of a covalent bond in a molecule had previously occurred.

For the fluorescence produced by cathode rays, the isolated electrons are obviously the equivalent of the free radicals.

Support for this suggestion is afforded by the following considerations:

(*a*) The fluorescence of sodium and mercury vapours is definitely associated with the neutral diatomic molecules Na_2 and Hg_2.[2] These can obviously be produced only by the association of single atoms.

(*b*) Fluorescent inorganic molecules can dissociate into free neutral radicals, as NO.

(*c*) The well-known inhibition of fluorescence by added substances can only be brought about by those compounds (for example, iodide ion or O_2) which can easily lose *an* electron:[1] these same substances also inhibit photochemical reactions by terminating chain processes, and combine instantly with known free radicals.

(*d*) Only certain classes of organic molecules, possessing aromatic ring systems and of unsaturated structure, are fluorescent,[3] and *all these compounds are capable of yielding free radicals* either by dissociation or by addition of the alkali metals (for example, xanthyls, *meso* anthracene derivatives, metallic ketyls, anils, etc.).

(*e*) All aromatic compounds, even if not otherwise fluorescent, give characteristic Tesla luminescence spectra, the seat of which is the aromatic ring, and which, it has already been suggested, is associated with the tautomerism of the valency bonds between the two specific 'Kekulé' phases.[3] Any such isomerisation, however depicted, must involve fission of valency bonds, with subsequent reunion of momentarily existing free radicals.

Other examples of chemi-luminescence seem capable of interpretation in accordance with the above suggestion, which it is hoped to develop further. The author is indebted to Dr. J. T. Hewitt for encouragement in submitting this speculation for publication.

W. A. WATERS.

University Science Laboratories,
Durham, Oct. 14.

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[1] F. Perrin, *Annales de physique*, **12**, 169-275; 1929.

[2] Pringsheim, *Zeit. fur Physik*, **38**, 161; 1926.

[3] Kauffmann, "Beziehungen zwischen physikalischen Eigenschaften und chemischer Konstitution".

Matter: Life: Mind.

BEFORE bio-chemists knew much about the chemical contents of a fertilised ovum, and especially before physicists knew anything about the size of chemical atoms, it was possible to think that the whole of the complication of an adult animal was potentially represented in such a cell. I venture to assert that the fertilised germ cell of a higher animal *in no way* contains potentially represented in it, in terms of the nature and configuration of the chemical atoms, even the outline design of vertebrate anatomy, let alone such details as the marvellous structure of the retina of an eye.

All it can possibly be is the material-to-start-on with which some non-material entity begins the work of clothing itself with a physical duplicate of its own non-material nature. This should be evident since the germ cell begins its development by dividing into two, for which its contents first practically go into solution, so there can be left no possible potential representation of the adult creature it will develop into.

The evidence points to the fact that the *energy* such an entity can exert on the germ cell is very minute compared with the energies associated with physical matter. If so, the entity could only manipulate chemical molecules that are in a state of delicate equilibrium, as is the case in the germ cell. Perhaps it can directly do no more than move electrons that are very lightly held in equilibrium. It could thus move matter only as a driver can move a locomotive, namely, by moving the starting handle.

If this is so, we can see why it is necessary that the physical body should be primarily a 'prime mover', since it must itself develop all the energy (minus perhaps a trillionth part) which the creature puts forth through it.

Biology is thus *not* the 'science of life', but only a study of the prime movers with which, in this world, life has to work through. The science of life is psychology, not biology; and psychology has in recent years seen that its fundamental subject matter is the motives and 'intentions to realise the ends they desire to realise' which living beings possess.

ALBERT EAGLE.

The University, Manchester,
Nov. 11.

PROF. BOYCOTT'S significant suggestion (NATURE, Oct. 24, p. 727) that the 'events of life' may be quantitatively out of proportion to the *perceptible* matter makes plausible the existence of *imperceptible* matter. For if we accept the idea of General Smuts, that matter, life, and mind are three grades of the same thing, we are logically entitled to describe that *same thing* by any of these conventional connotations, which become interchangeable terms denoting different aspects or principles of one 'matter', one 'life', or one 'mind'.

Are not these grades, in effect, the old 'kingdoms' —mineral, plant-animal, and man? And are not their outer distinguishing characteristics due to inner modifications of the *same thing*—a universal electromagnetic activity? If photosynthesis be essential to maintain biological existence, 'energy' and 'life' must be the same thing. Again, energy or motion implies that something is moving, however imperceptible. The polar action in chemical 'affinity' is as mysterious and imperceptible *per se* as the *selective* electromagnetic activity of biological organisms, and no less inscrutable than is the power of selection or choice exercised by means of the human brain. In minerals the polarity is superficially stable, and, therefore, *matter* is prominent; in biological forms the energy-aspect is apparently more active and *life* is more evident; in the human kingdom the selective power functions through a wider gamut than the instinctive intelligence of animals, and *mind* predominates.

As this polar function does not refer to 'size', its matter-aspect must be of a different tenuity than 'matter' so called, and hence imperceptible to us before it is precipitated or condensed into concrete states.

The supposition of an evolution through these grades is as fantastic in the present state of scientific knowledge as the ancient Hermetic axiom, "The stone becomes a plant, the plant an animal, the animal a man, and man a god". Such a process implies interacting *cycles* of evolution producing modifications of the *inner* 'structures' of bodies in the successive grades. The conception of the ancients was that evolution is a progressive functioning of the mysterious polar principle actively *synthesising* more and deeper fields within a single organism. W. W. L.

THE presidential address of Dr. H. H. Dale on "The Biological Nature of the Viruses", in NATURE of Oct. 10, puts clearly one aspect (the pathological one) of substances that may possibly lead to the most notable juncture in contemporary thought. General Smuts—and he is but one of several—adumbrates, in his holism, a synthesis of mental with physical science. The viruses, including as they do the minutest particles to which life is attributed, give promise of leading to such a synthesis. Some appear to be so small that they raise the question whether, in their series, life does not exist in sizes below any protein molecule. This class of questions is at present engaging much attention in America and Germany, and some investigators postulate the hydrogen atom as perhaps a member at the lower end of the series of living things. Dr. Dale, of course, does not consider this point. If such a view should obtain general acceptance, the notable juncture would occur *that the two greatest lines of modern thought—the evolutionary biology of Darwin and the physics of Newton and Faraday—would find a common meeting point in the atom.*

May I presume to mention that I[1] and others have tried to show that directivity and affective feeling are inherent in the processes of evolution. If so, it is fair hypothesis to attribute these to the atom, if ever it is adopted as a member of the series of living things. Dr. Dale, in his acutely logical treatment of the new facts, makes some sound remarks, one of which is: "Let us recognize that the evidence is not perfect, but beware of a merely sterilizing scepticism". (F. d'Herelle, "The Bacteriophage"; Med. Research Council (Gt. B.), "The Viruses"; E. W. Schultz, "The Ultrascopic Viruses", in *Scientific Monthly*, Nov. 1930; H. Busher, "Where Life Begins", *Atlantic Monthly*, July 1930; and authorities cited.) W. D. LIGHTHALL.

McGill University, Montreal,
Oct. 27.

[1] "The Person of Evolution" (Macmillan, 1930), Chaps. iv. and v.

A Two-Dimensional Space Lattice?

ON cooling a warm aqueous solution of dimethylthallium iodide, or on adding a ten per cent solution of potassium iodide, preferably slightly alkaline, to its cold saturated aqueous solution, part of the thallium compound separates on the surface in a regular pattern. Each crystal is equidistant from six others. The size of the pattern varies, being smaller the more rapidly crystallisation is allowed to take place. The effect is not permanent; after about half an hour the arrangement breaks down and the crystals group together in irregular aggregates, which collect at the sides. In a slightly acid solution the regular arrangement breaks down in a few seconds. I should be glad to know if other similar effects are known, and also to be given an explanation which I am unable to supply.

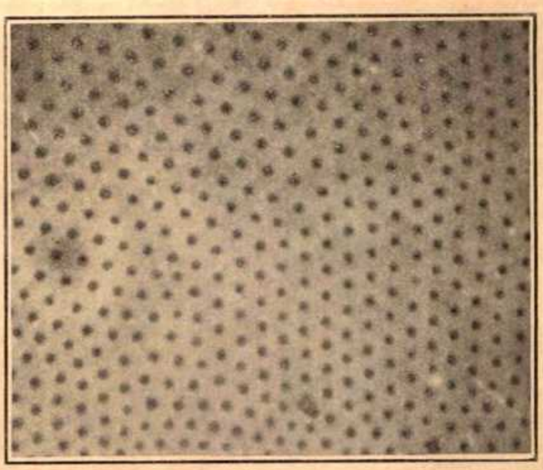

FIG. 1.

Fig. 1 is an enlargement of part of a photomicrograph, kindly taken by Dr. W. J. Elford by focusing on to the surface of a small quantity of the solution allowed to crystallise on a microscope slide.

R. C. MENZIES.

Chemical Department,
The University, Bristol,
Oct. 13.

Coagulation of Colloids by Electrolytes.

ALTHOUGH the impurities present in a colloid considerably modify its behaviour as regards coagulation by electrolytes, the importance of this point is still not sufficiently realised by many workers in colloid chemistry. It has been pointed out by one of us (Desai)[1] that a colloid can be made to show either normal or abnormal behaviour towards the dilution rule, namely, that the greater the concentration of a colloid, the greater the amount of an electrolyte required to coagulate it, by varying the amount of the peptising agent present in the colloid by subjecting it to dialysis.

In a recent note in NATURE we (Nabar and Desai)[2] have shown that in the case of colloidal gold the stability as defined by the flocculation value with KCl goes hand in hand with the charge on the colloid when it is subjected to dialysis. Since then we have made measurements of the charge on colloidal ferric hydroxide dialysed and diluted to different extents in the presence and absence of added electrolytes. The following is a summary of the results:

1. On the addition of increasingly small amounts of KCl and $MgCl_2$ the charge first increases and then decreases, the initial increase being greater with the concentrated sol than with the dilute one.

2. The initial increase in the charge is not noticeable with K_2SO_4, even when it is added in very small amounts.

3. With the progress of dialysis, although the charge

first increases and then decreases, the flocculation value with KCl shows a continuous decrease.

4. The charge increases on dilution of the colloid, the increase in charge of a sol dialysed for 2 days being greater than of one dialysed for 10 days—the dilutions in the two cases being the same.

In a paper which has been sent for publication the above results have been utilised to show that in the case of colloidal ferric hydroxide some of the fundamental assumptions made by colloid chemists in explaining their results of coagulation of colloids by electrolytes, namely, that (1) the charge and stability go hand in hand, (2) the charge continuously decreases with the progress of dialysis, and (3) the applicability of the general dilution rule, are justified. The abnormality in any particular case has been explained as being due to the preferential adsorption of the stabilising ions which may be present in an amount greater than that which corresponds to the maximum in the cataphoretic speed-concentration curve of the colloid with the particular electrolyte.

B. N. DESAI.
P. M. BARVE.

Physical Chemistry Laboratory,
Wilson College, Bombay 7,
India, Sept. 25.

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[1] *Kolloidchem. Beihefte*, **26**, 384; 1928.
[2] NATURE, **127**, 666; 1931.

Application of the Simonis Reaction to Monohydric Phenols.

IN continuation of the work of Robertson, Sandrock, and Hendry[1] on the condensation of monohydric phenols with esters of acylacetic acids by means of phosphoric oxide, the following results have been obtained: *o*-cresol, *o*-chlorophenol, *o*-bromophenol, *p*-chlorophenol, *p*-bromophenol, and β-napthol on submission to this reaction give rise to 1 : 4-pyrones. Compared with polyhydric and with monohydric phenols, the behaviour of *m*-cresol is interesting. On condensation with ethyl acetoacetate in the presence of phosphoric oxide this phenol yields 4 : 7-dimethylcoumarin, but with esters mono-substituted in the α-position 1 : 4-pyrones are obtained, for example, ethyl α-methylacetoacetate gives rise to 2 : 3 : 5-trimethyl-1 : 4-benzopyrone.

In view of the recent communication of Chakravarti[2] on the application of the Simonis reaction to resorcinol (compare Canter, Curd, and Robertson[3]), it may be stated that the proof of the true nature of the products was first described by Canter in a dissertation submitted in 1930 for the degree of M.Sc. of the University of London.

A. ROBERTSON.

London School of Hygiene and
Tropical Medicine,
University of London,
Oct. 10.

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[1] *Jour. Chem. Soc.*, p. 2426; 1931.
[2] *Jour. Ind. Chem. Soc.*, **8**, 129; 1931.
[3] *Jour. Chem. Soc.*, p. 1255; 1931.

Aitken Condensation Nuclei.

INVESTIGATIONS made by Prof. J. J. Nolan[1] and collaborators,[2, 3, 4] as well as Schweidler,[5] Hess,[6] Israel,[7] Wait,[8] and others, point to the importance of the part played by Aitken nuclei of condensation in atmospheric electric processes. It has been shown[2] that some of these nuclei carry single electronic charges, the remainder being uncharged. It has been claimed[2] on theoretical grounds that, under equilibrium conditions, the ratio of charged to uncharged nuclei is substantially a constant.

At the Commonwealth Solar Observatory, situated on Mount Stromlo, ten miles from Canberra, the nuclei have been classified into groups according to their mobilities. To effect this, electrostatic fields have been applied to a current of air passing through a cylindrical condenser and the resultant diminution in nuclei content has been measured with a modification of the original Aitken counter.[9]

Observations, made near the open window of an atmospheric electric hut, gave as a mean of 49 tests:

Nuclei.	Mobility, cm./sec./volt./cm.	Number per c.c.
Intermediate ions[10] N_A .	0·005	975
Large ions[11] N_B .	0·005 – 0·0005	385
Uncharged N_0 .	0·0005	810

Subsidiary tests indicated that the atmospheric small ion did not act as a nucleus in the apparatus, nor did any appreciable fraction of charged nuclei escape precipitation. The results appear to be statistically represented by the equation

$$2N_0 = 1{\cdot}12\ N_A + 1{\cdot}37\ N_B,$$

which does not indicate a constant ratio of charged to uncharged nuclei. The form of this equation was derived theoretically on the assumption that the uncharged nuclei were of two grades, N_{α} and N_{β}, the former giving rise, by combination with atmospheric small ions, to intermediate ions N_A, and the latter to large ions N_B. It has been assumed that the small ions were the agents in distributing the charges amongst the nuclei, and any action of the intermediate and large ions was negligible. The above equation indicates that on the average the specific rate of the combination of the N_A nuclei with small ions of opposite sign is 1·12 times greater than that of the small ions with the N_{α} nuclei, whilst for the $N_B : N_{\beta}$ equilibrium the corresponding value is 1·37. The average ratio of $N_{\alpha} : N_{\beta}$ deduced from these observations is 2 : 1.

Comparison of the N_A counts obtained by the Aitken counter with ion counts given by a Wulf unifilar electrometer attached to a cylindrical condenser indicates that the N_A group of nuclei carry single electronic charges. The mean of twenty observations gives the charge as $1{\cdot}0 \pm 0{\cdot}04$ electronic units.

Further work is proceeding in order to discover whether an equilibrium exists between N_{α} and N_{β}.

A. R. HOGG.

Commonwealth Solar Observatory,
Mount Stromlo, Canberra, F.C.T.,
Australia, Sept. 15.

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[1] NATURE, **113**, 493; 1924.
[2] *Proc. Roy. Irish Acad.*, **37**, 1; 1925.
[3] *Proc. Roy. Irish Acad.*, **38**, 1; 1928–29.
[4] *Ger. Beit. zur Geophys.*, **25**, 414; 1930.
[5] *Wien. Ber.*, IIa (**133**), 29; 1924.
[6] *Wien. Ber.*, IIa (**138**), 169; 1929.
[7] *Ger. Beit. zur Geophys.*, **26**, 283; 1930.
[8] *Terr. Mag.*, **36**, 111; 1931.
[9] *Proc. Roy. Soc. Edin.*, **38**; 1890–91.
[10] J. Pollock, *Phil. Mag.*, **29**, 514 and 636; 1915.
[11] Langevin, *Compt. rend.*, **140**, 305; 1907.

The Relativistic Opacity Coefficient.

THE recent paper of Prof. Milne[1] on "The Analysis of Stellar Structure" has excited great interest, and several papers by various investigators have appeared on the subject. The knowledge of the opacity coefficient for the different physical states in which matter can exist in the stellar interiors is of importance in these developments. The value of the opacity coefficient for the non-relativistic non-degenerate case was first worked out by Eddington following Kramers' treatment of X-ray absorption. The non-relativistic degenerate case has been recently treated by several authors.

The present note attempts to evaluate the opacity coefficient for the relativistic case. It is to be mentioned here that such a calculation has now been possible from the recent work of Hall and Oppenheimer,[2] and Sauter.[3] Following them the absorption coefficient works out to be in the case of Free-Free transitions

$$K_\nu = \frac{1{\cdot}9 \times 10^{-22} z^3 h^2 ckT}{2m\pi^2 e^4 \nu} \, \frac{e^{h\nu/kT}}{e^{h\nu/hT} - 1} \log \frac{1 + A}{1 + Ae^{-h\nu/kT}}$$

where A is the degeneracy discriminant and the rest of the symbols have their usual meaning.

When $A << 1$, $K_\nu = \frac{1{\cdot}9 \times 10^{-22} z^3 h^5 c^4}{32m\pi^3 e^4 k^2 \nu} \frac{n}{T^2}$, and taking the mean after Rosseland the opacity coefficient is

$$K_2 = \frac{1{\cdot}9 \times 10^{-22} z^3 h^6 c^4}{160m\pi^3 e^4 k^3} \, \frac{n}{T^3}$$

n denotes the electron concentration.

When $A >> 1$, $K_\nu = \frac{1{\cdot}9 \times 10^{-22} z^3 h^3 c}{2m\pi^2 e^4} \, \frac{e^{h\nu/kT}}{e^{h\nu/kT} - 1}$,

and $$K_2 = \frac{1{\cdot}9 \times 10^{-22} z^3 h^3 c}{2m\pi^2 e^4}.$$

For comparison, all the cases are tabulated below. The numerical calculations have been made for the coefficient of opacity K_2 referred to per gram of the material composed of fully ionised iron atoms (μ, mean molecular weight $= 2{\cdot}1$). ρ represents the mean density ($\rho = \mu m_H n$).

State of Matter.	Non-Relativistic.	Relativistic.
Non-degeneracy .	$3{\cdot}6 \times 10^{23} \frac{\rho}{T^{7/2}}$	$1{\cdot}1 \times 10^{21} \frac{\rho}{T^3}$
Degeneracy . .	$4{\cdot}7 \times 10^{16} \frac{1}{T^2}$	0·34

It will be seen that the above calculations are only a first approximation. The detailed paper will be published elsewhere.

R. C. Majumdar (Jena),
D. S. Kothari (Cambridge).

Universitat-Sternwerte,
Jena.

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[1] Milne, *M.N.R.S.*, **91**, 4; 1930.
[2] Hall and Oppenheimer, *Phys. Rev.*, **38**, 57; 1931.
[3] Sauter, *Ann der Phys.*, **11**, 454; 1931.

National Needs.

The writer, H. E. A., of the leading article under this caption in Nature of Nov. 14 once more summons scientific workers to do something about public affairs, and to do it quickly. We are to "become militant without delay and in every quarter".

This is most stimulating; but what, precisely, are we to do? There is not a single major issue of statesmanship on which the scientific profession can speak with one voice. A very pertinent example relates to the "wise socialism" which H. E. A. evidently regards as a crucial necessity for mankind. Some scientific workers are socialists—not only 'wise', but *sans phrase*; while others are liberals or conservatives—non-socialists and anti-socialists of unimpeachable respectability.

What can we, as a profession, achieve in the world of statesmanship in face of such radical disagreement amongst ourselves? Even on comparatively trivial issues such as the Dyestuffs Act and the university franchise the profession was notoriously divided. Science is as ambiguous politically as the Christian faith.

Nevertheless, I believe that science has a contribution to make to political life over and above the indirect results of its material discoveries. That contribution is not a policy. It is an intellectual method and a temper of mind. For example, a sufficient acquaintance with scientific method might induce people to think quantitatively about public affairs. It would then be impossible for politicians to talk the sort of rubbish about the pound sterling which most of them talked during the recent election.

The scientific worker, who knows better than anyone else what the method of science means and how successful it has proved, is more concerned than anyone else to see that a due appreciation of that method is part of the cultural equipment of the citizen. This can only be brought about through a new kind of scientific education, differing from the current type in having a definite social and political reference. If he would create and sustain such an educational movement, even at some cost to himself, he would deserve still better of his generation than he does to-day.

But this can no more be described as becoming "militant without delay and in every quarter" than can the efforts of an acorn to grow into an oak.

Louis Anderson Fenn.

545 Church Road, Yardley,
Birmingham,
Nov. 15.

Derived Early Mousterian (Levalloisian) Implements in the Melt-water Gravels of the Coombe Rock Glaciation.

Recently in these columns[1] I directed attention to the occurrence at Greenhithe, Kent, of flint implements of Upper Palæolithic facies in association with fragments of coarse pottery on an occupation-floor situated some twelve feet below present-day ground-level.

This 'floor' rests upon coarse gravel which overlies Coombe Rock. Both at Greenhithe and elsewhere in the locality I have since recovered from the coarse gravel (the melt-water gravels of the Coombe Rock glaciation) a series of rolled and patinated artefacts of Early Mousterian (Levalloisian) age, consisting chiefly of flakes with faceted butts and tortoise-cores. These specimens will be fully described and illustrated on a future occasion.

The deposits capping the horizon of the occupation-floor are shown on the Geological Survey Map (Sheet IX. N.E. Kent. Scale 6″ to 1 m. geologically surveyed 1920 by Mr. C. E. N. Bromehead) to be "Coombe Deposits", which on page 3 of the Survey Memoir on Dartford (1924) have been classed as "Pleistocene".

Two of my excavation-sites coincide with points specifically detailed by the Survey as:

(1) "10 to 12 feet Brickearth"
and (2) "2 to 12 feet Brickearth".

Thus, what I described as stony loam with 'rafts' of Coombe Rock, brickearth, and sand has been mapped by the Geological Survey under the comprehensive term—Brickearth.

It is of significance that the stony loam of Danes' Dyke, Flamborough Head, Yorks, described by Lamplugh as late-glacial,[2] which I have shown to contain derived artefacts of Upper Palæolithic types, has an officially recognised Pleistocene counterpart in the Thames Estuary.

J. P. T. Burchell.

30 Southwick Street,
Hyde Park, W.2,
Nov. 9.

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[1] Nature, Sept. 26, p. 548.
[2] *Quart. Jour. Geol. Soc.*, vol. 47, p. 410; 1891.

Research Items.

Central Wyoming Pictographs.—Dr. E. B. Renaud of the University of Denver, in a special investigation report to Science Service of Washington, describes two series of pictographs in Central Wyoming not previously visited by archæologists. On a prairie trail 15·5 miles south of Moneta and 77 miles west of Casper numerous pictographs were found on much eroded sandstone cliffs, extending over a district about a quarter of a mile long. The most curious, and in fact unique, pictographs are shields or circles, mostly coloured, the principal shades still discernible being a strong green, a pale orange, and a purplish red. These disks are sometimes grouped in panels of ten or twelve. They represent conventional designs, human and animal figures, usually one in each circle or two or three, one being central and the other two smaller and artistically distributed, or arranged in quarters. For various reasons they cannot have been made less than two hundred years ago, and are perhaps older. In addition to the coloured type of circular pictographs there are many incised figures of men, animals, and conventional designs of the more generally known type of petroglyph. Some are isolated; more often they are grouped in panels. They may be more recent than the coloured pictographs. Among the animals represented are deer or elk, buffalo, antelope, small quadrupeds, others not identifiable, snakes and birds. The turtle is usually coloured, and never appears except on circular pictographs. This is an animal at present non-existent in the region. There are several styles of anthropomorph. One has pointed shoulders and the sexual parts are emphasised; the other, which is rarer, represents human figures with a bigger round face or head, no shoulders, and neck as broad as the body, which is rectangular. The arms are uplifted as in worship. A third type has shield and lance and recalls the type of Sand Creek, south of Laramie. A second group of pictographs, 19 miles south-east of Lander, consisting of realistic figures of men and animals, was also visited.

Marugin Warfare.—Warfare among the Marugin and surrounding tribes of north-east Arnhem Land is described by Mr. W. Lloyd Warner in *Oceania*, vol. 1, No. 4. It is one of the most important of social activities, and without it Marugin society as now constituted could not exist. There are six distinct varieties of warfare, and each has a distinctive name. In an additional form only the women participate. They are (1) a fight within the camp; (2) a secret method of killing; (3) a night attack in which an entire camp is surrounded; (4) a general open fight; (5) a pitched battle; and (6) a ceremonial peace-making fight, which is in part an ordeal. The first is the most frequent, but seldom results in a killing; while the pitched battle, although there have been two only in the last twenty years, has accounted for the death of twenty-nine men. The weapons used are the wooden or stone-headed spear, the throwing stick and the club. No shields are used, the throwing stick serving its purpose. White clay is used as war-paint. The most frequent causes of warfare are the desire to avenge the death of a relative; next, the stealing of a woman; then comes killing by black magic and ritual offences against a clan, such as the illegitimate assumption of a totem emblem, an insult to the clan to which the emblem properly belongs. The underlying principle is that of reciprocity, to inflict on the enemy clan a loss similar or identical with that which has been suffered by the attacking clan. Another belief centred around killing, and a frequent cause of war, is that the spirit of the dead man enters the body of the killer, giving him double strength and actually increasing his bodily size. Hence young men who wish to gain strength go out and kill. The women's fights are frequent. Occasionally more than two women are involved. The weapons used are the ironwood digging-sticks, and bloodshed is always a result.

The Pigmy Right Whale (*Neobalæna*).—In 1890 there were recorded the occurrences at various times of three individuals of this species, limited in distribution, on South Australian coasts, but although the recorder, A. Zietz, stated that photographs and measurements had been taken, no further details were given. The old MS. records and photographs have been hunted out by H. M. Hale, and appear in the *Records of the South Australian Museum* (vol. 4, No. 3, p. 314, 1931). Two of the specimens were males, 9 ft. 1 in. and 11 ft. 2 in. long respectively. Instead of 43 vertebræ, one specimen had 41, another 40, and in one, in place of the typical two lumbar vertebræ, there were three. The longest plate of baleen measured 200 mm. The third skeleton is in the museum at the University of Cambridge. In the 11-foot specimen the small intestine, from pylorus, was 132 feet long, and the large intestine, including 6 in. cæcum, 5 ft. 6 in. The photographs show well the curious elongated body of this rare animal.

A Nematode Parasite of a Lucanid Beetle.—J. R. Christie and B. G. Chitwood contribute (*Jour. Wash. Acad. Sci.*, vol. 21, No. 15, 1931) observations on the life-history of *Chondronema passali* (n. gen.), a nematode which occurs in large numbers in the body cavity of a lucanid beetle, *Passalus cornutus*, common in the eastern States of America. Nearly every beetle examined was infested with large numbers (500-1000) of the worms in various stages of growth; of the relatively few grubs examined about one-fifth were infested. A description is given of the youngest larvæ, about 0·4 mm. long, found in the body cavity and of the last stages found there, which are easily distinguished as males and females, about 3·3 mm. and 3·9 mm. long respectively. In the youngest stages the genital primordium is composed of a large anterior cell and three slightly smaller posterior cells, and an anterior cap cell was present; the subsequent stages of growth of this primordium are briefly described. The parasites enter the beetle as very young larvæ, being probably taken in during the act of feeding; it is suggested that the beetle swallows a female worm with its contained young. The larvæ moult once while inside the parent worm, and another moult probably takes place soon after emergence from the host. The method of exit of the worms from the beetle was not ascertained. *Chondronema* is related to *Atlantonema* and *Tylenchinema*, but is differentiated from all related genera by the fact that the vulva, if it functions at all at the time of copulation, becomes vestigial; it never serves for the extrusion of eggs or larvæ. The larvæ remain parasitic until full grown and the adults are free living.

The Auditory Region in Certain Extinct Mammals.—In the *Bulletin of the American Museum of Natural History*, vol. 62, 1931, Dr. van der Klaauw gives an account of the auditory region as observed in a wide series of extinct mammals, preserved in various collections in the United States. This section, however, forms a comparatively small proportion of the whole paper, not being more than some thirty out of 350 pages. The bulk of the work is devoted to what the author terms a " review of the tympanic region ", in which he treats, in considerable detail, a great number of questions arising out of an examination of the ear region in general of mammals, living as well as extinct. While there is no summary of results, there is a mine of useful information in the body of the work and a full citation of the literature.

Frost Injury to Plants.—It is natural that the *Canadian Journal of Research*, vol. 5, July 1931, should contain papers upon this subject of very live interest to the Canadian community. R. Newton and W. R. Brown, of the University of Alberta, conclude that dehydration is the basic cause of first precipitation of plant proteins rather than the pressure of the ice crystals, as suggested by Maximow. An exposure of five hours at − 7° C. caused maximum precipitation of the proteins of the expressed juice from the leaves of unhardened winter wheat grown in the greenhouse. Sucrose added to the juice acted as a protection against the precipitation; its protective value increasing with concentration up to 8 per cent, a value often attained by hardy varieties of winter wheat in the field. Similarly, sugar protected the proteins against precipitation by acids, bases, or 'salting-out'. This action of sugar seems to be of very considerable significance, although its explanation still remains obscure.

The Melting of Glaciers.—In a note written for Science Service (Aug. 26, 1931), Dr. W. J. Humphreys, of the U.S. Weather Bureau, discusses the melting of glaciers. It is often said that glaciers limit themselves to a moderate thickness because their own weight continually melts them at their base at a rate that increases with the load. He points out that though the melting point is lowered by pressure, an increase of pressure on the bottom layers does not enforce rapid melting, and would not do so, except briefly and to a small extent, even if the initial temperature there were exactly at the melting point. This is because melting requires the supply of much heat, and the very act of melting automatically cools the ice, the further melting of which is controlled entirely by the rate of supply of heat. At the bottom of a glacier even 10,000 feet thick the melting point would only be 4·12° F. below the normal value. In the case of a thick ice sheet, the supply of heat for melting must come almost solely from the earth below, and this is enough to melt only about a quarter of an inch of ice in a year. Thus the limiting thickness of glaciers must be determined mainly not by melting due to excess pressure but by other causes, such as horizontal flow, surface melting, the removal of surface snow by winds, and the reduced precipitation at high levels.

Mixing of Warm and Cold Saturated Air.—The *Memoirs* of the Imperial Marine Observatory, Kobe, Japan, contain papers in English on a variety of scientific subjects, including meteorology. In vol. 4, No. 2, there is a paper dealing with what is, strictly speaking, a problem of ordinary physics, but it is a problem of fundamental importance to meteorology. It is by K. Hidaka, and is entitled "On Mixing of Warm and Cold Saturated Air". The author follows the methods of Von Bezold for calculating the results of such mixing, according to which the two masses are first supposed to mix without condensation so as to give a supersaturated mixture, and then to begin to condense water with liberation of latent heat. This heat, of course, raises the temperature of the mixture. The problem is far from being so simple as might at first sight be supposed, owing to such complications as arise, for example, from freezing or melting of ice, the effect of pressure on the freezing point, and variations in the specific heat of moist air in accordance with the amount of water vapour therein. These are treated mathematically, the final result being a valuable set of tables giving at three different atmospheric pressures (1) the final temperature, (2) the amount of water vapour in 1 kilogram of the mixture at the final temperature, and (3) the amount of water condensed per kilogram, when 1 kilogram of air at temperature t_1° C. is mixed with 1 kilogram at t_2° C., t_1 and t_2 being taken for 5° steps from − 30° C. to + 30° C. The pressures to which these figures apply are those corresponding with 760 mm., 700 mm., and 600 mm. of mercury under standard conditions (0° C. and latitude 45°). The author proposes to deal in due course with the problem of calculating the results of an admixture of equal volumes instead of equal masses of air at different temperatures.

Changes of Intensity in the Hyperfine Structure of Lines.—A number of discrepancies have occurred in the descriptions of the hyperfine structure of spectra, different observers finding in some instances different structures for the same line. When it has not been possible to explain this by self-absorption, it has usually been inferred that some flaw in technique has existed. An investigation of certain lines of cadmium which is described by H. Schüler and J. E. Keyston in the issue of the *Zeitschrift fur Physik* for Sept. 3 now shows that the effect may be real. The lines studied were found to exhibit a difference in the intensities in their hyperfine structures according to the part of the source of light, the spectrum of which was photographed. The line at λ5086, for example, could be produced with either two or three components, the relative intensities in the pair of lines common to both cases being reversed when the third was present. Self-absorption of the light in the source is believed not to be the cause of these changes, and their origin remains completely unexplained. Whatever it may be, however, it has evidently to be taken into account in the investigation of isotopes by this method, and it is remarkable that the hyperfine structure, which is due to the quantised spin of the atomic nucleus, should be so easily influenced by causes external to the atom.

Collision Properties of Protons.—Some measurements of the mean free paths of protons, which are described by C. Ramsauer, R. Kollath, and D. Lilienthal in the *Annalen der Physik* (vol. 18, p. 702), compare in an interesting way with the results for slow electrons. With both types of particles, the mean free path changes considerably with velocity; for protons, there is a maximum in the curve showing the mean free path as a function of the velocity of the proton for four of the five gases studied (argon, nitrogen, hydrogen, and neon), and possibly also for the fifth (helium). The maximum moves to greater velocities with increase in the ionising potential of the gas through which the protons are passing, and at the maximum the mean free path is greater than its kinetic theory value, being four times as large for nitrogen, eight times for neon, and still larger for helium. For greater velocities, the mean free path again decreases, becoming, at least for the diatomic gases and argon, less than its kinetic theory value, but with argon it then passes through a minimum, and there are signs that this will also occur at higher velocities with some of the other gases. The maximum and minimum also occur with electrons passing through argon, but there is no obvious close correlation between the electron and proton curves. The energy of the proton at maximum and minimum points is much greater, and its de Broglie wave-length much smaller, than the corresponding quantities for the electron, only the linear velocities being of the same order of magnitude. The protons were produced for most of the experiments by bombarding a piece of impure metallic lithium with electrons, and were rendered homogeneous in speed and separated from other ions by magnetic sorting after acceleration in an electric field.

Oxidation of Ethylene.—The slow oxidation of ethylene was studied by Bone and R. V. Wheeler in 1904, who found that formaldehyde was produced as an intermediate product, and Blair and T. S. Wheeler in 1922 showed that acetaldehyde was an oxidation product, in one case half the ethylene oxidised being converted to this product. In two papers in the October number of the *Journal of the American Chemical Society*, Lenher describes extensive experiments on the slow thermal oxidation of ethylene in various types of apparatus. The reaction is mainly homogeneous and of the chain type, the velocity being dependent on the third power of the ethylene concentration and practically independent of oxygen, in agreement with experiments of Thompson and Hinshelwood in 1929. Among the products of reaction at high temperatures and short times of contact, with high ethylene concentrations, is propylene, so that oxygen can activate ethylene to undergo polymerisation. Oxidation products include ethylene oxide and formaldehyde formed in the early stages of the oxidation, and preceding the appearance of acetaldehyde, dioxymethyl peroxide, formic acid, carbon oxides, and water. Hydrogen peroxide is formed in the reaction, probably giving, with formaldehyde, the dioxymethyl peroxide. The paper contains a concise scheme of the mechanism of the oxidation of ethylene, which is obviously much more complex than has previously been supposed.

Synthesis of Anthocyanins.—The *Journal of the Chemical Society* for October contains eight papers by Robinson and several co-workers on the synthesis of anthocyanins. It had previously been shown by synthesis that callistephin chloride is 3-β-glucosidyl pelargonidin chloride, and the first of the present papers deals with the synthesis of 3-β-glucosidyl cyanidin chloride by an analogous method, and the proof that it is identical with chrysanthemin chloride, the latter being probably the same as asterin. The results involve the attribution of the 3-bioside structure to mesocyanin, kerocyanin, and prunocyanin, whilst cyanin is regarded as cyanidin 3 : 5-diglucoside. The second paper describes the synthesis of the four isomeric β-glucosides of pelargonidin chloride. Pelargonenin chloride, the product of the partial hydrolysis of pelargonin, is pelargonidin chloride 5-glucoside. Although pelargonin yields pelargonidin-5-glucoside on hydrolysis, and it might be concluded that the anthocyanin is a pelargonidin 5-bioside, the evidence seems to show that the position 3 does not bear a hydroxyl group. Ferric chloride in dilute solution gives with compounds containing hydroxyl in position 3 a fugitive colour, whilst compounds with hydroxyl in position 3 absent or modified give a relatively stable colour. In the third paper the synthesis of œnin chloride, from the skin of purple-black grapes, is described, and the substance is shown to be identical with 3-β-glucosidyl malvidin chloride. Succeeding papers deal with the syntheses of oxycoccidin chloride (one of the pigments of American cranberries), which is shown to be 3-β-glucosidyl-peonidin chloride; of 3-β-galactosidyl chloride, believed to be identical with idæin chloride from the cranberry, and the corresponding derivative of peonidin chloride; and of fisetinin chloride, which has alkali colour-reactions very similar to those of cyanin chloride, thus supporting the constitution of the latter advanced in the first paper. The colour-reactions of fisetinidin and luteolinidin are described, and the evidence is completed for the 3-5-diglucoside constitution of pelargonidin, cyanin, and malvin. The 5-glucoside and 5-lactoside of hirsutidin were prepared, the latter being the first diglucosidic synthetic anthocyanin obtained.

Astronomical Topics.

The Leonid Meteors.—There was no very grand display of these meteors, but a report from Mr. J. P. M. Prentice, of Stowmarket, Suffolk (who is director of the B.A.A. Meteor Section), states that he saw thirty-nine Leonids, of which fifteen were of the first magnitude, between $0^h\ 40^m$ and $3^h\ 30^m$ on the morning of Nov. 17; he thinks that the shower was increasing in strength, so we may hope for more complete reports from North America, where there is an active meteor section under the leadership of Prof. Olivier.

The Rev. W. F. Jameson, of Willesden Green, saw a bright Leonid on Nov. 16 at $11^h\ 45^m$ P.M. Mr. Prentice also saw a stray Leonid at $3^h\ 50^m$ A.M. on Nov. 14. Some of them have been dispersed to a considerable distance from the main stream.

It is to be feared that the odd quarter-day in the year will bring the rich display into daylight in 1932. This is not certain, however, as the time may be considerably modified by perturbations.

The Faint Outer Satellites of Jupiter.—Prof. M. Wolf notes in *Astr. Nach.*, No. 5819, that an object which he reported last December as a new minor planet (1930 *YC*) proved to be the satellite Jupiter VI. He gives positions of it on six days last winter, extending from Dec. 19 to Feb. 9. He also found images of Jupiter VIII on the plates of Dec. 19 and 20. He made an extended search for Jupiter VII, but without success; he has not been able to find any observations of this satellite for several years, so it appears to be lost. It will be remembered that Jupiter VIII was lost for many years, until the careful calculations of Prof. Numerov led to its recovery.

It would seem desirable to have some definite plan of observation of these faint satellites, such as has been arranged for the minor planets. This would diminish the chance of their getting lost to observers.

Nagata's Comet.—Although this comet passed its perihelion five months ago it has brightened up unexpectedly, and displayed a short tail on some photographs taken by M. F. Quénisset in October. It has remained low in the evening sky ever since its discovery, but has been assiduously observed in many countries though not in England. The late observations seem to indicate clearly that there is appreciable deviation from parabolic motion, and that the period does not exceed a few centuries. A search through the catalogues has not revealed any comet likely to be identical with it. The comet of 1804 has a distant resemblance, but not close enough to suggest more than the possibility that both were derived from a single parent comet. That comet passed near the earth, and its orbit is known with considerable precision.

No fewer than nine periodic comets are due to pass perihelion in 1932; six of these (Grigg-Skjellerup, Borrelly, Neujmin (2), Brooks (2), Kopff and Faye) were observed at their last return, so that their positions should be accurately known. Ephemerides including perturbations by Jupiter, and in some cases those by Saturn also, are contained in the "Handbook of the British Astronomical Association for 1932".

The Hakemite Tables of Ebn Jounis.

By J. H. REYNOLDS.

ON Nov. 8, 1929, the last occasion on which the late Dr. Knobel attended a meeting of the Royal Astronomical Society, he presented to the Society a rare copy of the Hakemite Tables of Ebn Jounis, translated by "Citoyen" Caussin, professor of Arabic in the College of France, An XII de la Republique (= A.D. 1804). This valuable and interesting book throws a strong light on the high standard of accuracy in observation which had been reached by the Arab and Egyptian astronomers. At the time the tables were compiled (*circa* A.D. 1000) the semi-barbaric European nations were seldom at peace, either internally or externally, and all learning had suffered grievously from civil disturbances and the neglect and ignorance of the ecclesiastical foundations. In the Near East at that time astronomy and mathematics were considered to be an intrinsic part of the education of Mohammedan princes, and astronomers were therefore often attached to their courts. It is true that astrology and prognostics were the *vera causa* of this princely interest in the majority of cases, but that did not make the observational work of the Arab astronomers any less valuable in the ultimate event.

The original Arabic MS. from which the translation was made was, and still is, in the library of the University of Leyden, and it was lent to the Institut de France by the Dutch Government of the time. There is no record of how it came into the possession of the University of Leyden, but it was undoubtedly a copy of the original MS., transcribed about seven hundred years ago. There were several copies of the work originally in the library of the Alhazar University in Cairo, and it is possible that the Leyden MS. may be part of one of these, as many of the MSS. of the library were scattered and destroyed in the repeated conquests and sackings of Cairo in the Middle Ages. Caussin was of the opinion that the Leyden MS. contained about half of the original observations made by Ebn Jounis, and that there were two volumes.

Besides a long preface, the whole work originally contained eighty-one chapters, the title of each being given in the introduction. The twenty-second chapter is the last which appears in the Leyden MS., so the greater part of the work is unfortunately totally lost to us. The titles of some of the chapters sound sufficiently modern: for example, Chap. iii., On mean time and true (solar) time—how to convert one into the other, and different methods employed by various authors of tables; Chap. x., On chords of a circle, on sines, and how to use them in calculating from the tables; Chap. xi., On the obliquity of the ecliptic, on the dimensions of the earth's shadow, and tables relative thereto; Chap. lxxvii., On radiation from the stars, according to general opinion. Other chapters introduce us to matters which, fortunately, do not affect us to-day: Chap. xv., On arcs diurnal and nocturnal; on fractions of the hour by day and night; on equal and unequal time. Chap. xvi., On the twelve houses of the sun. Chap. lxxxi., On the revolutions of the years of the earth, and on nativities.

Caussin's translation only includes the introduction and the fourth, fifth, and sixth chapters, so there is still ample work to be done in the way of translation by Arabic scholars.

An Arabic MS. in the French Bibliothèque Nationale contains the tables of the sun and moon by this author, amongst various tables taken from the works of the other astronomers. These tables form part of a work entitled "Al zij Almosthal ali", which seems to have been composed in the fourteenth century of our era. Caussin remarks: "Le titre encore plus récent qui est à la tête, l'attribue à Ebn Jounis, apparemment pour lui donner plus de prix. C'est une supercherie dont les Orientaux se servent quelquefois vis-à-vis des Européens qui achètent des manuscrits sans les lire".

Ebn Jounis came of an ancient Arab-Egyptian family. Like many of his contemporaries, he was something of a poet and a musician, as well as an astronomer. The date of his birth is unknown, but he died on May 31, 1008. There seem to have been two editions of his astronomical tables, one written about 990, in the reign of the Caliph Aziz, to whom it was dedicated, and the second, a corrected and extended series of observations, being written in the reign of his son Hakem, and dedicated to him, whence the title of the Hakemite Tables is derived.

Ebn Jounis's observatory was on a rocky spur of the Mokattam Hills near Fustat (Old Cairo), at a place called Birket Alhabash, originally a reservoir on the east side of the Nile, afterwards turned into a garden. This was probably near the old aqueduct to the citadel built by Nasir in 1311, parts of which are still standing.

In one of the Arabic texts there is mention of observations at 'Holwon', to which Caussin adds the following note: "Holwon, quelques lieues au-dessous du Caire, sur le bord oriental du Nil". This is without doubt the present town of Helwân, near which the modern observatory was erected in 1904 under the supervision of Sir Henry Lyons.

Ebn Jounis presupposed in the table a knowledge of Ptolemy's work, and his first aim was to assemble all that related to practical observation, calculation, and the use of tables. His ultimate object was to correct the tables current in his time, and his own observations were therefore of great assistance in the new tables. A quarter of the MS. is devoted to the chronology of the *Hegira*, and is omitted in the French translation, as it is comparatively unimportant. The commencement of the preface is worth translation and reproduction here:

"In the name of Allah, the compassionate, the merciful! The study of the heavenly bodies is not unconnected with religion. By this alone can be known the hours of prayer; the time of sunrise, when he who observes a fast should abstain from drinking and eating; the end of the evening twilight, the term of vows and religious obligations; the time of the eclipses, of which a man should be forewarned, so that he may prepare himself with the special prayer proper for such an occasion.

"The same study is necessary for turning in prayer always towards the Kaaba (Mecca), for determining the commencement of the months, for knowing certain doubtful days, the time for seeding, the budding of the trees, the picking of fruits, the position of one place with regard to another, and for journeying in a definite direction without straying.

"The movement of the heavenly bodies being thus allied to many divine percepts, and the observations made in the time of the Caliph Almamoun [at Bagdad] being already out of date, and containing errors similar to those made aforetime by Archimedes, Hipparchus, Ptolemy, and others, our Lord and master the Commander of the Faithful Abou Ali Almansour al imam al hakem bams Allah (May God bless him, his virtuous ancestors, and his noble descendants), has ordered me to observe anew the heavenly bodies whose movement is more or less in accord, and many of those whose progress is slow compared with the existing tables.

"First of all I assured myself of the excellency of the instruments with which I made my observations. I constructed them with greatest care, and divided them with the finest accuracy I could command. I spent much time in examining them and verifying their divisions. I compared them one with the other to assure myself of their reliability; and when I had found with certainty the places of the planets, I used, in order to determine their mean motions, the observations of the ancients, since it is in this way alone that such a correct determination can be made."

The principal instruments used by Ebn Jounis were the armillary sphere and the azimuth circle. The larger the diameter of these, the greater the accuracy with which they could be divided. Unfortunately, no details are given as to their dimensions and construction, so we have to fall back on descriptions of such instruments constructed at Cairo after the death of Ebn Jounis and contained in Caussin's notes.

The armillary sphere was a series of rings, the outer and principal one representing the meridian. Then came a movable declination ring pivoted on the poles, containing on its inner edge two other pivots 23° from the poles, and on these pivots were fixed two other rings at right angles to each other, representing the ecliptic and colures. Still another sliding inner ring with sights at the ends of a diameter enabled readings to be taken both in latitude and longitude. These were made up to 2 ft. in diameter and probably more, as the azimuth circle constructed by the order of Alfadel a hundred years later was 200 inches in diameter.

Numerous references are made in the introduction and Chap. iv. to the "Verified Table". This table was compiled by order of the Caliph Almamoun at Bagdad about fifty years before Ebn Jounis worked out his own Tables. Several astronomers were engaged in this compilation, the principal being Jahia ebn Aboumansour. An Arabic MS. of this Verified Table was, and presumably is now, in the library of the Escurial.

Ebn Jounis devotes the whole of Chap. iv. to a comparison between recent observation and calculation by the Verified Table, especially with regard to eclipses of the sun and moon. He was specially critical of tables of the sun's longitude, which he found to be largely in error. He points out that the armillary sphere of Jahia ebn Aboumansour was only divided to 10′ of arc, and was not, therefore, of the accuracy required for close determinations of the sun's place. As an example of the refinement of accuracy attempted by the Arab astronomers, Ebn Jounis cites results obtained for the mean motion of the sun in a Persian year of 365 days. The sons of Moussa ebn Shaker at Bagdad gave this as 359° 45′ 39″ 58‴ 2⁗! The division of the second into sixty thirds, and that again into sixty fourths, and on occasion even to fifths, must come as a great surprise to present-day astronomers, for a fifth was only equal to 0·0004″, a quantity representing less than probable instrumental error even to-day. Of course, the figures given were simply obtained by continuing division.

A list of conjunctions of the planets with each other and with the 'Lion's Heart' (Regulus) are given with considerable detail. One observed by Habash at Bagdad on Oct. 10, A.D. 864, was that of Mars and Venus in Virgo, so close as to appear one planet. "We have obtained their conjunction in this manner in the table Alshemashia by adding to the epicycle of Venus, and to the mean motion of the sun in the table 4° 30′; next deducting from the epicycle of Mars 30′, and deducting the result from the mean motion of the sun."

Some partial eclipses of the sun visible in Cairo were observed with great interest by Ebn Jounis and his friends, who assembled at the Mosque of Aboufaafer Almagrebi for the purpose. One on Dec. 12, A.D. 977, was evidently a great astronomical occasion. The names of many of those in attendance were given, of whom he says: "These persons were instructed without being versed in the practice of judiciary astronomy (prognostics)". The eclipse was first seen when the sun was between 15° and 16° above the horizon. Its greatest phase was estimated at 8 digits (twelfths of the diameter) in magnitude. "When the sun seemed to regain all its brilliancy I found its altitude to be about 33° 20′, all being in agreement as to the end of the eclipse." Next appears a list of determinations of the vernal and autumnal equinoxes, made by various astronomers, commencing with one by Ptolemy in the third year of the reign of Antoninus Pius, at Alexandria. Many observations by Arab astronomers at Bagdad and Damascus, from A.D. 830 to A.D. 851, appear also in the text.

Chap. v. contains various determinations of the sun's mean motion in the Persian year of 365 days, almost all of them being in agreement with a value of 359° 45′ 39″, differing only in thirds. All of the astronomers arrived at their results by dividing the number of solar revolutions by the number of Persian years which had elapsed between the time of their observations and the original observation of Hipparchus. By the same method Ebn Jounis arrived at a slightly larger value—359° 45′ 40″ 3‴ 44⁗. He is especially interested in various estimates of the position of the 'Lion's Heart'. "I am going to give particulars of these differences, so that those who wish to know the science of calculation and observation of the heavenly bodies, by comprehending every difficulty and by seeing how much trouble is involved in arriving at the truth, may be more disposed to excuse errors which escape the notice of persons who give themselves up to this kind of study; and Allah conducts whom he will in the path of exactitude."

The differences in the positions of Regulus were found to range from 3′ to 33′ for the same year by interpolation from various observations made in previous and subsequent years. The Arab astronomers who contributed the results are mentioned individually and their calculated places given in detail.

Chap. vi. is entitled: "On the mean motions of the Verified Table, on its equinoxes, and on the position of its apogees: on the mean motions of the present Table, on its equations and its apogees". This chapter consists entirely of comparisons between various determinations by Ptolemy and others of the mean motions and other elements of the sun, moon, and planets and Ibn Jounis' own results. It is scarcely of sufficient general interest to quote extracts here. Caussin had evidently intended to translate and publish the rest of the Leyden MS., but this unfortunately he never accomplished. He ends the volume by giving various small extracts from other Arabic astronomical MSS., with a computation based on the Tables.

All the way through, the actual Arabic text is given on one page with the French translation on the other. The text is fully annotated with references to Arab astronomers, their instruments, and their methods of observation. Evidently, Caussin was a master both of classical written Arabic and Arab literature, and his work deserves the grateful appreciation of scientific historians.

Forest Gardens.

THE 'forest garden', as it has come to be known, consists of a group of experimental plots of different species of forest trees maintained for the purpose of obtaining statistical data of rate of growth and so forth, under uniform soil conditions. It is a pity that some term more expressive of the real nature of these experimental observation centres is not employed. 'Forest garden' can only convey to the public an erroneous idea of the objects aimed at, whilst even to foresters the use of the term is liable to considerable misunderstanding. In parts of the Continent the term 'forest garden' is applied to the demonstration area attached to a forest school. This area is maintained, partly as a botanical partly as a forestry one, for educational purposes. Groups of plants and shrubs are grown, often in strict botanical divisions; types of different species of trees may be maintained in an arboretum; and, lastly, experimental plots of trees, indigenous and exotic, are grown for the purposes of study and obtaining statistical data so far as the local factors admit. Such a centre is a true forest garden, and is so understood by foresters in many parts of the world.

The nomenclature of British forestry is still in its infancy. It may be suggested therefore that a more appropriate term than 'forest garden' might be decided upon for so important a piece of work as that carried on at the Observation Statistical Centres maintained in the British Isles. These are five in number, and the work inaugurated at each is now made available to the public in "Forestry Commission Bulletin (No. 12), Forest Gardens (1931)". The bulletin has been prepared by Mr. J. MacDonald, research officer (Scotland), partly from notes taken by himself, partly from published data. The vice-chairman of the Forestry Commission (Sir R. L. Robinson), in a foreword, gives a brief history of the forest gardens, five in number: Cockle Park, near Morpeth, Northumberland; Cirencester, Gloucestershire; Abbotswood, Forest of Dean, Gloucestershire; Alice Holt, Hampshire; and Ceiriog, Denbighshire. The areas vary in size from three acres at Alice Holt, where there are only five plots, to fifty acres at Ceiriog, with more than fifty plots and groups. The value of plots of this nature was pointed out by the Departmental Committee on Forestry, the report of which appeared in 1902. At this time only the Cockle Park area existed, planted in 1898-99 by Sir William Somerville, at that time director of the Station. There is considerable variation in the growth of some of the plots owing to the soil conditions of the areas chosen not being uniform. Cirencester plots were planted in 1903-4 and 1904-5, under the supervision of Mr. F. C. McLellan, in connexion with the Royal Agricultural College, Cirencester, thus following Sir William Somerville's example, the Cockle Park areas being designed for the benefit of the students of Armstrong College, Newcastle-upon-Tyne. The conditions at Cirencester are as nearly as possible uniform.

The chief part of the Abbotswood plots was planted under the auspices of the Office of Woods between 1904 and 1909, other plots being added later. The plots are comprised in four series, covering some 43 acres, some being of very considerable interest. The Alice Holt area was also laid out for the Office of Woods by Sir William Schlich and Dr. (now Sir William) Somerville in 1908. The Ceiriog experimental plots comprise the most extensive area and are managed by the Forestry Department of the University College, Bangor. They are the property of the Denbighshire County Council. The planting was commenced in 1907 and has been continued since. The other areas of the same type are those at Bagley Wood, Oxford, and Avondale, County Wicklow, Ireland.

Reference must be made to the bulletin for a detailed description of the different plots on the various areas, the descriptions being accompanied by statistical data, height growth curves, and some excellent photographs. On the whole this brochure is entitled to rank as one of the most interesting bulletins yet issued by the Forestry Commission.

Insect Relations of Plant Virus Diseases.

A MASTERLY review of the present stage of our knowledge of the relations between plant virus diseases and insect vectors has recently appeared. The author is Dr. Kenneth Smith of Cambridge, and the paper is entitled "Virus Diseases of Plants and their Relationship with Insect Vectors" (*Biological Reviews*, vol. 6, No. 3, July 1931, pp. 302-344). A survey of all the virus diseases yet described is first given, and all information as to their insect vectors, if any are known, is brought together. The amount of information passed under review is so large and the conclusions drawn from a consideration of it are so important that it seems advisable to give them in considerable detail.

Biting insects (Coleoptera and Orthoptera) are responsible for the spread of only one or two viruses, and the transfer is considered to be purely mechanical. Sucking insects, on the other hand, transmit many virus diseases, and the aphid *Myzus persicae* Sulz. has been known to spread fourteen viruses. A close relation between the virus and the sucking insect is usually demonstrable. There is a close specificity between the insect and its particular virus or viruses. An insect which becomes disease-transmitting does so only at the end of a short period after its feeding on a diseased plant; it is not, as a general rule, diseased or malformed itself and often retains its power to transmit until it dies. The power of transmitting a virus is not transmitted to the progeny. Male and female seem to have equal facility to become vectors, with the possible exception of the streak disease of maize, where there exists a difference between the sexes. Individual differences between the members of a species or strain exist, and there may be one or two insects which are incapable of transmitting, though all their fellows in a species or strain will spread the disease. The toxicity of an insect's saliva is not correlated with lack of power to transmit a plant virus.

The insect or the plant may be the agent in selecting a virus from a complex. Some viruses can be separated by feeding an appropriate insect on a plant infected with them, whilst a plant may take only one virus from an insect which may be transmitting two or more. The virus can in general be picked up by an insect from any part of the plant, though not always with the same facility. It is possible for an infective insect to feed on a susceptible plant without transmitting disease. A single insect is capable of becoming a vector, and takes from five minutes to six hours of feeding to acquire this faculty, and from two minutes to fourteen hours to transfer virus to a plant. Different symptoms are sometimes produced by needle inoculations from those induced by insect transfer. Insects may transmit virus from a symptomless carrier. Transmission by soil insects is considered to play a very small part in virus transmission.

The whole is an exhaustive treatment of a very complex subject, and is worthy of the attention of all workers on plant virus diseases.

University and Educational Intelligence.

CAMBRIDGE.—Prof. Albert Einstein has been appointed Rouse Ball lecturer for the year 1931–32.

At Magdalene College, Prof. David Keilin, Quick professor of biology, has been elected to a professorial fellowship.

Dr. C. G. Lamb has been re-appointed reader in electrical engineering, and Mr. T. R. B. Saunders has been re-appointed University demonstrator in engineering.

LONDON.—As the result of a consensus of opinion among representative graduates of the University, the Earl of Athlone has consented to be nominated Chancellor of the University. Other nominations have been withdrawn.

MANCHESTER.—At a special congregation on Nov. 20, the honorary degree of LL.D. was conferred upon Prof. E. Fiddes, formerly Ward professor of history, and Prof. F. E. Weiss, formerly Harrison professor of botany, on their retirement from active service and in recognition of their long and distinguished membership of the teaching staff of the University.

ST. ANDREWS.—General the Rt. Hon. J. C. Smuts, president of the British Association, has been elected Rector of the University in succession to Sir Wilfred Grenfell.

DR. J. WARD, senior lecturer in mechanical engineering at the Northampton Polytechnic Institute, London, has been appointed head of the Department of Civil and Mechanical Engineering at the Technical College, Huddersfield, in succession to Mr. J. W. Button, who is about to retire after twenty-four years' service as head of the Department.

IT is announced that the Annual Conference of the Geographical Association will be held at the London School of Economics on Jan. 6-11, 1932. The presidential address will be delivered by Sir Leslie Mackenzie on "A Health Administrator's Attitude to Geography". There will also be a discussion on historical geography, to be opened by Prof. C. B. Fawcett. Other speakers at the discussion will be Dr. J. E. Morris and Profs. F. S. Marvin and E. G. R. Taylor. Lectures are to be delivered by Mr. S. A. S. Hozayen, on the expansion of the Arabs and their contribution to geography; Mrs. H. Ormsby, on the effect of limestones on the human geography of France; Mr. J. Fairgrieve, on the use of films in teaching; Prof. P. F. Kendall, on "How Britain became an Island"; Brigadier H. S. L. Winterbotham, on new developments of the 1-in. map; and Prof. Gerhard Schott (Hamburg), on the relation of the Humboldt current to conditions on the coast of Peru. Several excursions of geographical interest have also been arranged in connexion with the Conference. There will be the usual publishers' exhibition of books, maps, and appliances, and it is hoped to have a demonstration of educational films.

Birthdays and Research Centres.

Nov. 29, 1849.—Sir AMBROSE FLEMING, F.R.S., honorary fellow of St. John's College, Cambridge, Albert Medallist of the Royal Society of Arts, fellow of University College, London, and emeritus professor of electrical engineering in the University of London.

I sent to the Congress of Physicists' meeting in Rome, on Oct. 11–18, a paper describing some researches, made during the present year, intended to ascertain if possible whether the passage of a powerful beam of light or of X-rays through a stream of moving electrons would hinder or assist it. The method adopted was to construct a Fleming thermionic valve with dull emitter filament and two wire network grid anodes, one on each side of the filament. When these anodes were kept positively charged, streams of electrons flowed from the filament to each grid. Hence, if a powerful beam of X-rays was passed transversely across the valve, the photons in this beam moved against the electron stream on one side of the filament and with it on the other. Without entering into details here, it may be said that no sensible change in the electron current on either side was found, even when the X-ray beam proceeded from a hot cathode X-ray tube with a cathode stream of 20 milliamperes. The experiments are being continued.

Nov. 29, 1859.—Sir ROBERT A. HADFIELD, Bt., F.R.S., past president of the Iron and Steel Institute and the Faraday Society; foreign associate of the National Academy of Sciences, Washington; corresponding member of the Paris Academy of Sciences; honorary foreign member of the Royal Swedish Academy, Stockholm.

In no section of science has there been more activity during the last twenty-five years than in metallurgy. In recent research on Faraday's specimens of steels and alloys made a hundred years ago, the modern metallurgist has been able to extract from these specimens (many of them weighing less than an ounce and the largest not more than five ounces) most valuable information, including full composition, by means of some five hundred chemical determinations. All this has been obtained from about 582 gm. of material. I have just completed a volume on Faraday's metallurgical researches. This book deals, among other matters, with his alloys of iron containing high percentages of platinum, rhodium, and palladium, upon which exhaustive tests have been made, showing in the case of the rhodium-iron alloy higher resistance to corrosion than any other known iron or steel alloy.

I am continuing researches made formerly with Dewar and Onnes on the effect of low temperature in increasing tenacity upon some of the iron alloys. A joint research at the University of Leyden has been undertaken by Prof. W. J. de Haas and myself, on the effect which liquid helium produces upon the tenacity of various iron and steel alloys.

One of my present researches is to ascertain whether it is possible to produce steel of high tenacity accompanied by sufficient ductility. Such material would possess about five times the strength of the latest and best mild steel containing about 0·25 per cent carbon. A steel with, say, 150 or 200 tons tenacity, and at the same time not brittle but of tough quality, would be a product of great value.

Nov. 29, 1866.—Prof. E. W. BROWN, F.R.S., professor of mathematics, Yale University, New Haven, Conn.

I am at present trying to make use of knowledge of the methods of treating gravitational problems, chiefly those of the solar system, accumulated during the past forty-five years. Lately this has led to studies in expansions, both literal and numerical, in sums of harmonic terms of various functions, but chiefly of the disturbing function. Methods for abbreviating the planetary theory form another outcome. The most important factor in the development of the gravitational history of the solar system in the remote past and remote future is, I believe, the existence of resonance relations in all such problems, and a start towards a general theory of resonance has been made. These and other developments, some already published, will be treated in a volume on the planetary theory by Prof. C. A. Shook and myself, which we hope may appear within the next twelve months. An elementary treatment of resonance with special application to the motion of a pendulum has already gone to press.

A difficult satellite problem—the motion of the eighth satellite of Jupiter—is being worked out in conjunction with Dr. D. Brouwer.

The variations in the earth's rate of rotation from year to year are being obtained with the co-operation of Dr. Brouwer and a large number of amateur and professional astronomers all over the world, by means of occultations of stars by the moon. This campaign has led to studies of the records obtained by Mr. A. L. Loomis from his Shortt clocks and oscillating crystal, which it is hoped will be continued.

During the past year a study of the problem of the prediction of an unknown planet by means of its effects on other planets has resulted in the discovery of a criterion which shows quite clearly why the existence of Neptune could be predicted and that of Pluto could not.

Nov. 30, 1858.—Sir JAGADIS C. BOSE, C.S.I., C.I.E., F.R.S., founder and director of the Bose Research Institute, Calcutta.

The results obtained at the Bose Research Institute on conduction of excitatory impulse in plants, such as *Mimosa*, demonstrate the existence of definite conducting channels between the central and peripheral parts of the leaf; direct and indirect stimulation could thus be made to act either in concordance or in opposition, which result in characteristic mechanical responses. The variation of growth induced by the stimulus of light is complicated by several factors, the individual effect of which has been determined. The modifying factors are the quality or colour of light, the energy content of the tissue, and the point of application of stimulus, constituting direct or indirect stimulation.

The characteristic effects of minute traces of indigenous plant extracts on the activity of different organs of the animal are also being investigated. Satisfactory explanation has been found of the method of capture of large quantities of fish by applying traces of certain plant extracts to the water in hill streams. Continuous records, obtained by a special automatic recorder, show that the extract has no poisonous action, but induces inactivation of the respiratory mechanism, death of the fish being due to asphyxiation.

A spectrographic method is being perfected in the Department of Chemistry of the Institute for investigating the proteolytic enzymes of plants.

Dec. 5, 1868.—Prof. A. SOMMERFELD, For.Mem.R.S., professor of theoretical physics and director of the Institute for Theoretical Physics in the University of Munich.

The electron theory of metals is being considered further with the aim of simplifying the wave mechanical treatment, especially for high temperatures. The problem of the continuous X-ray spectrum, advanced in *Ann. der Phys.*, 1931, is being studied in certain details and applied to questions of astrophysical interest. The problem of the scattering of slow electrons, treated by Allis and Morse in *Zeit. für Phys.*, 1931, is being extended to atoms of greater atomic number and to protons. The experimental researches of Dr. Kirchner concerning electron diffraction and the value of e/m are being continued.

Societies and Academies.

LONDON.

Royal Society, Nov. 19.—**J. E. Barnard** and **W. J. Elford**: The causative organism in infectious ectromelia. Appendix—filtration experiments with virus of infectious ectromelia. From mice infected with the virus of infectious ectromelia, minute bodies have been obtained, both from characteristic inclusion-bodies and by differential filtration of infective organ extracts, which are shown, in ultra-violet photomicrographs, to be minute, coccoid micro-organisms. Evidence is given that these organisms are the virus.—**V. B. Wigglesworth**: The extent of air in the tracheoles of some terrestrial insects. In the flea, mealworm, cockroach, and bed-bug, the tracheal endings normally contain fluid, as in the mosquito larva. This fluid is removed after active muscular contraction, but *not* during prolonged fasting under dry conditions. This suggests that the osmotic pressure of the blood of these insects is maintained during life at a more or less constant level (see NATURE, Feb. 28, p. 307).

Royal Meteorological Society, Nov. 18.—**J. Edmund Clark, Ivan D. Margary, Richard Marshall, C. J. P. Cave**, and **L. C. W. Bonacina**: Report on the phenological observations in the British Isles from December 1929 to November 1930. Abnormal December and January warmth and excess of sunshine in December 1929 and November 1930 made very partial amends for almost continuous adverse conditions in between, save only in June and the brief spell of glorious harvest weather which ended August. Hence for farm and garden conditions were, as a rule, bad. Spring flowers in southern parts were almost a week late. But the floral isophenes are naturally much nearer normal than in 1929. The corresponding isakairs are early mainly over southern Scotland and north-west Ireland; they are latest in west Ireland, central Highlands, and scattered English areas. Insects and birds were late.—**Sir Gilbert Walker** and **A. C. Phillips**: The forms of stratified clouds: Part 1, Experimental. Part 2, Discussion. In continuation of experimental work on vertically unstable liquids by E. H. Weber, Bénard, Idrac, and Mal an examination was made of the patterns set up in a heated liquid moving along a rectangular trough. As this did not produce vortices with their axes at right angles to the flow, recourse was had to unstable air flowing along a small wind-channel, the motion being indicated by fumes of titanium tetrachloride. By suitable increases of velocity, from zero, the patterns produced were polygons, transverse vortices, crossed vortices, and longitudinal vortices, the resemblance to clouds being more obvious than when liquids were used.—**William Dunbar**: Eighty years' rainfall at North Craig Reservoir, Kilmarnock. All but one of the dry years occur during the first forty years, while the majority of the wet years occur in the second half of the eighty-year period. The first forty years of the period were drier than the second forty. Comparing the North Craig figures with those of a gauge in the east of Scotland, and with the average for Scotland, it is suggested that the west is becoming wetter and the east drier.

Physical Society, Nov. 20.—**Miss F. Lowater**: The band spectrum of zirconium oxide. The spectrum has been photographed from λ2600 to λ8800, and bands have been found to extend from λ3200 to λ7600. The most prominent bands have been analysed into three systems, all having the same lower electronic state. Analysis of the remaining bands is in progress. —**W. A. Wood**: Lattice-distortion of cold-drawn constantan wire. A method is described for determining the variation in distortion quantitatively as constantan wire is cold-drawn, and the variation across the section of the wire during the drawing. Distortion increases quickly to a steady maximum, which is maintained despite further drawing; orientation does not begin until the maximum distortion appears; just below the surface in the less drawn wires is a region of diminished distortion, but as the wire is further drawn the degree of distortion evens out across the section (this is explained in terms of the action of the die on the surface); the temperature-coefficient of electrical resistance exhibits changes in drawing similar to the variation in distortion, and the two properties are practically proportional.—**F. Aughtie**: (1) A remote electrically recording accelerometer with particular reference to wheel-impact measurements. The instrument was developed for the measurement of the acceleration of the rear axle of a vehicle. It was necessary for the recording to be done remotely in order accurately to phase three records, two of acceleration and one of spring load. A new method of remote recording has been developed for the purpose. —(2) A remote electrically recording load-gauge for wheel-impact measurements. The load-gauge designed for measuring that component of the wheel-load which arises from the spring weight is described. —**E. V. Appleton** and **G. Builder**: Wireless echoes of short delay. An account of a simple method of producing short pulses of radio-frequency energy is given, with notes on its application in the investigation of wireless echoes of short delay. The discussion of sample records and results serves as a basis for drawing conclusions concerning the relative advantages of the frequency-change and group-retardation methods of investigating the ionised regions of the upper atmosphere.

PARIS.

Academy of Sciences, Oct. 19.—**H. Douvillé**: Some examples of evolution. In the course of work on the lamellibranchs, examples of sudden modification involving the appearance of new transmitted characters have been observed. One of the best characterised marks the origin of the Rudists. Other instances of the influence of the mode of living on the constitution of the shell are given.—**H. Vincent**: New researches on the cryptotoxins. The phenomenon of the supersaturation of the toxins by the salicylic ion. The toxin has the property of actively fixing a large quantity of salicylic acid, largely in excess of the inhibiting dose. There is supersaturation of the toxin by the chemical antibody.—**E. Mathias**: The usefulness of long periods of observation of the rainfall in a given place. A direct relation between deforestation and rainfall is proved by two sets of observations at Ambert and at the summit of the Puy-de-Dôme.—**L. Cuénot**: The athrocytary function in the Hirudineæ.—**E. Pinte**: The geometry of Hilbertian space. —**O. Boruvka**: The hypercircumferences and certain parabolic surfaces in four dimensional Euclidian space. —**F. Tricomi**: A differential equation of electrotechnics.—**G. Cerf**: A generalisation of Monge's problem.—**M. Ghermanesco**: The fundamental solutions of the n-metaharmonic equation.—**Florin Vasilesco**: The method of the *balayage* and the conductor potential of an ensemble.—**Al. Proca**: First integrals of Dirac's equation.—**D. Riabouchinsky**: The different forms of movements capable of being reproduced by the method of coloured threads between two surfaces, whether parallel or not, sufficiently close together.—**G. Blum**: Measurements of the photochemical energy of the moon obtained during the total eclipse of Sept. 26, 1931.—**J. J. Trillat** and **Th. v. Hirsch**: The diffraction of electrons by a single crystal.—**R. de Mallemann**: Molecular polarisation.—**P. Vaillant**: The constitution of solutions deduced from absorption measurements. From the spectrophotometric examination of a series of solutions of cobalt chloride it is concluded that the optical properties, although independent of the density of the chlorine ions in the medium, are slightly influenced by the simultaneous presence of foreign cations.—**R. Freymann**: The study of some liquid absorption spectra in the infra-red by means of a photoresistant cell.—**L. Dubar**: The sensibility of cuprous oxide photoelectric cells, of the type with copper grid. Comparison with the optical absorption and the photoconductivity of cuprous oxide. The experimental results are given graphically and show the variation of the photoelectric current with the wave-length of the incident radiations. The sensibility of these cells falls rapidly as the temperature of the cell rises, the e.m.f., with constant illumination, falling at 60° C. to eight per cent of its value at 15° C.—**N. Thon** and **J. Pinilla**: The deposit potentials of copper in complex solutions of cuprous halides.—**W. Swietoslawski** and **Mlle. L. Wajcenblit**: The ternary heteroazeotrope formed of carbon disulphide, acetone, and water. This contains carbon disulphide, 75·21 per cent; acetone, 23·98 per cent; water, 0·81 per cent, and boils at 38·042° C. under normal pressure.—**J. Wyart**: The crystalline networks of thomsonite and of mesotype.—**Victor Babet**: The geology of the basins of Haut Niari, Bouenza, and Haut Ogooué (French Equatorial Africa).—**Edouard Chatton, André Lwoff**, and **Mme. Marguerite Lwoff**: The infraciliary origin and the genesis of the trichocysts and trichites in the Fœttingeriideæ.—**Ch. Dhéré** and **J. Roche**: The fluorescence and especially the fluorescence spectra of pigments of the urobilin group.—**A. Paillot**: Bacterial parasitism and symbiosis in *Aphis atriplicis*.

SYDNEY.

Linnean Society of New South Wales, Aug. 26.—**T. G. B. Osborn, J. G. Wood**, and **T. B. Paltridge**: The autecology of *Stipa nitida*: a study of a fodder grass in arid Australia. Observations were made on correlation between soil type and the root system, the nature of the seed bed, and the conditions favouring germination of the seed. The influence of grazing has been studied by means of an extensive quadrat system both inside the Reserve and also in the adjacent paddocks, so that it has been possible to compare the entirely protected plants of the Reserve and those outside which have been subject to different intensities of grazing. The results of the investigation show that only by careful control of grazing during drought periods can the population of *Stipa* plants be maintained. In an area that shows degeneration of the plant cover, material benefit to the *Stipa* population is derived by leaving the area ungrazed for one or two years.—**G. H. Cunningham**: The Gasteromycetes of Australasia. (13) The genus *Pisolithus*. In structure this genus is closely related to *Scleroderma*, and is therefore grouped under the family Sclerodermaceæ of the Gasteromycetes. The genus is represented in this biological region by the two species, *Pisolithus tinctorius* and *P. microcarpus*, the former having a wide distribution through the hotter parts of the world, the latter being confined to Australia.—**J. R. Malloch**: Notes on Australian Diptera. A résumé of the known Australian members of the Piophilidæ, description of a new genus of Helomyzidæ, and some data on certain genera of Tachinidæ. The recorded occurrence of *Catharosia* is also dealt with on the basis of the material upon which it was included in the Australian list.

Diary of Societies.

FRIDAY, November 27.

Royal Sanitary Institute (at Town Hall, Sheffield), at 3.

Andersonian Chemical Society (at Royal Technical College, Glasgow), at 3.15.

Diesel Engine Users' Association (at Caxton Hall), at 3.30.

Royal Astronomical Society (Geophysical Discussion), at 4.30.

Royal Society of Medicine (Disease in Children Section), at 5.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.

Manchester Literary and Philosophical Society (Chemical Section) (at 36 George Street, Manchester), at 7.

Institution of Mechanical Engineers (Informal Meeting), at 7.

Manchester Association of Engineers (at Engineers' Club, Manchester), at 7.15.

Junior Institution of Engineers, at 7.30.

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.

Royal Institution of Great Britain, at 9.

SATURDAY, November 28.

Royal Institution of Great Britain, at 3.

MONDAY, November 30.

Royal Society, at 4.—Anniversary Meeting.

Royal Institute of British Architects, at 8.

Royal Society of Arts, at 8.—Howard Lecture.

Royal Geographical Society, at 8.30.

TUESDAY, December 1.

Royal Institution of Great Britain, at 5.15.

Institution of Civil Engineers, at 6.

London Natural History Society (Annual General Meeting) (at London School of Hygiene and Tropical Medicine), at 6.30.—President's Address.

Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Section) (at Borough Polytechnic), at 7.

Royal Photographic Society of Great Britain, at 7.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.

nstitute of Metals (Sheffield Local Section) (at Sheffield University), at 7.30.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.30.

Institution of Automobile Engineers (at Royal Society of Arts), at 7.45.

British Psychological Society (Education Section) (at London Day Training College).—Annual General Meeting at 8.15; Ordinary Meeting at 8.30.

WEDNESDAY, December 2.

Royal Society of Medicine (History of Medicine Section), at 5.

Geological Society of London, at 5.30.

Institution of Electrical Engineers (Wireless Section), at 6.

nstitution of Heating and Ventilating Engineers (at 20 Hart Street, W.C.1), at 7.

Alchemists' Club (jointly with Glasgow Geological Society) (at Westerlands, Glasgow), at 7.30.

nstitution of Automobile Engineers (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.30.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.

Royal Society of Arts, at 8.

Royal Philosophical Society of Glasgow (at 207 Bath Street, Glasgow), at 8.

Royal Society of Medicine (Neurology and Surgery Sections), at 8.30.

Royal Microscopical Society (Biological Section) (at B.M.A. House).

THURSDAY, December 3.

Linnean Society of London, at 5.

Child-Study Society (at Royal Sanitary Institute), at 6.

Institution of Electrical Engineers, at 6.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.

Institution of Structural Engineers (at Hotel Metropole, Leeds), at 7.

Society of Chemical Industry (Nottingham Section) (at University College, Nottingham), at 7.30.

Chemical Society, at 8.

Royal Society of Medicine (Tropical Diseases and Parasitology and Therapeutics and Pharmacology Sections), at 8.

Society of Chemical Industry (Chemical Engineering Group) (jointly with Bristol Section) (at Bristol).

FRIDAY, December 4.

Royal Society of Medicine (Otology Section), at 10.30 a.m.

Association of Economic Biologists (in Botany Department, Imperial College of Science and Technology), at 2.30.—Discussion on Laboratory Methods as a Means of Testing the Value of Chemical Substances for the Control of Injurious Fungi.

Royal Society of Arts (Indian Section), at 4.30.—Sir George Birdwood Memorial Lecture.

Royal Society of Medicine (Laryngology Section), at 5.

Physical Society (at Imperial College of Science and Technology), at 5.

Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6.

Institution of Electrical Engineers (Meter and Instrument Section), at 7.

Society of Chemical Industry (Manchester Section) (at Engineers' Club, Manchester), at 7.

Royal Photographic Society of Great Britain, at 7.

Junior Institution of Engineers (at Royal Society of Arts), at 7.30.—Dr. S. L. Pearce: Presidential Address.

Geologists' Association (at University College), at 7.30.

Royal Institution of Great Britain, at 9.

SATURDAY, December 5.

Royal Institution of Great Britain, at 3.

Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.

Public Lectures.

FRIDAY, November 27.

London School of Economics and Political Science, at 5.—Prof. L. Hogben: Genetic Principles in Medicine and Social Science. (Succeeding Weekly Lectures in Michaelmas Term and in Lent Term beginning on Jan. 15.)

SATURDAY, November 28.

Horniman Museum (Forest Hill), at 3.30.—Miss I. D. Thornley: Pilgrims of Medieval England.

MONDAY, November 30.

King's College, London, at 5.30.—Prof. M. Polanyi: Atomic Reactions. (Succeeding Lectures on Dec. 2 and 4.)

TUESDAY, December 1.

University of Manchester, at 5.15.—Prof. G. Dawes Hicks: The Philosophy of Religion (Hibbert Trust Lectures). (Succeeding Lectures on Dec. 2, 8, and 9.)

WEDNESDAY, December 2.

Royal Institute of Public Health, at 4.—Prof. H. R. Kenwood: The Health Education of the Citizen.

Royal College of Surgeons of England, at 4.—Prof. F. W. Twort: The Future of Bacteriological Research (Brown Institution Lecture). (Succeeding Lectures on Dec. 4, 7, 9, and 11.)

Belfast Museum and Art Gallery, at 8.—Prof. W. J. McCallister: Adult Education.

University of Oxford.—Prof. Freundlich: The Deflection of Light in the Sun's Gravitational Field (Sumatra, 1929).

THURSDAY, DECEMBER 3.

SCIENCE MUSEUM, SOUTH KENSINGTON (in connexion with Exhibition of Modern Glasses), at 4.45.—J. W. Wilson: Safety Glass.

INSTITUTION OF MECHANICAL ENGINEERS.—J. D. Watson: The Need for More Effective Treatment of Sewage Sludge (Chadwick Lecture).

SATURDAY, DECEMBER 5.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth-Davis: Insect Pests and their Enemies.

Congress and Exhibition of Apparatus.

DECEMBER 2 TO 4.

BRITISH INSTITUTE OF RADIOLOGY (at Central Hall, Westminster).

Wednesday, Dec. 2, at 2.30.—Lord Rutherford: Official Opening.

At 3.30.—Prof. F. Haenisch: Experiments upon the Inflammability of Films (Cinematograph Film).

At 5.—Sir James Jeans: What is Radiation? (Silvanus Thompson Memorial Lecture).

Thursday, Dec. 3, at 10 A.M.—Dr. G. Grossman: Advances in X-ray Engineering with Special Reference to High Potentials.

Dr. A. Bouwers: Economy and Quality in Radiology.

Dr. O. Bloch: The X-ray Emulsion.

W. E. Schall: Power Factor in Radiography.

C. G. Osment: Experimental Radiography Utilising the Gamma Rays of Radium.

At 3.—Dr. R. G. Canti: The Effects of Radium on Living Tissues cultivated *in vitro* (Cinematograph Film).

At 5.—Prof. H. Holfelder: Comparison of Medical, Surgical, and Radiological Conceptions in Relation to the Treatment of Disease (Mackenzie Davidson Memorial Lecture).

Friday, Dec. 4, at 10 A.M.—Discussion: The Radiation Treatment of Leukæmia.

At 11.30 A.M.—Discussion: Lipiodol in the Diagnosis of Inthrathoracic Disease.

At 3.—The Third International Congress of Radiology, Paris, 1931 (Cinematograph Film).

At 5.—Dr. A. E. Barclay: Presidential Address.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society. Series A, Vol. 183, No. A822, October 1 Pp. 351-695+xiv. (London: Harrison and Sons, Ltd.) 18*s.*

The Year's Photography, 1931–1932. Pp. 22+xlvi+75 plates. (London: Royal Photographic Society of Great Britain.) 2*s.* 6*d.*

International Federation of University Women. Bulletin No. 13: Report of the Sixteenth Council Meeting, Wellesley, April 1931. Pp. 43. (London.)

The Smoke Abatement Handbook, 1931. Pp. 48. (Manchester: National Smoke Abatement Society.) 6*d.*

Colony and Protectorate of Kenya. Forest Department Annual Report, 1930. Pp. 27. (Nairobi.) 1*s.*

Tanganyika Territory. Tsetse Research Annual Report for the Year ended 31st December 1930. Pp. iii+48+7 plates. (Dar es Salaam: Government Printer.)

Journal of the Indian Institute of Science. Vol. 14A, Part 5: Contributions to the Study of Spike-Disease of Sandal (*Santalum album*, Linn.). Part 12: Ecology of Sandal By M. Sreenivasaya and S. Rangaswami. Pp. 59-65. (Bangalore.) 8 annas.

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 59: The Poisonous Action of Ingested Saponis. By Prof. Alfred J. Ewart. Pp 28. Pamphlet No. 20: The Identification of Wood by Chemical Means, Part 1. By H. E Dadswell. (Division of Forest Products, Technical Paper No. 1) Pp. 16. Pamphlet No. 21: The Density of Australian Timbers, a Preliminary Study. By H. E. Dadswell. (Division of Forest Products, Technical Paper No. 2.) Pp. 16. Pamphlet No. 22: The Chemistry of Australian Timbers. Part 1: A Study of the Lignin Determination. By W. E. Cohen and H. E. Dadswell. (Division of Forest Products, Technical Paper No. 3.) Pp 27. (Melbourne: H. J. Green.)

Straits Settlements. Annual Report of the Education Department for the Year 1930. By Dr. R. O. Winstedt. Pp. ii+67. (Singapore: Government Printing Office.)

Anthropological Bulletins from the Zoological Survey of India Bulletin No. 1: A Report on the Human Relics recovered by the Naga Hills (Burma) Expedition for the Abolition of Human Sacrifice during 1926–27. By Dr. B. S. Guha and P. C. Basu. Pp. 68+22 plates. (Calcutta.) 1.12 rupees; 3*s.*

Union of South Africa: Department of Mines and Industries: Geological Survey. Memoir No. 27: A Bibliography of South African Geology for the Years 1926 to 1930 (Inclusive) Author's Index. By Dr. A. L. Hall. Pp 160. (Pretoria: Government Printing Office.) 5*s.*

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 1, No. 4: The Electric Field in Terrestrial Magnetic Storms. By A. H. R. Goldie. Pp. 143-177. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4*s.* 6*d.*

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1929–30. Vol. 74. Pp iv+111+lii. (Manchester.) 12*s.*

Bradford Education Committee. Journal of Research of the Bradford Technical College: a Series of Papers dealing with Investigations undertaken by Members of the Technical College, Bradford. Vol. 1, 1930. Pp. xii+295. (Bradford.)

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending 31st March 1931; with Appendices. Pp. 45. (London: H.M. Stationery Office) 9*d.* net.

Transactions of the Institution of Chemical Engineers. Vol. 8, 1930. Pp. 232 (London.)

The Scientific Proceedings of the Royal Dublin Socitey. Vol. 20, N.S., Nos. 8-12: Award of the Boyle Medal to Sir John Purser Griffith; A Study of Bacteria belonging to the Sub-genus *Aerobacter*, by M. Grimes and A. J. Hennerty; Report of the Irish Radium Committee for the Year 1930; On a Method of distinguishing the Seedlings of Swedish Turnip (*Brassica napus* L. var. *Napobrassica* (L.) Reichb.) from those of Rape (*Brassica napus* L. var. *Biennis* (Schubl. et Mart.) Reichb.), by M. J. Gorman and A. J. Hennerty; The Influence of the Work of Sir William Rowan Hamilton on Modern Mathematical Thought, by Prof. A. W. Conway. Pp. 85-128. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 3*s.*

The Journal of the Institution of Electrical Engineers. Vol. 69, No. 418, October. Pp. 1189-1328+xx. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

FOREIGN.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des pêches maritimes des pays du nord et de l'ouest de l'Europe. Rédigé par D'Arcy Wentworth Thompson. Vol. 19: Pour l'année 1929. Pp. 81. 3.25 kr. Rapports et procès-verbaux des réunions. Vol. 74: Procès-verbaux (Mars 1931). Pp. 208. 7.75 kr. Vol. 75: General Marine Physiology; Conditions of Growth of Phytoplankton. Reports of the Proceedings of a Special Meeting held on March 27th, 1931, at Copenhagen. Pp. 70. 2 75 kr. Vol. 76: The Mixing Question, viewed Theoretically and Practically, together with a Consideration of Internal Waves. Reports of the Proceedings of a Special Meeting held on March 27th, 1931, at Copenhagen. Pp. 62. 2.50 kr. (Copenhague: Andr. Fred. Høst et fils.

Bulletin of the National Research Council. No. 83: A Compendium o the Statute Law of Coroners and Medical Examiners in the United States Issued under the Auspices of the Committee on Medicolegal Problems By George H. Weinmann. Pp. 240. 3 dollars. Reprint and Circula Series of the National Research Council. No. 97: The Committee on State Archaeological Surveys of the Division of Anthropology an Psychology, National Research Council By Carl E. Guthe. Pp. 9. 1 cents. No. 98: Report of the Committee on Sedimentation, 1929–1930 Pp. ii+97. 1 dollar. No 99: Bibliography of Acoustics of Buildings By F. R. Watson. Pp. 31. 50 cents. No. 100: In Quest of Glacial Man a Plan of Cooperation between Excavators and the Representatives of th Sciences of Man and of the Earth. Prepared by Madison Bentley. Pp 20. 40 cents No. 101: Doctorates conferred in the Sciences by America Universities, 1930–1931. Compiled by Callie Hull and Clarence J. West Pp. 55. 50 cents. (Washington, D.C.: National Academy of Sciences)

Journal of the Faculty of Science, Hokkaido Imperial University Series 2: Physics. Vol. 1, No. 2: Further Studies on the Striated Electri Discharge Figure. By Tadasi Itoh. Pp. 77-85+2 plates. Series 4 Geology and Mineralogy. Vol. 1, No. 2. Pp. 113-255+18, plate (Sapporo.)

Abisko Naturvetenskapliga Station. Observations météorologiques Vassijaure. 6, 1911. Exécutées et rédigees par Fritz Hallberg. Pp iv+68. 7, 1912. Exécutées et rédigées par Fritz Hallberg. Pp. iii+6 (Stockholm.)

Philippine Earthquake Epicentres (1920 to 1929) North of Latitud 14° 30′. By the Rev. William G. Repetti. Pp. 69-95. (Manilla: Burea of Printing.)

Journal of the Federated Malay States Museums. Vol. 8: *Results* an Expedition to Korinchi Peak, 12,400 ft., Sumatra. Part 3: Invertebrates. Pp. 205-225. (Kuala Lumpur.)

Federated Malay States. Annual Report of the Education Departme for the Year 1930. By Dr. R. O. Winstedt. Pp. ii+58. (Kuala Lumpu Government Press.)

Memoirs of the College of Science, Kyoto Imperial University. Seri [illegible] 14, No 3, May. Pp. 79-130. 1.20 yen. Series B, Vol. 6, No. A, Vol. [illegible]cle 6: Über die Beeinflussung des Wachstums des Mesokoty June, Arti[illegible]leoptile von *Avena*-Keimlingen durch das Licht. Von Hide und des Ko[illegible]161-238. (Tokyo and Kyoto: Maruzen Co., Ltd.) Hamada. Pp. [illegible]t of Commerce: Bureau of Standards. Bureau U.S. Departmen[illegible]Research. Vol. 7, No. 3, September, Researc Standards Journal of [illegible]p. 419-615. (Washington, D.C.: Governme Papers Nos. 348-360. [illegible] Printing Office.) [illegible] Wisconsin. Serial No. 1760, General Seri Bulletin of the University of [illegible]hort Traffic Counts and Estimati No. 1534: A Method of making S[illegible]z A. Aust, Prof. H. Traffic Circulation in Urban Areas. By Prof. Fra[illegible]arrison. Pp. 5 Janda, assisted by John R. Campbell and Robert S. H[illegible] (Madison, Wis.)

Proceedings of the United States National Museum. Vol. 79, Art. 1 A New Species of Trematode of the Family Heterophyidae, with a Note the Genus Apophallus and related Genera. By Emmet W. Price (N 2883). Pp. 6. (Washington, D.C.: Government Printing Office.)

CATALOGUE.

The Cannon House Catalogue of Scientific Books and Serial Publicatio (Transactions, Journals, Periodicals). (N.S. No. 5.) Pp. 96. (London: Wm. Dawson and Sons, Ltd.)

SATURDAY, DECEMBER 5, 1931.

CONTENTS.

PAGE
Science and Service 921
Progressive Biology. By Sir Frederick Gowland Hopkins, Pres.R.S. 923
A Century of Meteorology. By Sir Napier Shaw, F.R.S. 925
Recent Developments in Optical Glass Manufacture. By W. M. Hampton and W. N. Wheat . . . 926

Obituary :

Dr. S. W. Stratton. By Sir Richard Glazebrook, K.C.B., F.R.S. 928
Mr. Elsdon Best. By H. D. Skinner . . . 929
Mr. Henry Garnett 930
News and Views 930

Letters to the Editor :

Determination of the Yard in Terms of the Wave-length of Light.—J. E. Sears, Jr. ; Dr. A. E. H. Tutton, F.R.S. 965
Electron Exchange Phenomena in the Excited Atom.—Prof. R. Whiddington, F.R.S., and J. E. Roberts 966
The Atomic Weight of Fluorine.—Prof. E. Moles 966
Respiration of Healthy and Leaf Roll Potatoes.—Dr. T. Whitehead 967
Eurytemora thompsoni, A. Willey : A New European Record.—A. G. Lowndes . . . 967
Uteroverdin.—Dr. R. Lemberg, Prof. J. Barcroft, F.R.S., and Dr. D. Keilin, F.R.S. . . . 967
Properties of Aerosols.—S. C. Blacktin . . 968
Carbon Contacts.—C. Turnbull ; C. V. Boys, F.R.S. 968
Electrical Conditions in Stratified Clouds.—Dr. Michael Grabham 969
The Band Spectrum of AsH.—George E. Kimball and John R. Bates 969
Branching of Lightning.—Major J. L. P. Macnair, R.A. 969
Esperanto in Scientific Literature.—R. M. Morris-Owen 969
Research Items 970
Astronomical Topics 972
Anniversary Meeting of the Royal Society . . 973
The Wellcome Research Institution 974
Plant Breeding in Germany 975
University and Educational Intelligence . . . 975
Birthdays and Research Centres 976
Societies and Academies 977
Diary of Societies 979
Official Publications Received 980

SUPPLEMENT.

A New Summary of Knowledge. By Prof. F. S. Marvin 937
Topography and Tradition. By Prof. J. L. Myres, O.B.E. 938
History of Medicine 939
History of Demography 940
Animal Aggregations 940
Problems in Parthenogenesis. By Prof. A. D. Peacock 941
Agricultural Entomology. By Dr. A. E. Cameron 943
Researches on Fungi 944
General Stratigraphy. By J. P. 945
The New Surveying. By C. F. C. 946
Viscometry. By Emil Hatschek 947
Nature of Chemical Forces 948
Paper Making. By Dr. E. F. Armstrong, F.R.S. 949
The Teaching of Mathematics 950
Short Reviews 951

Science and Service.

THE universal interest aroused by the Faraday centenary celebrations in spite of the world-wide economic and political unrest well attests the power of scientific biography to arrest public attention when its human aspects are adequately stressed. Beyond question, the contrast between Faraday's humble beginnings as a bookbinder's apprentice and the revolutionary effect of his discoveries on industry and on society has profoundly stirred the public imagination. The immense benefits which society has derived from the researches of this prince of investigators, no less than his unflinching devotion to the pursuit of scientific truth for its own sake, apart from all utilitarian consequences, commanded the homage of the entire world of industry and science, and have manifested to thousands of others the worth and human interest of a scientific career.

There are, of course, innumerable other scientific workers whose lives and achievements, set out so as to reveal their forceful personality and the manner in which the restless, questing spirit of science enabled them to conquer obstacles and obtain, if not always their desired haven, at least some anchorage from which humanity could start its explorations afresh, are no less pregnant with human interest. Moureu, Pasteur, Rayleigh, Ross, Fabre—the brief memoirs we have of these and many others are aglow with inspiration for those who can sense the pulsation of their fateful thought as they wrestled with Nature for her secrets.

Nor is less human interest to be found in the lives of those scientific workers who have devoted their labours to industry. Much has been written in recent years regarding the dyestuffs industry, but the full romantic story of the development of that industry still awaits the chronicler who can weave the fragmentary pictures we have of Perkin wrestling with nitrobenzene at Greenford Green, Dr. Ter-Meer at Uerdingen, or Dr. H. Levinstein's own sketches of the early growth of his father's firm, into some vivid odyssey of industry. Possibly even yet we are too near to the field of action for this task to be attempted. The great combines of chemical industry, of which almost everywhere the dyestuffs industry now forms an integral part, are dynamic and not static, and by no means represent a final phase.

There is, however, a tendency, from which not even Dr. Levinstein appears to be entirely free, to regard the great days as past, and to consider the rationalisation of industry as synonymous with the departure of initiative and enterprise. To such an assertion, made even of the field of industry represented by the manufacture of dyestuffs, the careers of such leaders as Dr. Duisberg and Dr. Engi, to cite two alone, provide a remarkable answer. Both of these outstanding leaders of chemical industry entered the dyestuffs industry as research chemists, and both were responsible for brilliant discoveries in the dyestuffs field which contributed largely to the rapid development of their respective firms. To Duisberg's discovery of the benzopurpurins and of important intermediates like benzidine sulphone must be added that of numerous other dyestuffs for which the Bayer Company has become famous, as well as the discovery of phenacetin.

Duisberg's talents as investigator, however, were combined with a personality and a vision which not only resulted in his becoming in 1925 the head of the I.G. Farbenindustrie Aktiengesellschaft at Leverkusen, but also an outstanding leader in chemical industry, whose influence was felt in the whole organisation of scientific research in Germany, in the developments which enabled Germany to reconstruct her industries to meet the difficult situations arising in the post-War years, as well as in professional associations and the training of students for industry. Similarly, Dr. Engi's scientific genius, which gave the Society of Chemical Industry in Basle thioindigo and the halogenated indigoid and thioindigoid dyes of the Ciba series, was linked to organising powers and a personality which rapidly brought him to the head of the great Swiss firm.

Other examples might readily be found, but the career of the present chairman of Imperial Chemical Industries, Ltd., Sir Harry McGowan, who entered the service of the Glasgow branch of the Nobel Co. as an office-boy; and, in the United States, Dr. A. D. Little's creation of the largest industrial consulting organisation in the world, are all the further evidence that space permits us to adduce that, even in the present industrial conditions, romance is not dead, and that there is still scope for personality and originality.

The truth is that those who view the rationalisation of industry as involving the suppression of individualism and opportunism commit the ancient blunder of regarding industry and society as static and not dynamic, and are in the company of those who saw in the passing of mail armour, the stage coach, the sailing ship, the windmill, the end of decency and order. Even on its narrowest scientific and technical side, industry is constantly changing, and every technical advance tends to bring other changes which little by little bring new demands and confront industry with fresh problems of supply. So have the growth of the rayon industries and the lacquer industries made fresh demands on the dyestuffs industry, and the relation of these industries, and particularly the lacquer industry, to the development of the automobile industry is sufficient evidence of the rashness of attempting to prophesy the demands which will be made upon any industry two or three decades hence.

Apart from this technical aspect, rationalised industry itself offers a challenge to personality which is missed by many superficial observers. These see in the magnitude of the combine a security which they assume was not possessed by the smaller firms of a previous generation, and conclude that individualism and initiative will wither for want of stimulus. The very care with which the progressive rationalised undertakings provide for the welfare of their employees tends to blind these observers to the fact that size does not affect the dependence of the large combine for security upon the same law of service as the individual and smaller firms from which it has grown.

Rationalisation of industry is only a means to render more effective service under modern conditions, and such service will not be continuously rendered unless originality and personality find their full play in the direction of the large combine and ensure that its policy is not stereotyped but develops to meet the changing needs of the world. Service, not security, is the goal, and if prizes are greater in the larger enterprise, the possibilities and consequences attending a blunder in management can equally be more serious. New methods have to be elaborated, forecasting and planning to be attempted on a larger scale, and not even in these days can an adventurous spirit be diverted from the successful conduct of industry. The great prizes of industry as of life are never to the safe and prudent, but to the adventurous who are willing to sail the uncharted seas, who take risks and know that they take them. In the fields of industrial and economic co-operation which open before us to-day, in the planning of industry on a national and an international scale so as to avoid the recurrence of such depressions and economic crises as we are at present experiencing, no less than in the complex reactions of scientific discoveries and their technical applications, there is scope for man's noblest intellectual and moral gifts in securing control of his environment.

Progressive Biology.*

By Sir FREDERICK GOWLAND HOPKINS, Pres. R.S.

IT is not going too far to claim that recent progress in experimental biology, though to a superficial view less impressive, has been not less significant, and indeed not less revolutionary than the progress of modern physics. I might support this claim in many ways. It is, I think, justified in that region of knowledge where cytology and genetical studies meet. The progress and the significance have become the greater since it was recognised that the material units of characters—the chromosomes and subdivisions of chromosomes—are 'determinants' rather than 'carriers' of genetic factors.

This domain of disinterested science is making many practical contacts. To mention but a single recent instance: Prof. R. C. Punnett, one of the original discoverers of the phenomenon of sex-linkage in inheritance, by applying his expert knowledge of that phenomenon, has produced what may be called a synthetic fowl, of which the qualities are such as to make it of extreme value to the now highly important industry of poultry breeding and egg production. The bearing of the same body of knowledge upon human affairs has been recently very ably discussed by Prof. L. T. Hogben.

The phenomena of heredity were long the stronghold of those who cling to the obscurantism of vitalistic doctrines. Infinitely complex as of course they are, we have now abundant proof that they are susceptible to analysis and that to-day they are yielding their secrets to well-controlled experimental studies. The results of these are becoming quantitative and are even yielding material for mathematical treatment, as the interesting writings of Dr. R. A. Fisher and Prof. J. B. S. Haldane have shown.

Another region in which accurate experimentation has removed, and is continuing to remove, inhibitions due to obscurantist assumptions is the physiology of the nervous system of vertebrates. It is, perhaps, too late in the day to refer to the work of Pavlov upon conditioned reflexes, though it is justifiable to emphasise its still growing influence upon thought. The work is a supreme proof of the success of the experimental method in analysing even such apparently transcendental phenomena as those which underlie the higher functions of the brain.

The nature of the transmission of events in the nervous system is receiving much illumination from the work of the Royal Society's Foulerton professors. Prof. E. D. Adrian, having developed a most admirable experimental technique for the purpose, is studying the nerve impulse and its origin with highly profitable results. He and his colleagues are now able, with great gain, to work with single nerve fibres and single isolated end organs.

A striking circumstance, brought to light by Adrian's work and that of his colleagues, is that the nervous structures so far examined exhibit such physical regularity in their behaviour that results can often be predicted within about one per cent. His experiments on animals have shown how the phenomenon of a grading in the contraction of muscles is controlled by the frequency of impulses sent out from the central nervous system, and by the number of nerve and muscle fibres involved. Moreover, he has been able to observe the activity of a single nerve cell in his own spinal cord by needle electrodes placed in his muscles, and finds human voluntary contractions are regulated in exactly the same way.

Further, Adrian has found that slow potential changes occur in nerve cells and that these are connected with their discharge of impulses; so far this work only extends to isolated nerve ganglia from insects and to nerve cells in the brain stems of fish, but the phenomena he has found are extremely significant, and it seems possible that changes of potential may be of fundamental importance in the activity of nerve cells.

Adrian has found that damaged nerve fibres set up impulses at very high frequencies, and these perhaps play an important part in sensations of pain, though his more recent work has made it clear that impulses in the smaller slowly conducting nerve fibres must also be concerned in the physical mechanism responsible for pain. A most striking feature of all this work is the general similarity of behaviour of nervous structures from whatever animal they may be taken.

Prof. A. V. Hill is studying the nerve impulse from the point of view of the thermal phenomena which accompany it. So small, of course, is the heat production in the nerve that its measurement, like that of the potential changes, calls for great refinements. It is becoming clear, though we do not yet know the details of its nature, that the nerve impulse consists of a transmitted physico-chemical event, probably involving changes of ionic concentrations at membranes with consequential changes of electric potential; the whole cycle of events, comprising activity and recovery in the nerve, being supported by the energy derived from metabolic oxidative processes which, very small in scale, are associated with the cycle.

When we hope for an increase in our knowledge of the nervous system we are always accustomed to look to researches from the laboratory of Sir Charles Sherrington. An extended study of reflexes has shown that the centripetal impulses do not pass straight through the spinal cord, but at central stations in the cord they are transformed into an enduring excitatory state, which may in turn set up fresh nerve impulses yielding the reflex discharges. The nature of this central excitatory state is being studied and will link up, I think, with some of Adrian's observations upon cell potentials.

It has long been suspected that when a sympathetic nerve is stimulated, adrenalin is liberated at the nerve ending, and that the observed effects are immediately due to the action of that substance. Now Dr. H. H. Dale, in conjunction with a member of his staff, Dr. Gaddum, has investigated the case of the para-sympathetic nerves, the influence of which in general opposes that of the sympathetic group, and has obtained good evidence that when one of these is stimulated, the substance acetyl-choline, previously existing in some inactive form, is liberated at the nerve ending. The action of acetyl-choline when injected into the circulation resembles in general the effect of stimulating para-sympathetic nerves, and there is every reason to believe that the physiological activity of the substance, rather than the transmitted physical impulse itself, is immediately responsible for the observed effects of stimulation. I may say that Otto Loewi, of Graz, has shown that when the heart beat is inhibited by vagus stimulation, acetyl-choline is actually formed in the organ, and the same substance, when artificially injected, is known to produce effects like those of the vagus.

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* Excerpts from the presidential address at the anniversary meeting of the Royal Society on Nov. 30.

In rather unexpected circumstances we have thus brought before us an example of specific physiological effects due to the influence of the specific structure of an organic molecule. Such effects and such relations are being demonstrated in increasing diversity as fundamental factors of organisation in the animal body. This is illustrated most strikingly, of course, in the domain of the control of its activities by a group of hormones. We find in the cases of adrenalin and thyroxin, the constitution of each of which is accurately known, widely different influences depending on differences of molecular structure.

I may logically pass from hormones to devote a few words to vitamins. We now possess proof that vitamin A is closely related to the carotenes, and this knowledge may well lead, without long delay, to the artificial synthesis of the vitamin itself. With respect to vitamin D, it seems probable, if not yet quite certain, that its artificial production is already accomplished. Some four years ago the constituent of animal and vegetable substances, which is converted into the antirachitic vitamin D by ultra-violet radiation, was identified as ergosterol by Rosenheim and Webster at the National Institute for Medical Research, and concurrently by Windaus in Göttingen. A team of workers at the National Institute, led by Dr. R. B. Bourdillon, appear now to have arrived at the next stage, of isolating the vitamin itself, in crystalline form, from the mixed products of irradiation; and Prof. Windaus, following with his co-workers a different route, has again arrived simultaneously at the same goal.

There is no doubt that the substance which the British group now term 'calciferol', and which they have isolated as a dinitrobenzoate from the mixed product, is identical with the 'vitamin D_2' which Windaus and Linsert obtained by a different method; and there is little doubt that this substance, as obtained in either laboratory, is the essential vitamin D in a state of practical purity. One milligramme of calciferol has an antirachitic activity corresponding to 40,000 of the newly accepted international units.

Before I close I would like to refer to a certain aspect of the chemical dynamics of living cells, concerning which progressive studies have been made during the last few years. The cell is, of course, a seat of catalysed chemical reactions and would seem to possess a multitude of catalysts each highly specific in the influence it exerts. In the case of reductions and oxidations, however, there are other agencies of less specific activity which promote the final stages of oxidation. Of great interest among these are certain combinations of metallic iron with pyrrol groupings. One such compound is concerned, possibly with the intervention of yet another, in bringing molecular oxygen into the field of activity. What, however, is specially interesting about these associations of pyrrol groupings with a metal is the wide extent of their biological functions.

We have long known, of course, of the presence of one such association in the chlorophyll molecule, where it functions as part of the trap for solar energy, and we have been long familiar with the presence of another in hæmoglobin, where its function is to hold oxygen during its transference from the lungs of vertebrates to their tissues. Further, we now know that, within the tissues, two others promote oxidation, and yet a third prevents by its presence any deleterious accumulations of hydrogen peroxide. For adjustment to each separate function there is some slight modification of a fundamental structure. Compounds of the type in question are found in many of the lower organisms. Just as Nature seems to have hit upon sound principles for nerve structure early in evolution, so she seems to have satisfactorily chosen, very early, the chemical materials for life. This same suggestion is carried by all the more important constituents of living stuff; fundamentally the same throughout, yet always with minor differences underlying specific morphological differences.

To return to cell dynamics. Knowledge of enzymic catalysts which, with highly specific relations, activate in a certain sense the molecules which are to suffer oxidation, is almost daily accumulating. It is because this specific activation must precede oxidation that the indiscriminate action of oxygen on the living cell is prevented. Although an understanding of the complex organisation of chemical events in the living unit is far beyond our present powers, we are, I think, beginning to see what kind of organisation it may be.

One last word, however. We have assumed that the living cells we have best known are the ultimate units in biology. But of late years the viruses have forced themselves into our thoughts. What are viruses? Do they merely simulate some of the properties of the living? Can we conceive of them as something between the non-living and the living? Are they alive? We do not yet know. Research upon them is at any rate intensely active at the moment. Its results may make it necessary to modify some fundamental biological concepts, and indeed be as revolutionary in their effects as the breaking up of the atom.

A Century of Meteorology.*

By Sir Napier Shaw, F.R.S.

THE progress of the science of meteorology to the evolution of the weather-map and beyond that to the introduction of broadcasting, which makes its treatment a matter of universal interest, can be traced from the unco-ordinated efforts of private observers, which were criticised in a report to the British Association in 1832 by J. D. Forbes, professor of natural philosophy in the University of Edinburgh, as the feeble expression of an infant science. It passes through the unfulfilled ambition of a Meteorological Society of London expressed in its transactions published in 1839 by John Ruskin, who defended the science as of universal interest and as necessarily dependent on universal co-operation, and then through the co-operative investigation of weather at sea, by which the tropical hurricane earned the name of 'cyclone' from Henry Piddington and riveted the idea of a travelling vortex on the science.

Co-operation in the study of weather at sea found further expression in the International Conference at Brussels in 1853, suggested by Lieut. M. F. Maury of the U.S. Navy, and the consequent formation of the Meteorological Department of the Board of Trade under Admiral FitzRoy in 1854.

About the same time, co-operation was extended to the collection of simultaneous observations from different stations by the aid of the electric telegraph. It began with some spasmodic efforts in 1851, and gradually developed until the weather-map in its present form, with the aid of wireless, is the most striking example of successful international co-operation.

Within each twenty-four hours the British Meteorological Office collects some seven thousand facts about the weather based on simultaneous observations at some hundred stations in Europe, Africa, Asia, the eastern Atlantic, its ships and its islands, in Greenland, Iceland and Spitsbergen, and the islands of the far north. The observations at the surface are supplemented by incidental observations of clouds and winds in the upper air, and occasional observations of pressure and temperature there too. Four hours of observation are chosen, and between the observing hours of 7 h. and 13 h. the observations for the twenty-four hours are transcribed, charted, printed, and posted with the inferences drawn from them about the weather to come.

For land-stations co-operation took the form of compiling observations of the meteorological elements as an expression of climate under the guidance of the British Meteorological Society from 1850, the Scottish Society from 1856, and the British Rainfall Organization from 1858. From the very beginning of regular observations the chronological sequence was used to identify the rhythm of the sequence of weather at individual stations as diurnal and seasonal. The temptation to seek for evidence of other rhythmic periods, especially those of the moon, was irresistible. It was ultimately guided into the righteous paths of harmonic analysis and the periodogram, which form an interesting chapter in the scientific history of the century.

Correlation came later when Galton had become disappointed with the behaviour of the cyclone and anticyclone. Francis Galton, who was one of the general secretaries of the British Association, had a great share in the development of the science of meteorology. He was actively interested in the establishment of a weather-map and also in the Kew Observatory in the Old Deer Park at Richmond, which was maintained by the British Association, and among other things he developed methods of recording automatically the variation of the meteorological elements.

When FitzRoy used his weather-maps to make public forecasts of weather and issue storm-warnings some prominent scientific authorities thought it premature, and on FitzRoy's death, at the request of the Government, a Meteorological Committee was appointed by the Royal Society to take on the work of the Meteorological Department of the Board of Trade and bring it into co-operation with the meteorological work of the British Association's Observatory at Richmond.

During twelve years a strenuous effort was made, chiefly under Galton's guidance, to use the records of the instruments at seven observatories like Kew to interpret the sequence of weather shown on the daily maps. Meanwhile forecasts were suspended. For twelve years every curve drawn by the instruments was reproduced with the associated maps for public information. The systems of closed isobars, now known as the cyclonic depression and the anticyclone, were the most striking features of the sea-level maps. The track and behaviour of every one of them during the twelve years was "set in a notebook learned and conned by rote". They were enthroned as Nature's proctors for the guidance of weather, and under their guidance forecasting was restored in 1879 by direction of those who had been critical in 1865.

The method of forecasting on the basis of cyclones and anticyclones was set out effectively by the Hon. Ralph Abercromby. The problem of the sequence of weather seemed to be solved. It was supposed that the progress of storms across the Atlantic could certainly be anticipated. Further investigation of the upper air by shell-bursts, by balloons, by the study of clouds under a new directing council, would clear up all the outstanding difficulties.

Somehow the effort failed. The maps used were bounded on the west by the Irish coast. Cyclones and anticyclones suggested rules of behaviour but did not keep to them, and a magnificent effort was made to find out the how and why of the irregularities by maps of the Atlantic and adjacent continents for the days of the year of polar exploration 1882–83; but no one has ever been able to make out a rational account of the behaviour of cyclonic depressions. The Norwegian school has traced with marked success the influence of the movement of the different kinds of air of which they are composed, but the origin of the currents of which they are composed is not yet understood. Disappointed, the council turned its attention to harmonic analysis of hourly values as a method of discovering the latent causes of weather, and Galton transferred his interest to eugenics.

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* Substance of a paper entitled "Meteorology after the Century" read before Section A (Mathematical and Physical Sciences) of the British Association on Sept. 25 during the centenary meeting in London.

All this while, Buys Ballot's law that wind is along the isobars with a deviation towards the low pressure and dependent for its strength upon the closeness of the isobars was recognised, and when the phenomena of turbulent motion were explained, it became apparent that the surface-layer was so much affected by turbulence that regularity in the relation of pressure to the surface-wind was not to be expected. But observation showed that in the upper air it might be assumed that the effect of turbulence is negligible, and the geostrophic relation between pressure-gradient and horizontal wind under the influence of the earth's rotation might be regarded as a definite meteorological law, most definite where isobars are straight and parallel. Moreover, it accounts for the development of high pressure, a matter which has been neglected in the study of weather. Wherever the horizontal wind in an air-current is not in agreement with the formula the rotation of the earth will push it sideways, from high to low if the horizontal component is too slow, from low to high if it is too fast. The adjustment will always be operative over the whole mass of the moving air so that the air may be regarded as adjusting the gradient to its motion as a bicyclist adjusts his inclination to the vertical.

In the concentration of attention on the closed isobars of cyclones and anticyclones the study of the straight isobars between them has been overlooked; and it may fairly be asserted that if the origin of the currents with straight isobars can be traced, they may be relied upon to adjust the pressure-gradient to meet the exigencies of the wind in the upper air, which is an indubitable expression of actual energy of vast amount.

Meanwhile, the air is everywhere stratified according to its entropy, and any change in the entropy by gain or loss of heat, by conduction to or from the ground, by radiation to or from the air, or by the condensation or evaporation of water within its mass, will have its effect on the stratification, and the readjustment of the stratification will transform the thermal energy of the air into the actual energy of wind. The currents of straight isobars have, therefore, an obvious claim upon the students of the dynamics of the atmosphere. The extension of the area of the daily map to include the whole hemisphere makes productive investigation possible.

To summarise, our survey leads to the conclusion that meteorology has been mistaken in regarding the cyclonic depression and the anticyclone of a hypothetical sea-level map as the principal agents in control of the energy of weather, and asks for the consideration of the currents in the free air indicated by straight isobars as expressing the real estate of energy in the atmosphere, while the differences in the distribution of entropy and water-vapour associated therewith represent its potential estate.

Recent Developments in Optical Glass Manufacture.*

By W. M. HAMPTON and W. N. WHEAT.

THE demand for particular types of optical glass has changed considerably during the post-War period, largely under the influence of the remarkable development of the modern photographic lens, which has been based on the production of the more extreme types of glass, notably the barium crowns.

This change is shown by the following table of the percentage of the various broad types manufactured by Messrs. Chance Brothers and Co., Ltd., of Birmingham, in the years 1914, 1918, 1929.

	1914.	1918.	1929.
Hard Crown and Zinc Crown	24	29	7
Borosilicate Crown	23	14	18
Light Flint and Baryta Light Flint	27	14	11
Dense Flint	23	27	13
Extra Dense Flint	2	4	16
Barium Crowns	1	12	35

Recent research has enabled the manufacture of the barium glasses to be put on a routine basis, the variation in optical constants from one melt to another not being appreciably greater than is normally obtained with the simpler types. This is largely due to the utilisation of refractories for the melting-pots of a composition which is sufficiently resistant to the solvent action of these very corrosive glasses, thus minimising the trouble, once serious, of dilution by aluminous material dissolved from the pot wall. Improvements in the knowledge of melting technique and of the volatilisation losses which accompany the process of fusion have enabled a more strict control to be exercised over the types of barium glasses which contain a percentage of boric oxide in place of silica, these glasses being indispensable in the manufacture of the modern wide aperture photographic lens. The most extreme example in this series has a refractive index of 1·6140 and a value of V, or reciprocal dispersive power of 59·8, representing the practical limit to which it has so far been found possible to go.

A knowledge of volatilisation losses is of great importance if exact control of the melting of the flint glasses is to be maintained, and it has been established that, within the limits of composition obtained in most optical glasses, the losses of any given oxide may be taken as being directly proportional to the concentration of that oxide, this proportionality holding in the case of lead oxide up to about 50 per cent concentration of PbO. Working at 1400° C. in a covered pot, it has been found that the loss of lead oxide may be expressed as 0·014 lb. per 100 lb. of glass for every one per cent of the oxide present, the corresponding figure for K_2O being 0·12. These values, of course, presuppose constancy in temperature, shape of pot, and length of melting-time.

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* Substance of a paper read at the Science Museum, South Kensington, on Oct. 29, in connexion with the Exhibition of Modern Technical and Artistic Glasses.

It is easily seen from the above considerations that in the case of an extra dense flint glass, approximately represented by SiO_2, 44 per cent, PbO, 50 per cent, and K_2O, 6 per cent, the loss in pounds of K_2O may exceed the total loss of PbO and the glass after melting actually be richer in PbO than is calculated from the batch composition.

With our present methods of manufacture, perfectly isotropic glasses are probably an impossibility. The degree of homogeneity obtained by stirring is the result of a compromise between various opposing factors. Thus the action of stirring, as the pot and the material of the stirrer itself are very slightly soluble in the glass, will tend to produce veins of different refractive index faster than they can be eliminated by the mixing process if the temperature of the melt is too high, this being due to the rapid increase of the rate of chemical attack with rising temperature. If volatile constituents are present a high temperature of stirring may mean that the surface of the glass, slightly poorer than the rest in the volatile oxide, may be stirred in faster than the resulting veins can be eliminated. On the other hand, too low a temperature produces a heavy 'drag', which may draw in aluminous material from the pot wall in sufficient quantity to render the melting useless.

The most noteworthy recent advance in optical glass manufacture is the production of improved refractories for pots. This work was undertaken recently by Messrs. Chance Brothers and Co., Ltd., with the co-operation of Sir Herbert Jackson, and full-scale pots based on the experimental small-scale samples have been in use for some time. It has been found that the more acidic glasses, such as the ordinary crowns and especially the borosilicates, are best melted in pots having a relatively acidic clay composition—$Al_2O_3,5SiO_2$ being typical. The more basic glasses, such as the flints and the barium crowns, need a lower concentration of silica in the pot material; in these cases a reduction up to 10 per cent of SiO_2 may be made. One of the immediate advantages gained from the use of these new pots was an improvement in the transparency to light of the resulting glasses. The task of measuring the small differences in absorption which exist between various meltings of optical glass is a difficult one, and the figures given in the present paper were obtained by the British Scientific Instrument Research Association, using an apparatus similar to that described by W. D. Haigh.[1]

It has been found that if the absorption per inch of glass material at each wave-length is plotted against percentage of iron oxide present in the glass, the points lie on smooth curves which do not pass through the origin but indicate a definite absorption at zero concentration of iron. However, the absorption in optical glass is largely proportional to the amount of iron oxide present, and the new refractories, coupled with the use of only the purest raw materials, have enabled this to be reduced to a minimum.

The extent of the improvement is shown by the following figures, which are published by permission of Sir Herbert Jackson:

Melt.	Iron per 10^6	Percentage of Light extinguished per Inch of Glass.						
		3650.	4078	4358.	4916.	5460	5790.	6500.
B S.C 5358	180	12 50	3 70	4 62	3·10	2 76	2·88	4 10
B.S.C. 6029	50	2·94	0·82	1 50	1·10	0 76	0 91	1·73

A similar improvement has been made in most of the optical glass types, particularly the dense flints, the barium crowns, and very heavy lead glasses of ^nD up to 1·8; and it is now safely claimed that the optical glasses of the new high transparency type made in Great Britain have a lower absorption of light than any glass of foreign manufacture.

In the efforts to eliminate iron oxide from the glass, work has been done on the purification of sand, and a process has been worked out and patented,[2] using a reducing gas such as sulphur dioxide and chlorine, which has on an experimental scale enabled the iron oxide concentration to be reduced from 0·008 to 0·0025 per cent. The use of purified sands may enable further improvements in transparency to be made in the near future, the present values being considered the maximum possible with existing raw materials.

Although from time to time it has been suggested that the chilling which takes place in moulding may cause heterogeneity in optical glass which is not removed by the subsequent annealing, no direct evidence in support of this has yet been advanced, and it is still considered that the laws approximately represented by Twyman's equation are the only considerations which govern the degree of freedom

Type.	Refractive Index and Value of *V*.	Autoclave Test (4 Atmospheres)	Test using Steam. Steam under Atmospheric Pressure.
B.S.C. .	1·5090 64·3	Unattacked	Unattacked.
H.C. .	1·5159 60·3	Practically unaffected	Unattacked.
L.F. .	1·5475 45·3	Slightly affected	Slightly affected (wipes clean).
Soft Crown	1·5143 56·8	Marked filming	Unaffected.
E.L.F. .	1·5337 49·1	Badly attacked	Surface dulled but wipes clean.
D.B.C. .	1·6140 56·2	Slightly affected	Severe iridescent tarnish.
D.B.C. .	1·6140 59·4	Slightly affected	Completely dulled.

from strain of a block after a certain heat treatment. The essential condition is the accurate measurement of the upper temperature at which strain in the glass block is released in a reasonably short space of time.

Research on methods of testing the resistance of polished glass surfaces to atmospheric attack has led to the abandonment of the old autoclave test of superheated steam at four atmospheres pressure. The abnormality of the conditions of this test must make the results open to doubt, and it has been found that the modified method of testing in water-vapour at atmospheric pressure and a temperature of 80° C. gives results more in accordance with general experience, although the period of the test has to be increased from two hours to two weeks. The revised method of testing puts the various types of optical glass in a different order as regards resistance to surface attack, some of the types previously thought unstable from the results of the autoclave test now being shown to be perfectly reliable, while certain other types previously thought of fair durability are now shown to be very unstable, confirming the experience of the lens manufacturer.

The table on p. 927 shows the classification of representative types of optical glass according to the autoclave and atmospheric durability tests.

Among the new types which have been successfully produced in recent years is a dense barium flint made of ^{n}D 1·6437, $^{n}C - {}^{n}F$ 0·01332, V 48·3, which is as extreme a member of the flint series as the barium crowns are in the crown series. The very heavy lead glasses of ^{n}D up to 1·8 are now produced in large blocks of a degree of homogeneity and freedom from colour never previously attained, this being largely due to the use of the new refractories and correct temperature control in melting.

[1] "Proceedings of the Optical Convention", 1926.

[2] Brit. Pat. 325,386 (1929), Chance Brothers and Co., Ltd., and J. English.

Obituary.

DR. S. W. STRATTON.

SAMUEL WESLEY STRATTON was born at Litchfield, Illinois, in 1861. He graduated in 1884 from the University of Illinois, where he remained for the next eight years, at first as an instructor, then as professor of mathematics, and finally as professor of physics and electrical engineering. In 1892 he became assistant professor of physics and later professor in the University of Chicago. Nine years afterwards he was invited by the Assistant Secretary of the Treasury to formulate a project for the development of work on weights and measures, and in 1901 was mainly responsible for the Act which established the Bureau of Standards at Washington. Of this he became the first director, retaining the position until 1923, when he was appointed president of the Massachusetts Institute of Technology. He had a lifelong connexion with the American Navy, and in 1898 served during the Spanish American War. This brief summary of his activities shows that the most important part of his work was connected with the Bureau of Standards, which is indebted to him for its existence and for many of its most striking developments.

Stratton was a welcome visitor to the National Physical Laboratory, and spent some time at Bushy House in early years; from this time on the connexion between the two institutions has been a close one. Visitors to the National Physical Laboratory will remember an old chestnut tree near the door of Bushy House, said on good authority to have been planted by Charles II. Round the Bureau of Standards, when founded, was a wood of chestnuts; the site was part of Washington's estate, and tradition says that, after one of his visits to England, Washington took back the chestnuts which formed the nucleus of this wood.

An Electrical Congress, in connexion with an International Exhibition, took place at St. Louis in 1904 and proved to be Stratton's introduction to that international work which for the rest of his life occupied much of his time. This Congress passed two important resolutions: one in favour of a formal International Conference to deal with electrical units, the other inviting the leading technical societies of the world to co-operate in the standardisation of electrical machinery; the first led to the International Conference on Electrical Units in London in 1908, the second to the establishment of the International Electrotechnical Commission.

After the St. Louis Conference, at which I represented the British Government, I spent some time with Stratton at Washington discussing with him, much to my own profit, questions of laboratory organisation suitable for any institute such as those we directed respectively. In 1905 he became a member of the International Committee of Weights and Measures and, as a result, a frequent visitor to this side of the Atlantic

The International Electrical Conference foreshadowed at St. Louis was summoned by the British Government and met in the rooms of the Royal Society in October 1908. Stratton was prominent among the American delegates; he was accompanied by Dr. E. B. Rosa, who had done much valuable work at the Bureau on electrical units.

A distinction had been drawn at the Chicago Electrical Congress, some years previously, between the ohm, the ampere, and the volt, multiples of the C.G.S. units, and the International Ohm, Ampere, and Volt taken to be close approximations to the absolute units, and defined in a manner which it was hoped would permit their realisation with sufficient accuracy for all practical purposes in any fully equipped laboratory. Some of the American delegates would have preferred definitions based only on the C.G.S. units.

The Conference also passed a resolution recommending the various governments interested to establish a permanent International Commission for Electrical Standards and, pending the appointment of this, requested its president, Lord Rayleigh, to nominate a committee to advise as to its constitution and to direct such work as might be necessary in connexion with the maintenance of standards. It was suggested that the functions of the International Conference of Weights and Measures might be enlarged with the view of some combination of effort. The Electrical Conference was of opinion, however, that the Permanent Electrical Commission should be a distinct body.

Stratton was closely concerned in the consequences which followed from these two resolutions and took an active part in the development of each. He was a member of Lord Rayleigh's Committee, and in connexion with the maintenance of standards invited representatives of the Reichsanstalt, the Laboratoire Centrale d'Électricité, and the National Physical Laboratory to meet at the Bureau of Standards in 1910 and complete the work, left incomplete in 1908, of preparing specifications for the standards. The representatives (Dr. E. B. Rosa and Dr. Wolff, Dr. W. Jaeger, Prof. F. Laporte, and Mr. F. E. Smith) met at Washington and worked together during a large part of 1910; their report, "On the Concrete Standards of the International Electrical Units", was issued in January 1912 and has formed up to the present the basis of international co-operation. Dr. Stratton undertook the duties of treasurer of Lord Rayleigh's Committee and collected funds to meet the cost of this joint investigation from certain American societies interested in electrical matters.

The establishment of a Permanent International Electrical Commission was a more difficult matter. The International Conference of Weights and Measures was established to give effect to the resolutions adopted in 1875 by the Metric Convention. The Conference dealt solely with standards of length and mass. To these had been added, as a necessary outcome of accurate measurements of length and mass, the standardisation of a limited range of temperature. A committee of the Conference guided the work of the Bureau International des Poids et Mesures at Sèvres, and Stratton had been a member of this committee since 1905. He believed that the enlargement of the functions of the Conference offered the best solution of the problem of establishing an International Electrical Commission.

After his retirement from South Africa, Sir David Gill became the British representative on the Conference of Weights and Measures, and Stratton found in him a congenial colleague and a cordial supporter, but 1914 prevented the immediate realisation of his ideas. This, however, was achieved, not entirely in the manner originally suggested, in 1927, when the Committee of Weights and Measures adopted the following resolution, ratified later by the Conference: "The International Committee of Weights and Measures approves the organisation of a Consultative Committee for Electricity to advise the International Committee of Weights and Measures on questions relating to systems of Measurement and Electrical Standards". That Committee is now in being and has already done valuable work; the International Committee of Weights and Measures has become the central organisation for the issue of electrical standards. For this purpose it works in close co-operation with the national standardising laboratories, and the standards it proposes to issue will be based on the comparison and co-ordination of the results of these laboratories. At the meeting of the Conference held during the current year, at which Dr. Stratton was present, photometric standards were brought within the ambit of the Committee.

International standardisation did not by any means include the whole of Stratton's work. Since the War, standardisation has been much to the fore in the United States as elsewhere, and Stratton has been a leader on many of the committees dealing with engineering matters. He was a member of the National Screw Thread Commission, and all who have had occasion to study the report of that Commission have appreciated the thoroughness with which its work was done and the value of its results. Stratton was himself a very skilful mechanic. He also served on the National Research Council and on the Advisory Committee for Aeronautics, which under the guidance of Dr. Ames has done much to secure to America a leading place in the scientific study of aviation problems.

Stratton's friends in England welcomed him recently as a delegate to the British Association, Faraday, and Clerk Maxwell centenary meetings in London and Cambridge. These he enjoyed greatly. We met at the National Physical Laboratory and discussed old times, and again at Cambridge, by chance in a bookshop where he was collecting literature relating to Maxwell, as well as during the meetings themselves. He was a guest at Caius College, much impressed by the advantages of college life and the kind hospitality of his hosts.

The end came on Oct. 19, soon after his return to Boston—"No warning, not a moment's illness—just fell forward while talking, that's all" are the words of a letter telling me about it.

R. T. GLAZEBROOK.

MR. ELSDON BEST.

ELSDON BEST, doyen of Polynesian ethnology, died at Wellington, New Zealand, last September. He was born in 1856 at Porirua and had little schooling, but was from his earliest years associated with the Maori population. At eighteen years of age he was in the Poverty Bay district, then emerging from the shadow of Te Kooti's massacres, working in the bush on fencing and felling contracts. He joined the armed constabulary for the, as it turned out, bloodless campaign against Te Whiti, the latter part of his service being in control of a party of 'friendlies' in the bush. In 1883 he went to Honolulu, later moving on to California, engaging in timber work among the redwoods of the Sierra Nevada. He then moved east into Arizona, New Mexico, Texas, and Louisiana, working as a cowboy and as foreman in railroad construction. At the end of 1886 he returned to New Zealand and entered on the period of twenty-five years' intimate connexion with the Maoris which furnished him with the material for his long series of books and bulletins. The latter part of his life was spent in Wellington, on the staff of the Dominion Museum.

Varied experience among men gave Elsdon Best ease of manner, and this, coupled with unusual natural gifts—sound judgment, clarity of thought, and quick decision—left a deep impression on all who met him. He was a master of direct English and had great linguistic abilities, best seen in his mastery of the Maori language, which he spoke in later years more accurately than any living Maori. To this was added the gift of thinking like a Maori. His achievement lay especially in accurately recording difficult data.

In the opinion of the late W. H. R. Rivers, Best was the greatest of all ethnological field workers who have worked in the Pacific. He changed the whole face of Maori ethnology, incorporating in his publications all old data of any value and placing on record a mass of his own data far surpassing, both in quantity and quality, all that had been recorded before him. By his death New Zealand has lost one of the first intellects among her native born.

H. D. Skinner.

Mr. Henry Garnett.

Mr. Henry Garnett, for many years director of Messrs. Flatters and Garnett, Ltd., opticians and scientific instrument makers of Manchester, died on Nov. 3, aged sixty-three years. Henry Garnett was born in Waterford, Ireland, in 1868, where his father was head of Newtown School (of the Society of Friends). There he formed a close friendship with the naturalist J. H. Salter (afterwards professor of botany at Aberystwyth). He was apprenticed to a chemist in Evesham, and during his scant leisure collected a herbarium which was awarded the Bronze Medal of the Pharmaceutical Society. Later he won the Bell Scholarship, and after passing the minor and major (1890) examinations, he secured three silver medals and the Pereira Medal. He worked out, under the direction of Prof. Dunster, the active principles of *Piper ovatum*, and some years later, with Mr. J. Grier, conducted a research into the active principle of ginger, contributing papers to the Pharmaceutical Conference in 1907. Mr. Garnett was keenly interested in birds and plants, and at the time of his death was vice-president of the Manchester Microscopical Society.

We regret to announce the following deaths:—

Major-General Sir David Bruce, K.C.B., F.R.S., president of the British Association at the meeting at Toronto in 1924, who was a pioneer in the study of tropical medicine, on Nov. 27, aged seventy-six years.

Mr. James H. Dellbridge, who was second engineer in Capt. Scott's first Antarctic Expedition, on Nov. 12, aged fifty-nine years.

Prof. W. A. S. Hewins, first director of the London School of Economics, formerly Tooke professor of economic science and statistics at King's College, London, and formerly Under-Secretary of State for the Colonies, on Nov. 16, aged sixty-six years.

Sir Thomas E. Hill, O.B.E., lately medical officer of health for the County of Durham and formerly professor of public health in the University of Durham, on Nov. 25, aged sixty-six years.

Mr. W. F. Reid, an original member of the Society of Chemical Industry and former president of the Society, known for his work on smokeless powder, on Nov. 18, at an advanced age.

News and Views.

The Savilian professorship of astronomy at Oxford, to which Prof. H. H. Plaskett, professor of astrophysics at Harvard University, has recently been appointed, is the oldest chair of astronomy in Great Britain, with the exception of that at Gresham College, London. Like the Savilian professorship of geometry, it was founded in 1619 by Sir Henry Savile (1549–1622), the Elizabethan scholar, provost of Eton, and warden of Merton College, Oxford. John Bainbridge became the first occupant of the chair, Henry Briggs being his colleague in the chair of geometry. Briggs died in 1631 and Bainbridge in 1643, and both were buried in the choir of Merton College Chapel close to the memorial to Sir Henry Savile. During the renovation of the chapel, a good many years ago, the tombstone of Briggs and the memorials to Savile and Bainbridge were removed to the west end of the chapel, where they are to be seen to-day. The immediate successor of Bainbridge was John Greaves, who measured the pyramids; he was deprived of his chair by Parliament in 1648. The chair then passed to Seth Ward, afterwards Bishop of Salisbury, while among his successors have been Wren (1661–1673), David Gregory (1691–1708), Bradley (1721–1762), Thomas Hornsby (1763–1810), Rigaud (1827–1839), W. F. Donkin (1842–1869), Charles Pritchard (1870–1893), and the late Prof. H. H. Turner, who held the chair from 1893 until his death last year.

It is announced in the *Times* that on Nov. 26, at the University of Coimbra, a room was dedicated to the memory of Sir Isaac Newton. At the invitation of the Rector, Dr. João Duarte de Oliveira, the British Ambassador to Portugal presided over the ceremony, and the opening speech was delivered by Sir Frank Dyson, the Astronomer Royal. Afterwards addresses were delivered on Newton's mathematics, physics, and philosophy, and on the law of gravitation; and the Ambassador then unveiled a bronze name-plate in the Sala de Newton in the observatory. Coimbra, once the capital of Portugal, is picturesquely situated on a hill on the bank of the river Mondego. The earliest certain information of a university in Portugal dates from 1288, but it was three years later that a "Studium Generale" was founded at Lisbon. That city not proving suitable, the new school was removed to Coimbra in 1308, but in the next two centuries it was twice transferred to Lisbon and back again, its final removal to Coimbra being in 1537, in the reign of John III. One of its professors in the sixteenth century was the famous Scottish reformer George Buchanan (1506–82), who went to Coimbra in 1547 and was imprisoned by the Inquisition. Mathematics and natural philosophy were first taught there in 1770, after the University was reorganised, and to-day there are five faculties, theology, law, medicine, mathematics, and philosophy. Coimbra has a population of about 20,000, and the students number 1400 or more.

THE Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1932 to Prof. V. F. K. Bjerknes of the Physical Institute of the University of Oslo, Norway. The medal is awarded for distinguished work in connexion with meteorological science and will be presented at the annual general meeting on Jan. 20. Prof. Bjerknes was born at Oslo on March 14, 1862. He received the degree of doctor of philosophy at Oslo in 1892, and from 1907 onwards has been professor of mechanics and mathematical physics at various universities in Norway and at Leipzig. His work deals almost entirely with the mathematical description of the motion of moving fluids, and especial reference must be made to the two volumes and plates of "Dynamic Meteorology and Hydrography", published at Washington in 1910 and 1911 and in German at Braunschweig in 1912. He has devoted much attention to the theory of cyclones, and has written several of the Norwegian series of Geophysical Publications on this subject. His work played a large part in the development of the Norwegian theory of the 'polar front', and in 1920 he read an important paper before the Royal Meteorological Society on "The Structure of the Atmosphere when Rain is Falling".

As Lord Moynihan remarked in laying the corner-stone of the Wellcome Research Institution on Nov. 25 (see also p. 974), the ceremony might well be regarded as referring to the corner-stone of a long life's work. The various constituent research laboratories of the Wellcome Research Institution are perhaps better known than some of Dr. Henry Wellcome's other scientific activities. Since the time when he paid a visit to the South American cinchona forests in 1879, Dr. Wellcome has given many evidences of his interest in the tropical regions. The results of his archæological excavations in the Anglo-Egyptian Sudan will, when published, throw new light on the racial history of north-east Africa. At the Wellcome Tropical Research Laboratories in Khartoum, Sir Andrew Balfour made war on the malaria-carrying mosquitoes by means of a highly organised system for searching out the mosquito breeding-places and destroying the larvæ. The researches on trypanosomiasis, kala azar, and other tropical diseases were carried out there with most beneficial results. By the establishment of this research centre, Dr. Wellcome has thus contributed materially to the welfare, not only bodily, but also morally, of a large section of the population of the Sudan. In 1914, Dr. Wellcome instituted a special commission to secure improvements in the construction of field ambulances, and equipped and supplied for the Army Medical Service a medical research laboratory which gave valuable service in Palestine and Egypt. In 1905 he founded the Medical Dispensary at Mengo, Uganda; and in 1927 he founded at the same place the Lady Stanley Maternity Centre.

Two hundred years ago, on Dec. 12, 1731, Dr. Erasmus Darwin, the physician and poet, grandfather of Charles Darwin and Sir Francis Galton, was born at Elston Hall, near Newark, being the youngest son of Robert Darwin, "a person of curiosity" who had married a daughter of Erasmus Earle, a sergeant-at-law and a member of Parliament. Entering St. John's College, Cambridge, at the age of nineteen, he graduated B.A. in 1754 and afterwards studied medicine at Edinburgh. He first practised at Nottingham, but after a short time, removed to Lichfield where he married and became a popular physician and a prominent figure in intellectual circles. His ability, his radical opinions, and his advocacy of temperance in drinking gained for him as much fame as his eight-acre botanical garden, his poetry, and his speculations. A friend of Wedgwood, Boulton, Watt, Priestley, Edgeworth, and others, he was a member of the once famous Lunar Society, which arranged to hold its meetings at the time of full moon, so as to facilitate travelling. Few to-day probably read his "Botanic Garden", his "Zoonomia, or the Laws of Organic Life", or his "Phytologia, or Philosophy of Agriculture"; all of which, however, testify to his originality and enthusiasm. An inventor himself of mechanical contrivances, it was with a knowledge of Watt's work on the steam engine that he wrote the oft-quoted lines:

> "Soon shall thy arm, unconquer'd Steam, afar
> Drag the smooth barge, propel the lumbering car
> Or on wide-waving wings expanded bear
> The flying chariot through the fields of air."

ERASMUS DARWIN'S first wife, Mary Howard, died in 1770, and in 1781 he married the widow of Colonel Chandos Pole. Shortly afterwards he removed to Radbourne Hall, and thence to Derby and finally to Breadsall Priory, where he died suddenly on April 18, 1802, at the age of seventy-one years. By his first wife he had three sons, the third of which. Robert Waring Darwin, who married Susannah Wedgwood, was the father of Charles Darwin, who was born in 1809. By his second wife, he had four sons and three daughters, of which Frances Anne Violetta married Samuel Tertius Galton, and had four daughters and three sons, the youngest member of the family, Francis, who was born in 1822, becoming famous as the founder of eugenics. To him was due the erection of a monument in Lichfield Cathedral to his grandfather, Erasmus Darwin.

THE twenty-ninth annual report of the Imperial Cancer Research Fund, presented at a meeting of the general committee on Nov. 25, records another year of the sound work and steady progress which is characteristic of that organisation. The investigations which have been in hand deal mostly, in one way or another, with resistance to cancer. For, helpless as the body may seem in the presence of rampant malignant disease, there is no doubt that it does put up some sort of resistance which, in animals at any rate, may be demonstrably successful. On one hand, Dr. R. J. Ludford has analysed the cellular reactions to implanted cancer, using their reactions to various dyestuffs to identify the cells and to indicate their functional capacity. He has in this way shown that the immunity which can be conferred by the inoculation of embryo skin depends on the connective tissue reaction. Dr. W. Cramer, on the other hand, from the study of mortality statistics, shows that an excess of cancer in one organ is often compensated for in the same community by a deficiency of cancer in other parts of the body: the presence of one tumour, that is, makes the body to some extent resistant to the development of another.

SIR ALFRED EWING's Friday evening discourse on Nov. 27, at the Royal Institution, was a tribute to the life and work of the late Sir Charles Parsons. The genius of Parsons opened up a new era in the production and distribution of power. With Parsons the development of an invention was a patient, laborious advance from experiment to experiment, rejecting the good for the still attainable better. In 1884 Parsons introduced his earliest compound steam turbine; in 1891 he took the further step of continuing the expansion in the turbine down to the low pressure attainable in a condenser. Before long this enabled the turbine to surpass the older engine of Newcomen and Watt in the efficiency with which it converted heat into work. Thanks mainly to further inventions by Parsons, a great modern steam turbine not only develops power in unprecedented quantity, but also with an economy of coal previously unknown. The steam turbine has an almost complete monopoly as a power generator in central stations, except, of course, in countries where hydraulic sources are available. In 1894 Parsons began to apply the turbine to marine propulsion, and in 1897 his little experimental vessel, the *Turbinia*, astonished the Fleet at Spithead. Before long the turbine was adopted in all warships and in many vessels of the mercantile marine. For the largest ships it gives a concentration of effective power that is attainable in no other way.

IN the report of the Newcomen Society for 1930–31, which was read at the annual general meeting held on Nov. 25, at the Chartered Institute of Patent Agents, reference was made to the need of steps being taken for the prevention of the decay of monuments to distinguished engineers and scientific men. The Society itself has done much in this direction and its example might well be followed by other bodies. In one instance a member of the Newcomen Society was able to locate the tombstone of John Blenkinsop, the pioneer of the locomotive, while the Society contributed towards its restoration. In the case of the monument in Row churchyard to Henry Bell, the pioneer of the steam boat, which was falling into neglect, through the Society the Institution of Shipbuilders and Engineers in Scotland was led to inquire into the matter and to arrange for the monument to be cared for. Following its usual custom, the Society, on Aug. 5, 1931, placed a wreath on the memorial at Dartmouth to Thomas Newcomen to mark the anniversary of his death, and early this year took the initiative in arranging for the celebrations of the centenaries of Henry Maudslay and William Symington. The membership of the Society now stands at 321, of which 63 are institutions and libraries at home and abroad which receive the *Transactions*. Up to the present, one of these subscribing institutions has been the Science Museum, and it is with regret that we learn that the call for economy has led to its withdrawal from the Society. In view of the closely related aims of the Science Museum and the Newcomen Society, and the work done by both, it is surely not too much to ask that this decision be reconsidered, especially as the sum at stake is only twenty shillings.

ON Nov. 26, the new Ramsay Memorial Laboratory of Chemical Engineering at University College, London, was opened by His Royal Highness Prince George, in the presence of a large and distinguished assembly representing many branches of science and industry. His Royal Highness, addressing the assembly in the Great Hall of the College, paid a graceful tribute to the life and work of Sir William Ramsay. He went on to say that the new laboratory should do much to bring scientific research in chemistry and engineering into closer contact with the needs of modern industry. The chemical engineer is an earnest student of the mechanism of his processes from all points of view: he deals not only with chemical reactions, but also with questions of suitable materials, heat balances, etc. He also makes full use of every branch of physics and engineering for the production of the perfect manufacturing plant. Such a spirit could well be introduced into all industries; it is not too much to say that a thorough study of these principles would go a long way towards restoring British manufactures. In chemical engineering, as in every other subject, an attempt should be made to maintain a balance, so that pure research, chemical engineering, engineering proper, and economics are linked together and play their part in that scientific harmony which can maintain Great Britain in her position as one of the greatest nations in the world. His Royal Highness then proceeded to open the new laboratory, and afterwards made a full inspection of the building, unveiling the Ramsay Memorial tablet.

IN his address on "Communications" to the Institution of Electrical Engineers on Sept. 22, which has just been published in the Institution's *Journal*, Sir Oliver Lodge points out clearly the essential difference between telegraphic and radio transmission. He says that the theory of wired signalling is not so simple as that of etheric signalling. Historically it came first, but if it had come later it would have been regarded as an improved method, because it enables privacy to be obtained: it is not broadcast, but concentrated. The answer to the question why a wire acts as a speaking tube is not very simple. Most people think that the wire conveys the impulse; but a metal wire is only a piece of matter, and has no power of transmitting ether waves. Directly the waves enter the wire, which they do laterally, they are dissipated, their energy being converted into heat. But the very fact that some of the energy does enter the wire enables the wire to act as a guide or director. The energy does not travel through the wire: it travels in the ether outside the wire. The laws which it follows are such that the main part of the wave does not leave the wire and spread out in all directions, but travels near it and so can be received at the far end without much diminution of intensity. It has to be remembered, however, that the waves in wired signalling are to some extent distorted. They do not all travel at the same rate, and these different rates cause the shape of the complex wave to be altered in the act of transmission. When pulses travel in the free ether they arrive without distortion. Hence it is possible to telephone freely by wireless across the Atlantic, although it is impossible to telephone through a cable.

THE paper read to the Royal Society of Arts on Nov. 17, by M. Hochstadter, W. Vogel, and E. Bowden, on an improved method of constructing high-voltage cables marks an important departure in cable construction which may have far-reaching consequences. It seems that by this new method, high-voltage cables could be installed at a cost which would render them formidable rivals to overhead cables. Large telephone networks, which were formerly strung overhead, are now placed underground, and if the new cable fulfils the expectations of its designers, overhead power lines may gradually be replaced by underground cables. At the present time, manufacturers and engineers have been using oil-filled cables for high-pressure work fairly successfully, but they are expensive and only compete with overhead lines in very special cases. In the new method the cable is drawn inside a pressure-tight steel pipe. Lengths of cable up to 550 yards can be drawn into the pipe without trouble. The pipe is then filled with nitrogen gas at a pressure of fifteen atmospheres, eight cylinders of nitrogen being required per mile. No stop-joints, pressure tanks, or expansion tanks such as are necessary for oil-filled cables are required. The thermal characteristics of the cable being good, it can carry a forty per cent greater load than the normal cable. In the case of a serious fault, the nitrogen employed as the pressure medium would have a quenching effect. Experimental results given in the paper show that the pressure cable shows technical and economic advantages over the oil-filled cable. The authors have benefited by the experience gained during the last twenty years, and their cable seems to have guarded against the ordinary causes of breakdown most scientifically.

A COMMITTEE of the Department of Scientific and Industrial Research, under the chairmanship of Sir William Bragg, has issued a short Report on "The Application of X-ray Crystal Analysis to Industrial Problems". (H.M.S.O.; 9*d*. net.) It is only eighteen years since the discovery was made that X-rays could be employed to determine the internal structure of crystals; and already results of great value to pure science and to industry have been obtained. It was found that the crystalline condition was far more widely extended than had been supposed, and that such substances as cotton, silk, hair, rubber, wood, muscle, and so on were more or less crystalline, and that their behaviour was closely connected with this condition. During the past three years the new method of analysis has been tested at the National Physical Laboratory, and the work, which has been of an exploratory character, is described in the Report. The method can be used to differentiate between mixtures, solid solutions, and pure compounds. In addition, the method yields information as to the size of the crystals in a substance. A material composed of crystals so small that they are well beyond the range of microscopic vision will still yield an excellent diffraction pattern. It is often found that the suitability or otherwise of a substance for a particular purpose depends on the state of subdivision rather than on its chemical composition. Again, it may happen that as a result of treatment the original random distribution of the crystallites is disturbed and the crystals tend to set themselves in some particular direction. This is shown, for example, in a metal subjected to rolling or drawing, and also in such substances as rubber, cellulose, and silk. The Report is illustrated by a number of excellent plates showing typical diffraction patterns for steels, paints, artificial sapphires, and other materials.

ONE of the series of lectures on "Physics in Industry" arranged by the Institute of Physics was delivered on Nov. 26 at the Royal Institution by Mr. A. Whitaker, who took as his subject, "Physics in Sound Recording". The fundamental inventions of the phonograph and gramophone were rendered possible by the general appreciation of many physical principles by the inventors of the last quarter of the nineteenth century, but the application of systematic quantitative investigation was delayed until the beginning of the last decade, when a technique, developed in connexion with telephony and radio, was applied to sound recording. Since this stage, the progress of sound recording and reproduction has been extraordinarily rapid. Knowledge of the limitations of existing systems has also accumulated, and a better appreciation of the extent to which improvement should be attempted. Both the general improvement in quality, which can be confidently anticipated in the light of recent physical research, and the special requirements and applications of sound recording to the gramophone, the sound film, and radio broadcasting, are likely to keep the research laboratories and factories of the industry busy. The sound-recording industries offer a remarkable example of cases where commercial enterprise may be revolutionised almost suddenly by discoveries emanating from their own laboratories or from the research organisations of technically allied industries. These revolutionary changes come, if unexpected, like tornadoes to the ship of commercial enterprise. It is the duty of the physicist in industry to act as weather prophet, and when the tornado arrives, as pilot.

Appliances for counteracting the rolling of a ship on a seaway have often been devised. In the British Navy gyro-stabilisers have been used for several years, and they have been installed on some large yachts. In the *Westinghouse International* for the last quarter of 1931 a description is given of the forty-ton stabilising device soon to be installed on the new 2000-ton Italian destroyer leader *Pigafetta*, now being constructed in the Royal Naval Yard at Spezia. The big gyroscopic machine, the rotating part of which weighs eighteen tons, was designed by the Sperry Gyroscope Company of Brooklyn. It was recently inspected and seen under test by naval attachés of the great powers. The rotor is ninety-one inches in diameter and twenty-two inches in thickness at the rim. The maximum speed of the great wheel is 1350 revolutions a minute, giving a peripheral speed of 32,000 feet a minute. The rotor is said to have been so carefully constructed that only 7·5 ounces of weight change was made on one side so as to ensure an accurate balance and smooth operation. New records in accuracy of gun-fire are expected as a result of the stabilisation. On a calm sea also the ship can be rolled at will by the gyro-stabiliser so as to increase gun elevations and thus secure a longer range of gun-fire. In rough weather the gyro-stabiliser eliminates heavy rolling and increases the ease with which the ship can be manœuvred. It also saves power; a twenty-degree roll is estimated to produce a ten per cent loss of propelling power. It is stated that the *Pigafetta* when completed will be the most efficient warship of its type in the world.

For the past eight years the British School of Archæology in Athens has been engaged in a series of excavations on prehistoric sites in Macedonia, which has established the existence of a uniform metal-using culture distributed throughout central and western Macedonia and Chalcidice during the latter half of the second millennium B.C. The affinities of this culture lie unmistakably with Troy and north-west Asia Minor; but it has at the same time such striking affinities with the early Helladic culture of south and central Greece itself, which is held to be of south and west Anatolian origin, that a common source for both cultures may be inferred. In a survey of the results of the School's work in this field, which Mr. W. A. Heurtley, the Director, contributes to *Man* for October, it is pointed out that while the persistence of the old Anatolian element, despite interruptions, into the iron age and the period of Greek penetration, has been established in central Macedonia and Chalcidice, in western Macedonia there is a gap in the records. Of the three sites excavated there, two, Servia and Amenochori, were occupied after the end of the early bronze age, while the third, Boubousti, is late bronze and early iron age. The north-west corner, around the head-waters of the Crna river, still remains unexplored. Investigation of this area is imperative to complete the School's programme in Macedonia. Two campaigns will be required, for which the goodwill of the Jugo-Slav authorities is assured. Further, Mr. Heurtley points out, such exploration may furnish evidence which will date the first period of Vinča, a result of which the significance was indicated by Prof. Vassitz's communication to the recent meeting of the British Association, in which he dealt with his excavations on that site.

The famous Roman camp at Housesteads, on the line of the Tyne-Solway Wall, is now the property of the National Trust, so that its vivid story of activity and conquest will be told to the people for all time. The camp is but an incident in a great defensive scheme, and the aspect which arouses the grand impression of the skill and indomitable force of the Romans is the wide view of the Wall itself running for miles up hill and down dale, deviating from the straight path only when some surface feature of the country offers special advantages for defence. Dr. Vaughan Cornish makes the admirable suggestion that this larger aspect of the Roman handiwork should be enshrined in a Housesteads National Park. The area would be about nine miles long by five broad, with Housesteads as its middle point, and would include the course of the Wall from near Carraw on the east to the summit of the ridge between Caw Gap and Haltwhistle Burn on the west. It is an unspoiled country, suitable in its remoteness and non-arable nature, grand in its possession of basaltic cliffs or 'crags', rising to 1230 feet, of which the Wall makes full use, and which afford glimpses of the Cheviot borders and the mountains of Lakeland. It is a park which could be devoted to recreation, education, and research. Dr. Cornish's views are contained in a pamphlet based upon his British Association address and published at the Map House, 67 St. James's St., S.W.1, at the price of one shilling.

Whether or no evolution has come to a close in wild Nature, animals under the control of man appear to be continuing to vary as much as ever. At the British Aquarists' Association show held in October, a blue goldfish of a scaleless variety was exhibited, and the present writer has seen an ordinary scaled goldfish of a steel-blue colour. Of late years, golden-yellow goldfish, as opposed to the red, which is usually the actual colour of 'gold' fish, have become quite common; it is tempting to regard these as representing the original variation, which may have been supplanted in public favour by the more richly coloured red variety, when this appeared; but Darwin, in "The Variation of Animals and Plants under Domestication", quotes an ancient Chinese work on the production of fish with vermilion scales. One fact about the colour variations of goldfish is worth noting: though gold-and-black, gold-and-white, and tricolour specimens are familiar, like the self-coloured gold and silver, black-and-white is almost as rare as blue, which seems curious. In canaries, Mr. G. E. Weston recently recorded in *Cage-Birds* the exhibition of a nearly black variety; whites and greys, like the yellow goldfish, have been in evidence for some years, but these are undoubtedly not new, having been mentioned by old authorities.

A note by Mr. C. S. Webb in the *Avicultural Magazine* for November throws light on what has always been a puzzle in the habits of trogons—why the neotropical species of this ancient tropicopolitan group, which, unlike the Old World forms, are mainly frugivorous, should fly at their food and pluck it on the wing instead of settling to gather it. He saw, in Guiana, a trogon alight on a bush about twelve feet away from some berry-bearing branches and, after a pause, fly out at these seven or eight times, each time plucking a berry and returning to its first perch to eat it. The reason for such an apparent waste of energy was revealed as soon as the trogon left, for the next fruit-eating bird to arrive, a tanager, settled among the berries and instantly fell a victim to a tree-snake which had been lying in ambush. It is quite possible that the fruit-eating habit in American trogons is a comparatively new one in the history of the race, and that the habit of darting out even at this stationary food is merely the blind instinctive continuance of the original fly-catching habit; but the above observation shows that it is certainly justified by results, and may perhaps, after all, be attributed to intelligence. To sit on a perch and dart out at any food looks lazy in a bird, but the habit at any rate encourages observation and gives time for reflection.

In the interests of the progress of forestry in Great Britain, it is pleasing to note that *Forestry*, the journal of the Society of Foresters of Great Britain (founded a few years ago), maintains its level of excellence. Vol. 5, No. 1 (June 1931), commences with the address delivered to the Society at the annual meeting of this year by the president, Dr. J. D. Sutherland. Two departures have been inaugurated in this number. The president had suggested that a series of biographical memoirs on notable men who have contributed to British forestry should be commenced. In the present number Dr. Sutherland contributes an article on Archibald Menzies, the botanical explorer, whose name is well known to the British forester in connexion with the Sitka spruce. The second departure is due to a suggestion of Sir R. L. Robinson that all available knowledge on the subject of the Sitka spruce should be published in a series of articles, and Mr. A. D. Hopkinson begins with a paper entitled "Sitka Spruce and other Conifers on the Queen Charlotte's Islands". Succeeding articles will deal with the species in Great Britain, its establishment, growth and production, and timber. Mr. Frank Scott contributes an article on "The Place of Douglas Fir in Scottish Forestry". The remarkably rapid growth of this fir in youth led to its being planted in many unsuitable localities; damage and destruction from wind, snow, frost, and, later, disease, almost inevitably followed—and the tree went out of favour. Mr. Scott sets himself the task of inquiring, point by point, into the true position and possible future of the Douglas fir in Great Britain, confining his remarks to Scotland, although they will be found to be equally relevant to many parts of England and Wales.

Among the recent acquisitions of the Department of Geology of the British Museum (Natural History) is a mammoth tusk from Siberia, nearly fourteen feet long, and probably the largest known, presented by the Rowland Ward Trustees. The Anglo-Persian Oil Company has presented some Cretaceous Mollusca from Persia, including some gigantic Rudists, one of which is eighteen inches high and nine inches across. These bi-valves, like the oyster, become fixed by one valve when young; but in the Rudists the lower valve further becomes extremely thickened and has a lattice-like internal structure, and grows upwards to form a pillar-like mass, which is often curved. The soft parts remain small, lying in the shallow cavity at the top of the pillar-like lower valve, and are covered by the lid-like upper valve. The Department of Botany of the Museum has received a valuable collection of West Indian marine algæ through the work of Mr. G. Tandy, Assistant Keeper in the Department. There are about a thousand mounted specimens, representing about 425 species. The algæ were collected mainly by Mr. Tandy while working at the Marine Biological Laboratory of the Carnegie Institution of Washington at the Dry Tortugas, Florida; others were collected by Mr. John Colman, who was working on zoological problems. This close co-operation in the study of a small area resulted in the discovery of a number of organisms which had not been found by the specialists who had previously worked over the area. The Friends of the National Libraries, with the co-operation of one of their members, Mr. Basil H. Soulsby, have presented to the general library of the Museum four rare Linneana, including a sixth edition (1764) of Linnæus's "Genera Plantarum", with the rare portrait of the author at the age of thirty-three years, engraved by Tanje, only found in a few copies of this edition.

That the law protecting the dwindling mammals of Australia lags behind enlightened public opinion is the conviction of the Council of the Royal Zoological Society of New South Wales. The Report presented to the annual meeting at Sydney states that the removal of protection from the opossum during an 'open' season was opposed by the Society and others, but was granted by the State partly on the ground of the strenuous economic period. It was claimed officially that extreme care would be exercised in the issue of permits to kill opossums (showing that the State recognises the difficulties), and strict rules as to the methods to be employed were issued, and yet, according to the Council's Report, the resulting slaughter was carried out in the usual uneconomic manner (*Australian Zoologist*, August 1931, p. 2). Probably 50 per cent of the skins taken represented females carrying young, which were uselessly destroyed. "So long as our so-called protection laws are subject to suspension at a few days' notice by a Minister acting under political pressure, so long will the continued existence of our native fauna be threatened."

Although much has been done of late, as, for example, by the establishment of the Joint Standing Committee on Library Co-operation, and by the pooling of library resources through the National Central Library, to enable readers in Great Britain to obtain books of which they know the existence, at the present time, at least on the technical side, the majority of people are not aware of a large proportion of the published data available throughout the world. Librarians have long realised that their duty is not merely to store books, or even to produce them on demand, but to put the serious reader into contact with the books on his subject, whether they are in the library or not. In the past they have been unable to fulfil this duty for lack of a comprehensive subject-catalogue of the best books on every subject published in different countries. To meet this need, the forthcoming publication is announced of an "International Bibliographical Guide" in five volumes (The Weardale Press, Ltd., 26 Gordon Street, London, W.C.1. Price £2 in advance, and £4 12*s.* a volume as issued). Its lists of books are being compiled and annotated by experts in every subject, who treat only of the works published in their own country. Although, probably, no librarian would contemplate the purchase of every book described in the Guide, it should be an indispensable tool whereby to ascertain what publications exist, and through available facilities to connect the reader with the literature of his subject. The Guide will also be of benefit to the book trade by indicating books on any subject.

PART I., "Medical Tables", of the Registrar-General's Statistical Review for 1930 has been issued (H.M. Stationery Office. 7*s.* 6*d.* net). The birth-rate per 1000 persons living was 16·3 (the same as that for the preceding year), the death-rate per 1000 total population was 11·4, and the deaths of infants under one year per 1000 live births was 60; all of these rates are the lowest recorded. The death-rate from all forms of tuberculosis was also the lowest recorded, 898 per million living. Puerperal deaths, however, show no improvement, being 4·40 per 1000 live births, compared with 4·33 in the previous year. The crude rate for cancer was 1454 per million living, against 1437 for 1929. Some comfort may be derived from the statement that the comparative mortality from cancer has been almost stationary during the last few years, if allowance is made for differences in the age constitution of the population. The toll of the roads is increasing, deaths resulting from accidental injury by mechanical vehicles being returned at 6404, as against 4492 in 1927, 5251 in 1928, and 5799 in 1929.

THE Marine Biological Association, Plymouth, has issued a second edition of the account of the marine fauna of the Plymouth district. A brief description is given of the principal collecting grounds and their physical conditions, with a note of the more common and characteristic species found in them. Then follows in systematic order the list of species (pp. 25-331) for which the exact locality is known. The initials of one or more observers are appended to the records, and under many of the species particulars are added as to relative abundance, breeding period, and occurrence of larval stages in the plankton. A list of works referred to and an index to genera and synonyms complete this useful volume, which is published at the remarkably low price of 2*s.* 6*d.* Congratulations are due to Dr. E. J. Allen, Dr. M. V. Lebour, and Mrs. Sexton, who have been chiefly responsible for the preparation of the volume.

IN the progress of the City of Leicester Museum and Art Gallery the past year has been remarkable for the extension of the Museum and Art Gallery building. This enlargement, consisting of a three-story block, contains, besides exhibition rooms, a muniment room and a research room, for the safe keeping and study of local records. But almost as great a gain has been the improvement in lighting and general attractiveness, for the dullness of museums has had much to do with their unpopularity; and the introduction of a fish-pool and fountain in the mosaic floor of the well-light of the central court was discovered by visitors to be a refreshing innovation.

ATTENTION may again be directed to the issue of *Building Science Abstracts* by the Department of Scientific and Industrial Research, published monthly by H.M. Stationery Office. Each number costs 9*d.* net, the annual subscription being 10*s.* This periodical contains a number of classified abstracts of papers in British and foreign journals, etc., dealing with all aspects of building, including timber, paints and varnishes, glass, metal, and design of structures, and it will be of great service to architects and others interested in building.

IT is announced in *Science* that honorary doctorates have been conferred by the University of Paris on Prof. Walter B. Cannon, professor of physiology in Harvard University, and Prof. Henry Fairfield Osborn, president of the American Museum of Natural History.

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just published another (New Series, No. 26) of their useful classified lists of scientific periodicals and publications of learned societies. It should be of great service to librarians and others desirous of completing sets upon their shelves.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A radium officer at the North of England Radium Institute, Newcastle-upon-Tyne—The House Governor and Secretary, Royal Victoria Infirmary, Newcastle-upon-Tyne (Dec. 7). An assistant lecturer in engineering at the Cardiff Technical College—The Director of Education, City Hall, Cardiff (Dec. 12). A lecturer in mathematics in the department of physics and mathematics of the Birmingham Central Technical College—The Principal, Central Technical College, Birmingham (Dec. 19). A Kirk Duncanson Fellow of the Royal College of Physicians of Edinburgh—The Secretary, Royal College of Physicians of Edinburgh, 9 Queen Street, Edinburgh (Jan. 15). A bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Director, Wellcome Tropical Research Laboratories, Khartoum, Sudan.

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Reviews.

A New Summary of Knowledge.

An Outline of Modern Knowledge. Edited by Dr. William Rose. Pp. xv + 1103. (London: Victor Gollancz, Ltd., 1931.) 8*s.* 6*d.* net.

THE publishers of this new composite book by twenty-two able and well-informed writers are fully justified for part of the large claim they make for it as the "cheapest book of our generation" and the "most remarkable event in publishing history". It contains, in just over a thousand pages, twenty-four essays on different branches of knowledge by acknowledged experts, and it offers the whole in a volume little larger than a new novel and at only a shilling more. Its production is welcome evidence, like so many similar popular series, that there is an increasing appetite abroad for something more than mere amusement or sensation, and we believe that the statistics of public libraries are beginning to tell the same tale. It is evident also that no reviewer, however conscientious, could hope to give an adequate account, much less a judgment, on so varied a menu served up by chefs each of them far more accomplished in his own branch than himself. The most that can be done is to give a general idea, noting outstanding excellences, and then to qualify—as is also necessary—the impression that might be created by the publishers' notice.

In a general way, then, it must be noted that the book is rather a summary of views than of news. The nearest analogy would be the collection in one volume of the general articles in an encyclopædia, though even from this point of view there are many lacunæ. There is practically nothing on aeronautics, education, engineering, law, linguistics, medicine, war, wireless, to name a few of the great modern topics for which one turns to an encyclopædia. In most of the articles the writer's chief attention is given rather to what has been thought about his subject and its general tendency than to the actual achievements of the workers. Thus, we have a chapter on the canons of literary criticism, but nothing on the modern works of literature themselves; an admirable review of the evolution of music since the Middle Ages, but only two casual references to Elgar and Sibelius for contemporary music; a chapter, as well expressed and stimulating as we might expect, from Sir Arthur Thomson on biology and human progress, from which it would be very difficult to find out the exact position of any particular question now in debate.

There are, of course, several articles of a more definite and informational kind, and the unevenness in this respect seems to indicate some weakness in the editing. A quite admirable introduction to mathematics by Prof. James Rice—the best bit of popular exposition in the book—should have had a more leading place. Profs. Seligman and E. A. Gardner both contribute accurate and well-filled summaries of their own subjects, one on the distribution of the different types of the human race, and the other on 'archæology', meaning in the latter case practically the artistic remains of early Greece. Prof. T. E. Gregory gives a sound and well-balanced statement of modern finance, but it is not exactly popular. Like most of the essays, it requires to be read as a whole and with a good deal of concentration. One writer who succeeds best—and this is very well—in covering his subject as a whole, giving both its main principles and their historical development and changes in recent times, with interesting illustrations, is Prof. C. H. Reilly, of Liverpool, whose forty pages on architecture are masterly.

There is much other first-rate material in the book, and it need scarcely be said that the whole is well worth the money; but as a book of reference—the other claim made for it—it cannot be recommended. It is a series of monographs bound up together, and these monographs leave untouched some of the most important domains of modern knowledge. One singular example of this—perhaps the most striking example of want of proportion and planning as a whole—is the almost complete absence of definite historical knowledge and the profusion of the discussion of sex. It must be added, in fairness, that one of the articles dealing with sex, that by Prof. F. A. E. Crew, director of the

Department of Research in Animal Breeding in the University of Edinburgh, is, side by side with Prof. Reilly's, that in which contemporary work is described with most accuracy. It is, of course, a little specialist treatise in itself, differing in that respect *toto cœlo* from Prof. Rice's introduction to mathematics.

Prof. Hearnshaw gives a closely packed article, with his accustomed precision and good arrangement, on historiography and how historians have regarded their work, and whether history could be considered as a science. But, when we ask what happened to anybody or any one thing in particular, we may search the book in vain. Mr. Cole discourses of Marx and capitalism, and shows that the Soviet system is a logical outcome of Marxism; but for how the Russian system came into being, we have to look elsewhere than in this book. Perhaps it will be felt that this is to ask too much of a thousand pages, but is it not a very important part of 'modern knowledge', and is there any reason why one should take down one 'book of reference' for the theories men have had about society and have—without warning—to find others to tell us how they have acted in practice? One reader at least would have gladly spared some of the more revolting absurdities of psycho-analysis for a few solid facts of history. England in the index has just fifteen items to its credit, Russia nineteen, while sex spreads out to seventy-four, being, except psychology and psycho-analysis, far the largest heading.

F. S. Marvin.

Topography and Tradition.

Joshua: Judges. By John Garstang. (The Foundations of Bible History.) Pp. xxiv + 423 + 73 plates. (London: Constable and Co., Ltd., 1931.) 20*s.* net.

In the topographical exploration of Palestine, our countrymen have always taken a leading part. The names of Sir Charles Wilson, Sir Charles Warren, Sir Charles Watson, Col. Conder, and Canon Tristram are eminent, and the great survey of western Palestine undertaken for the Palestine Exploration Fund by Conder and Captain H. H. Kitchener (afterwards Lord Kitchener of Khartoum) is fundamental. Under the present regime, the Mandatory Power is responsible for the protection and maintenance of antiquities, and the British School of Archæology in Jerusalem has been training a new generation of excavators and explorers.

In the first years after the War, Prof. Garstang was both Inspector-General of Antiquities and Director of the British School, and rightly devoted much of his time to co-ordinate in the archives of the Department what was already known about rites and monuments, and to supplement this by the work of the School and its students. Seven years of this experience "impressed him deeply", as it must anyone in his position, "with a sense of material reality underlying the historical narrative" of the Israelite conquest of Palestine; and in comparative leisure thereafter he has put together this valuable collation of traditional history with topographical fact.

In the received text of the books of "Joshua" and "Judges" there are discrepancies and contradictions; but literary criticism has, at all events, separated archetype from gloss and commentary, and earlier from later points of view among Hebrew editors and interpreters. By the single expedient of concentrating topographical inquiries on the earliest passages, which are relatively free from discrepancies, not only has the circumstantial veracity of the narrative been established, but a solution has also been discovered for the grave chronological difficulties which have been found in it by some scholars. So long as it was thought necessary to divide the exploits of the 'Judges' of Israel into regional and concurrent sections, the earlier events were inevitably 'brought down' to periods which preceded the establishment of the united kingdom of David and Solomon by only about one-third of the recorded intervals. It was as though a 'higher criticism' of English history had synchronised, on geographical grounds, the doings of the Houses of York and Lancaster, or the Norman and Angevin kings. The consequent difficulties, however, disappear, and Israelite history fits with Palestinian, when the 'longer chronology' is restored, and the 'exodus' and subsequent invasion of Palestine are assigned to the latter part of the fifteenth century B.C., when the recent Egyptian conquest of Palestine had broken up local dynasties and tribal groupings, but had itself in turn failed to maintain control of the political situation. The conquest, as was perhaps inevitable—for it was a war of revenge after the Hyksos oppression of Egypt—had been a reign of terror. "I sent the hornet before you, which drave them out" (Josh. xxiv. 12), and the "hornet" is the well-known symbol of the kingship of Lower Egypt. This 'historical background' and its implications are the subject of Prof. Garstang's first sections (§§ 1-2), in which the stage is set for the Israelite invasion by a general survey of the political and military topography of Palestine.

The military operations themselves (§§ 3-8) are in all respects the most effective part of the story. The sites are known; there has been excavation at Jericho, under Prof. Garstang's own direction; the waters of Jordan obligingly "rose up in one heap a great way off" in 1927, as in 1906, 1267, and in Joshua's day, the cause being the collapse of its steep alluvial bank, so that in 1927 "no water flowed down the river bed for twenty-one and a half hours". That the Israelites' good fortune likewise was due to earthquake seems, as Prof. Garstang notes, to have been in the earliest version of the story; in the Song of Deborah: "when thou marchedst out of the fields of Edom, the earth trembled".

Less spectacular, but no less important, contributions to the subject are the remaining topics, the "Settlement of the Tribes" (§§ 9-13) and "The Tribes under the Judges" (§§ 14-20), and the very full appendix in which the places, great and small, mentioned in the narrative are described and so far as possible identified with actual sites.

The value of the work is greatly increased by a large number of photographs, which give a very clear notion of the present state of the countryside, and of the vast amount of evidence awaiting exploration in its many mounds and other inhabited sites.

J. L. Myres.

History of Medicine.

Sixty Centuries of Health and Physick: the Progress of Ideas from Primitive Magic to Modern Medicine. By S. G. Blaxland Stubbs and E. W. Bligh. Pp. xvi + 253 + 55 plates. (London: Sampson Low, Marston and Co., Ltd., n.d.) 15*s.* net.

The object of this volume, as is set forth by Sir Humphry Rolleston in the introduction and the authors in the preface, is not to be a complete history of medicine, but rather "to seize the prevalent ideas of each age of medicine with some notes on the public health, to present them with due regard to the colour of the age, and ruthlessly to ignore minor names".

The work consists of twenty chapters, the first ten of which, covering the period up to the end of the sixteenth century, and the nineteenth, on the growth of hospitals and the sanitary idea, are the work of Mr. Stubbs, while the remainder are due to Mr. Bligh.

In the first chapter it is shown that prehistoric man is to be credited with a higher level of health than the products of most civilisations, inasmuch as he escaped most if not all of the diseases due to modern diet, although his ideas of medicine or health were but a crude mixture of the animal and the animistic. The Sumerians, Babylonians, and Assyrians, who are next considered, lived a reasonably hygienic life, though their knowledge of medicine and disease was closely intermingled with superstition and magic, as is illustrated by several quotations from Campbell Thompson's "Assyrian Medical Texts". Foolish and disgusting as many of the modes of treatment then were, they were no worse than those ordered 1600 years later, the object in both cases being to disgust the demon who was regarded as the cause of the disease.

Special emphasis is laid on two important contributions of the Semitic peoples to public hygiene, namely, the institution of the seventh day of rest and the prophylactic code of ritual hygiene and cult cleanliness as set forth in Leviticus.

In ancient Egypt, where, as Armand Ruffer and others have shown, atheroma, arthritis, and every form of dental disease were prevalent, advance was restricted by magic and the confinement of hygienic measures to the king, priest, and nobles, with little regard for the mass of the people.

Before dealing with the remarkable contributions made by the Greeks to the progress of medicine, Mr. Stubbs controverts the widespread opinion that prior to their advent there was no science in medicine but only meaningless magic and silly superstition. The beginnings of western science are to be found in the Minoan, Trojan, and Mycenæan civilisations, especially the first, as illustrated in Crete by the discoveries of Sir Arthur Evans, who found in the palace of Knossos a system of sanitation superior to that of any ancient or medieval civilisation.

A special chapter is devoted to Hippocrates, with numerous quotations from his works to show their modern spirit. The inheritors of Hippocrates and the state of medicine at Alexandria and Rome down to A.D. 200 are next considered, special attention being given to the work of Galen. Although Rome had no science, it is to be credited with an excellent system of hygiene, as exemplified by the construction of aqueducts and sewers and the foundation of hospitals.

The decline in medical science which took place during the Middle Ages, though not primarily due to medieval religion, was undoubtedly hastened thereby, and it was only by the intervention of heretics such as the Nestorians, Roger Bacon and Albertus Magnus, the Islamic invasion of Europe, and the newly discovered learning of ancient

Greece and Rome that the destruction was not rendered complete.

The remaining chapters deal with the foundation of the modern period of medicine in the fifteenth and sixteenth centuries; its progress in the seventeenth century, as illustrated by the birth of modern physiology, the foundation of the Royal Society and the work of Sanctorius and Harvey, the introduction of chemistry and mathematics into medicine by Paracelsus, van Helmont, and Borelli, the microscope and the discovery of germs, the clinical supremacy of Sydenham; the progress of medicine in the eighteenth century, which is described as an era of hygiene in which a lull took place in microscopic research; and the epoch of modern medicine.

The text is liberally interspersed with reproductions of contemporary illustrations, and a short bibliography of readily accessible English works supplementary to those mentioned in the text is appended. The volume may be warmly recommended to those in need of a well-written and lively introduction to the study of medical history.

History of Demography.

Theories of Population from Raleigh to Arthur Young: Lectures delivered in the Galtonian Laboratory, University of London, under the Newmarch Foundation, February 11 to March 18, 1929, with two additional Lectures and with References to Authorities. By Dr. J. Bonar. Pp. 253. (London: George Allen and Unwin, Ltd., 1931.) 10*s*. 6*d*. net.

DEMOGRAPHY, or the study of births, marriages, and deaths, is the science at the base of politics and economics, and its prime necessity is an accurate census, repeated at regular intervals. The author traces its rise by a series of examples from the seventeenth and eighteenth centuries, and it adds to our pleasure that he selects these from our own countrymen, for we know the economic conditions they were experiencing, and the constant question between the growth of population in city and country conditions. Raleigh, Hobbes, Bacon, and More were all great, and the incarceration in the Tower of the former gave us the "History of the World". Therein is praise of the dissimilitude of Nature, and the very practical consideration of an Ark, 600 ft. by 100 ft. by 60 ft. deep, leads Raleigh to conclude that Noah probably selected his animals, so that they by breeding gave us all the present species.

Harrington was a visionary, but Graunt, one of the original fellows of the Royal Society, elected in 1663 for his book on "Natural and Political Observations on the Bills of Mortality", was of a different order. It is based on his collected figures, and these were extended also to the country, so that the population of England is estimated at about 6½ millions, with about a fourteenth of the whole in London. He and all are shy in asking for a census, as it was deemed to be against the law of God.

Petty was a greater man, and his consideration of social conditions is almost such as we might hear to-day; his great remedy is migration, Nature's own method for excess of population. Halley, the astronomer, used Graunt's tables to consider life insurance, adding the tables of mortality of Breslau. Derham quotes the providence of God in reducing the longevity of man at first to 120 years and then to 70 years, so that "the peopled world is kept at a convenient stay". Süssmilch used all tables and applied them to the world, calculating percentages of all ages, and he even considered epidemics. Hume was more economist than demographer—and indeed the whole was then mainly an economic question. Price supported a sinking fund, and his remedy for the National Debt was an increase in the population, but Howlet contested most of his basal work.

Arthur Young, lastly, discusses population and agriculture. His life-work was to improve agricultural methods, and he never seems to have quite understood that manufacture and agriculture go hand-in-hand. He corresponded with Malthus, who later had the benefit of the first accurate census.

The subject is an interesting study, especially when as here illuminated by the mind of an author widely read in world history and the problems of economics. We imagine his view to be that population and world conditions present similar curves, the former lagging a little behind the latter, but that the number of censuses behind us is too few to allow the drawing of such at present.

Animal Aggregations.

Animal Aggregations: a Study in General Sociology. By W. C. Allee. Pp. ix + 431. (Chicago: University of Chicago Press; London: Cambridge University Press, 1931.) 22*s*. 6*d*. net.

DEEGENER'S great work "Die Formen der Vergesellschaftung im Tierreiche", 1918, was completely spoilt for us by its cumbrous classification of animal aggregations and the impossibility of assigning many cases to any single group. He saw that many animals normally live in communities consisting of a single or a few species, and was inclined to regard this as a general phenomenon. Earlier, Espinas, in 1878, had developed similar views. "Communal life, therefore, is not an accidental fact in the animal kingdom; it does not arise here and there fortuitously, and, as it were, capriciously . . . but . . . a normal, constant, universal fact." Wheeler, in 1930, classified aggregations into loosely integrated associations and more permanent societies. The extreme cases of the latter are in ants, termites and bees, and in man. These are not comparable, but Wheeler has shown more than thirty cases of prolonged association of young and adults in five orders of insects. In most cases it is an association of mother and offspring, the chief bond being 'trophallaxis' or mutual feeding. This family basis accounts for much of the phenomena of flocks, herds, and human societies, a certain amount of recruiting from outside being allowed.

Family association is easily understood, but Allee reviews much more widespread aggregations in Nature. He gives many examples of such from unicellular organisms, in which chemical and physical conditions often play a markedly forcing part, to higher and more active organisms, the movements of which, before they come together, may be termed 'random'. Sexual phenomena, moisture and drought, sleep, hibernation, etc., are all factors conditioning aggregations, and the individuals in the same keep together by touch, smell, vision, sound, and perhaps more subtle methods. Generally an aggregation consists of a single species, but allied species are frequently found together, and even the association of animals of different phyla is not unusual. The most common cause for most animals is the 'physiological state' of the gut, the need for food, but this certainly fails to explain the immense numbers often found together in the sea.

Space forbids us to attempt to follow our author into the large number of examples he gives of the harmful and beneficial effects of aggregations. He refers, not ultra-critically, to a host of research papers, and, giving the facts and references accurately, he merits the deep gratitude of busy teachers. In particular we are interested in the variety of the phenomena giving protection from toxic reagents and in the mass physiology of spermatozoa. The problems due to crowding cannot be absent from any chapter. As growth and reproduction may be either stimulated or inhibited in different animals by crowding, there is full scope for research here and the cases cited suggest many practical problems. Four cases affecting the sex ratio are cited as having survival value. Crowding produces morphological effects in many insects, such as the locusts, the story of which is so fashionable to-day. Some insects, too, show the highest known states of social organisation. It is clear that we know little or nothing of the less closely knit insect aggregations, and here there is a vast field for research as to how far in such there may be a co-operative effort, which is victorious in the struggle for existence.

The principle of co-operation in animal aggregations has in Prof. Allee an enthusiastic advocate. "Evidently mutual interdependence, or automatic co-operation, is sufficiently widespread among the animal kingdom to warrant the conclusion given above that it ranks as one of the fundamental qualities of animal protoplasm, and probably of protoplasm in general." Later it is claimed that co-operation and the struggle for existence are the two great principles in determining the trend of animal evolution. About 125 examples of aggregations are given, and more than a hundred of these are not connected with breeding. A phylogenetic tree of animals shows the groups to which these animals, supposed to be co-operating automatically, belong. Some might question this co-operation in unicellular organisms, and we must surely eliminate all colonial animals with repetitions of parts physiologically connected. Coming to the higher forms, it is significant that such surviving animals as are supposed to retain characteristics primitive in their evolution show the minimum of such automatic co-operation. We should ourselves regard it as a quality which has arisen many times over in the evolution of animals, and not a fundamental quality of animal protoplasm.

We have enjoyed reading this book and we thank the author for many suggestions, both for laboratory workers and for field naturalists. Both classes should have this book on their shelves for reference. The study of animal aggregation is clearly of great importance, not merely theoretically but also practically applied to man himself, the phenomena in whose social organisation may find useful analogies in such studies on animals.

Problems in Parthenogenesis.

La parthénogenèse. Par Prof. A. Vandel. (Encyclopédie scientifique : Bibliothèque de biologie générale.) Pp. xix + 412. (Paris : Gaston Doin et Cie, 1931.) 32 francs.

THE subject of virgin birth in animals is so interesting that it is curious that, until now, only two books have been devoted specially to it, those of Delage and Goldsmith (1913), and Winkler

(1920). The last decade has seen so much important progress, however, that a new work is a desideratum, and for its preparation no author is better fitted than Prof. Vandel of the University of Toulouse, as is abundantly proved by his researches on the isopod *Trichoniscus provisorius*, his development from them of the theory of geographical parthenogenesis, and his summaries of modern aspects of the general problem. His book is authoritative and is definitely a landmark.

The appeal is primarily to a scientific audience possessing a certain acquaintance with recent developments in biology. Accurate scholarship, as well as sheer hard work, are shown in the text matter and the comprehensive bibliography of some 700 titles. The results and views of other workers are presented fairly and with judgment. Great use is made of the working hypothesis, an excellent teaching device, but one not to be pressed too hardly. The whole is a model of Gallic scientific exposition—lucid and logical.

Of its uniformly excellent contents space allows special mention of the following only: the clear sensible classification; the skilful treatment of the complicated life-cycles in forms showing alternation of sexuality and agamy; the most useful chapters on precocious parthenogenetic reproduction (pædogenesis), the curious nematode conditions, and plant parthenogenesis.

The two important closing chapters discuss major questions, those of sex determination and evolution. Regarding the former, we may only touch upon the arrhenotokous parthenogenesis peculiar mainly to Hymenoptera and rotifers. The prevalent hypothesis is that males are virgin-born and haploid, while females are sexually-born and diploid. Many new facts, however, show that this interpretation cannot be universally applied, even in Hymenoptera, and raise root problems: (1) Are males really haploid? And (2), if so, why should haploidy spell maleness? The first arises because in cases of natural rudimentary parthenogenesis, and in experimental parthenogenesis, virgin-born organisms as a rule die in early life because their haploid condition inhibits development.

Vandel is sympathetic towards Tauson's findings on rotifers, which suggest that the male is really diploid and shows germ cell haploidy at maturation only, chromosome reduction occurring abnormally early in the diploid spermatogonia. Rotifer cytology being extremely difficult, this new interpretation may be wrong, but even if correct its application may be limited. For, since the publication of Vandel's book, saw-fly studies from the reviewer's laboratory show important features, namely, that the haploid-diploid ratio exists between males and females, while chromosome shape and arrangement suggest the existence of polyploidy and of odd chromosomes which may be sex-determining. Thus we may be within reach of answering the question of haploidy and maleness, hitherto a mystery. The somatic cytology of Hymenoptera will still well repay investigation.

Regarding the evolution of parthenogenesis, the author makes the following points: the parthenogenetic mode of reproduction derives from the sexual; it is very widely spread to a greater or less degree among animals and plants; it has arisen independently in different groups, and the course of evolution likewise differs from group to group.

Certain clues to the origin and evolution of parthenogenesis are seen in the facultative or accidental cases noted in species normally bisexual. The majority of cases are found in Lepidoptera, both sexes being produced (deuterotoky), while female-production (thelytoky), for example, in coccids, is rare. The virgin-born offspring are diploid, and this condition is brought about by different methods of auto-regulation of the chromosome equipment. Now Vandel stresses that among the groups which show rudimentary parthenogenesis there belong those very rare species susceptible to experimental parthenogenesis, and it is therefore deduced that the artificial agencies employed are responsible for the restoration of diploidy, the *sine qua non*, usually, of parthenogenetic development. Hence it seems reasonable to suppose that facultative parthenogenesis is induced by some natural agency or agencies supervening in rudimentary parthenogenesis to bring about the diploid (and viable) state. Of these natural agencies we can say very little.

Direct evidence of the possible origination of parthenogenesis only exists in moth hybridisation experiments first made by Harrison, where the hybrid offspring of two bisexual and non-parthenogenetic species were parthenogenetic. Vandel's alternative interpretation is that this is really a case of facultative parthenogenesis. Only further work will clear the matter. The hypothesis of Winge and Ernst of the hybrid origin of plant parthenogenesis is, of course, not new, and although the proofs are not direct, the many features shared in common by hybrid plants and parthenogenetic plants, particularly polyploidy, strongly warrant such a hypothesis. Vandel stresses another suggestive idea: as polyploidy is intimately associated with geographical parthenogenesis, it may be a cause of parthenogenesis. But of how polyploidy has originated there is no evidence. Parthenogenetic races have been derived by three main mechanisms : (1) a bisexual form has given origin to two types of parthenogenesis, as where thelytoky and arrhenotoky co-exist, for example, saw-flies, or where obligatory thelytoky and facultative parthenogenesis co-exist, for example, coccids ; (2) a heterogonous and migratory species, as among aphids, may have become continuously parthenogenetic owing to the absence of one of the hosts ; (3) a bisexual species may have produced a parthenogenetic race of different chromosomal (polyploid) constitution, for example, in geographical parthenogenesis. Briefly, new species are in the making, and as further proof there is a physiological *amixie* between daughter and parent species. Thus the evolution of parthenogenesis is bound up with the evolutionary rôle of the phenomenon.

There can be no longer any doubt that reproduction solely by parthenogenesis exists, as among rotifers, crustaceans, Hymenoptera, aphids, and all geographically parthenogenetic species. Hence the faculty is of survival value. Further, that parthenogenesis does not lead to stereotypy is abundantly manifest from the mutations observed.

Its widespread distribution suggests strongly that the parthenogenetic faculty, though it may be latent, is a fundamental vital phenomenon capable of being activated under certain conditions. This leaves us with the query: Do absolutely nonparthenogenetic organisms really occur ?

A. D. PEACOCK.

Agricultural Entomology.

A Textbook of Agricultural Entomology. By Dr. Kenneth M. Smith. Pp. xiii + 285. (Cambridge: At the University Press, 1931.) 12*s.* 6*d.* net.

IN this book the author has restricted himself to the treatment of insect pests of the farm, to the exclusion of fruit insects. By way of introduction, Dr. Smith briefly discusses the current methods of insect control and their application to farm practice, namely, insecticidal or chemical, cultural, biological, and legislative. The relationship of insect outbreaks to weather conditions is illustrated by reference to several well-known species. For example, the diamond back moth becomes abundant in hot dry seasons and decreases in wet cold weather. The pale western cutworm (*Porosagrotis orthogonia*) is subject to similar fluctuations, but for an entirely different reason, which the author does not explain on p. 13. The prevalence of heavy rains in the months of May, June, and July constrains this North American species to abandon its subterranean workings and emerge on the surface, when it is then an easy prey to its parasites. The result is a decided diminution of its numbers the following year. So noticeable is the effect that a close study of the meteorological conditions is important in the forecasting of outbreaks of this species.

The systematic discussion of the insect pests themselves occupies ten chapters. They are distributed among eight orders, which, with the families concerned, are briefly defined. Detailed descriptions of the known stages of each species are supplied, followed by an account of the life-history, the list of food-plants and injuries, distribution of the species, modes of control, and the natural enemies that have been recorded in the various countries of the host insect's occurrence.

On the whole, the insect pests of live-stock have received their due share of attention. It is observed, however, that the order Anoplura (not Anopleura) is but scantily noted, and the Mallophaga are not even mentioned. The Siphunculata are classified as sub-order 2, leaving one to imagine what sub-order 1 may be. If *Hæmatopinus suis* is sufficiently important as to receive a whole page to itself, there appears to be no good reason why *H. eurysternus* and *H. macrocephalus* should not have at least been mentioned. Similarly, *Trichodectes* and *Menopon* are of sufficient economic importance as to merit attention. Of other live-stock pests, the warble and bot flies, blow flies, horse-flies, and Hippoboscidæ are adequately treated, and the author is to be commended for bringing his account of the British Œstridæ up to date in conformity with recent researches.

The rôle of insects in the transmission of virus diseases of cultivated crops is a comparatively recent discovery, in the development of which the author has taken an active share. In Great Britain the potato and hop are subject to attack, and the sugar-beet in Germany. The points emphasised are: (1) the vector insect becomes infected when feeding on an infected plant ; (2) the virus remains infective in the insect's body for several days, during which it may infect an unlimited number of susceptible plants ; (3) certain varieties of both cultivated and wild plants may act as reservoirs of the virus without their being themselves adversely affected ; (4) certain plant viruses seem to have an affinity for particular vectors, as for example *Myzus persicæ* (Aphididæ) and the various forms of potato virus. In this new field of study there is opportunity for extensive research, which should be productive of important results.

At the end of each chapter there is given a list of reference literature for the use of those who may wish to tap the sources of information. In the first of two appendices following the last chapter, the author has tabulated for ready reference the characteristic symptoms of insect attack on cultivated crops; in the second he has listed the common farm weeds that serve as alternate hosts for many insect pests of the farm. In the tracking of any species discussed in the book the reader will find every assistance in the three indices, the first of which is authors, the second parasites and predators, and the third general.

It is evident that Dr. Smith has spared no pains in producing a book which will at once be very useful to student and teacher as well as to farmer. The illustrations, seventy-nine in number, are clearly and attractively reproduced. If one would offer criticism, it would be that they might well have been increased with advantage to the explanation of the textual descriptions of species. One also notes the lack of keys to aid the identification of the species discussed. Although most keys are admittedly arbitrary, nevertheless both teacher and student find them very helpful in taxonomic work. It is to be hoped that these suggestions will receive attention and be incorporated in the next edition, which should soon be required. A. E. CAMERON.

Researches on Fungi.

Researches on Fungi. Vol. 4: *Further Observations on the Coprini together with some Investigations on Social Organisation and Sex in the Hymenomycetes.* By Prof. A. H. Reginald Buller. Pp. xiii+329+4 plates. (London, New York and Toronto: Longmans, Green and Co, Ltd., 1931.) 21*s.* net.

PROF. BULLER'S "Researches on Fungi" is well known to mycologists. The first volume appeared in 1909, the second in 1922, the third in 1924. The present volume is divided into two parts. The first of these may be regarded as a continuation of the previous volume, for it is concerned with the further study of the types of fruit-body of the genus *Coprinus*. Eleven subtypes of fruit-body organisation are distinguished by the author, six non-*Coprinus* (Æqui-hymeniferii) and five *Coprinus* (Inæqui-hymeniferii). Nine of these had been described in detail in the two previous volumes, leaving the *curtus* and *plicatilis* types for the present one. Both these types contain only one species. These are set out with precision, though probably most mycologists will be content with reading the summary. *Coprinus plicatilis* is noteworthy in that it does not undergo autodigestion in the manner of the other species, to which they owe the popular name 'inky cap', though the spores ripen and are discharged as in other Coprini. An interesting point about *C. curtus* is that its fruit-bodies may be rendered sterile by fumes from fresh horse-manure.

The relative efficiency of the *Coprinus* and non-*Coprinus* types of fruit-body organisation are discussed. In such comparisons, however, which are based on a comparison of the nicety of the mechanisms which enable the millions of spores produced to be dispersed effectively, it should not be forgotten that this merely means their ability to leave the hymenium. The details of the processes are known chiefly through Prof. Buller's researches, and they are obviously so efficient that the ultimate spore wastage is all the more startling.

Among other points treated in this section are: the well-known *Coprinus* 'ink' used by Bulliard more than a century ago and recommended by Boudier for documents where forgeries might be attempted—the late Prof. G. H. Bryan suggested its use for spotting negatives; the fact that *Coprinus lagopus* is the species which grows on beet and mangel seeds, and that passage of the spores down the alimentary canal of a horse is an essential feature in the life-history of *C. sterquilinus.* The last-named species when growing is able to exert an upward pressure of nearly half a pound—it is the much more robust *C. atramentarius,* however, which so frequently causes surprise by appearing on hard tennis courts and asphalt paths.

The second section of the volume deals with social organisation and sex. A general consideration of social organisation throughout organic beings seems an unnecessary introduction to the well-known fact that the hyphæ of Hymenomycetes fuse on coming into contact and that such a compound mycelium acts as a unit in producing fruit-bodies. The biological advantages of these multiple fusions are stressed, but the experimental evidence that it is mainly nutritional is insufficient.

The problems of sex in the Hymenomycetes have always aroused interest. We seem to be approaching a clearer understanding of the phenomena, but much remains to be done before the facile interpretations of some writers can be accepted. From the time of Sir John Hill until the eighties of last century, sexual organs were discovered by enthusiasts at appropriate stages in the life-history of mushrooms and toadstools; Dangeard's discovery in

1895 of a nuclear fusion in the basidium seemed for some time to alter the focus, and attention was then paid to the origin of the binucleated condition of the mycelium which provided the fusing nuclei. Mlle. Bensaude (to whom the present volume is dedicated) startled the botanical world when she published her account of heterothallism—two different kinds of mycelium necessary for the formation of fruit-bodies—in a species of *Coprinus* in 1918, and showed the significance of clamp-connexions.

Since that time, research has been steadily carried out, and Basidiomycetes, from being more neglected in academic circles than were Fungi Imperfecti, have almost become laboratory pets. Prof. Buller and his pupils have played a prominent part in unravelling the conditions in *Coprinus*. The account he gives here is based on these researches. As, however, these for the most part have already been published, there is not here the stimulus of novelty, though there is a clear account of present facts and theories of heterothallism in Hymenomycetes. The more recent of the author's own researches were summarised in NATURE of Nov. 1, 1930, pp. 686-689.

Prof. Buller regards the phenomena of heterothallism in *Coprinus* and its allies as those of sex. (It is to be noted that heterothallism occurs in all fungal groups and that scarcely a week passes without an addition to the list of species.) The basis for the belief is the fusion of two nuclei in the basidium. It is obvious that this fusion is secondary and that the fusion of different mycelia is not the same as the fusion of sexual organs. Further, four different spores of different sex occur on a single basidium in such a species as *Coprinus lagopus*, and there may be geographical races which are intersterile. It is obvious that the study of these fungi will bring about a change in our ideas of sexuality.

The book is well printed and has a full summary and a good index. The illustrations are almost unnecessarily numerous and the text somewhat prolix, though perhaps this will not be disadvantageous to non-mycological readers. The volume is sure to find a place on the shelves of most mycologists.

General Stratigraphy.

General Stratigraphy. By Prof. J. W. Gregory and B. H. Barrett. (Methuen's Geological Series.) Pp. xii + 285. (London: Methuen and Co., Ltd., 1931.) 10*s.* net.

IN the preface, the authors state that "the international spirit is as necessary in Geology as in Politics". Undoubtedly, geological science cannot afford to be parochial in its outlook, though few geologists can hope to attain the world-wide experience of Prof. Gregory. The study of geology, however, should, like charity, begin at home, and unless a student is in possession of practical knowledge concerning the geology of his own country, he is not likely to profit by reading about the stratigraphical problems in lands beyond the seas.

To meet this need, the general scheme which is followed by Prof. Gregory and Mr. Barrett is to describe British rocks first, and then to give a brief account of their equivalents in other parts of the world. The facts concerning the distribution of land and sea during each geological period are set forth in a number of diagrammatic maps, and an appendix which gives a list of stratigraphical names employed in different countries might help the reader to a clearer understanding.

It must be confessed, however, that the book is disappointing. The compressions and omissions necessary to summarise the main facts concerning the geology of the world within the limits of 239 pages were bound to be unsatisfactory; the result is geological pemmican of a kind scarcely suitable for the student or general reader. Unfortunately, too, the book is marred by defects arising from the exclusion of important matter. Take, for example, the chapter devoted to the Carboniferous rocks. No mention is made of the occurrence of marine bands in British Coal Measures. These are of the highest practical importance for correlation purposes. Again, no account of the Millstone Grit of England is given, nor is any notice taken of the notable researches of Bisat, Wright, and others who have done so much to solve the stratigraphical problems of this formation which had so long defied the efforts of older geologists. Had the authors of this book appreciated the significance of zonal studies, they would have at once realised the misleading character of their statement that zone *S* [of the Lower Carboniferous] was represented by Millstone Grit in the Forest of Dean and that the formation began earlier in the Clee Hills.

Further, one is told that "as the arid climate which brought coal formation to an end began earlier in Scotland than in England only the lowest of the four divisions [the Lanarkian] of the English Coal Measures is represented in the Midland Valley of Scotland", whereas, as has been clearly demonstrated both by plants and shells, the four divisions (if there are four) have representation in the Scottish coalfields. Indeed, it has been shown that the Lanarkian, as originally defined by Kidston, includes rocks which range in age from the zone of

Carbonicola ovalis up to the zone of *Anthracomya pulchra*, and it has been placed beyond all reasonable doubt that Skipseys Marine Band is the Scottish equivalent of the well-known Mansfield bed. The statement "according to his [Hind's] identifications the fresh-water lamellibranchs in one seam at Shettleston, near Glasgow, include those of the three lowest of the six Coal Measure zones of the English Midlands established by Trueman and Davis" (*sic*) cannot be checked in the absence of a reference; while recent work on the Coal Measures lamellibranchs in the Scottish coalfields confirms the value of the zonal studies initiated by Dr. Trueman and his co-author, and successfully applied by numerous workers in British coalfields. In regard to the Barren Red Measures of Scotland which have been proved to fall within the zones of *Anthracomya phillipsi* and *A. tenuis* in Ayrshire, no mention is made of them, but the passing reference to their equivalents in Lanarkshire in the chapter devoted to Permian rocks is, to say the least, not helpful.

The reference to the succession in the Kent coalfield is also faulty. Neither Lanarkian rocks nor Lower Carboniferous beds of Pendleside facies are present; on the contrary, Coal Measures of Yorkian age rest with marked unconformity on Lower Carboniferous Limestones. Nearly every reference to South Wales in this chapter and throughout the book is definitely erroneous.

It is decidedly unfortunate that the printer's imp has been unusually busy. Some of the errors of spelling are harmless, but others are likely to mislead the reader. To mention one: *Cœnograptus* is quoted as a Cambrian graptolite. It seems a pity that the book, the compilation of which must have entailed an immense amount of labour, should have so many blemishes, but one may hope that in a second edition most of these will have disappeared. J. P.

The New Surveying.

Surveying from Air Photographs. By Capt. M. Hotine. Pp. xi + 250 + 8 plates. (London: Constable and Co., Ltd., 1931.) 30*s.* net.

It was chiefly due to the War that surveying from air photographs emerged from the state of being an ingenious but not very serious or practical method, into the condition of being in certain cases indispensable and in many cases of genuine value, and, it may be added, in all cases to be reckoned with. The history of the method ante-dates the invention of aeroplanes. It had been used with comparative success from balloons; and, in the British service, it was the late Col. Elsdale who developed the use of small free balloons, which travelled a sufficient distance to allow a series of plates to be exposed, and then upset themselves and came down to the ground. Photographs of this kind were taken so long ago as 1885.

Since then, as we all know, enormous progress has been made, and those who desire to learn the present condition of this up-to-date art cannot do better than study the admirable volume by Capt. Hotine which is here under review. From the author's preface we shall learn that the object of the book is to describe the way of constructing a map, plan, or detailed description of any portion of the earth's surface by the use of photographs taken from the air. The various chapters deal with such branches of the subject as the general characteristics of air photographs, their interpretation, their economic uses, and such matters. But the bulk of the book is, of course, taken up with discussion of perspective problems, surveying cameras, and, above all, with the employment of stereoscopic methods. In fact, it may be said that the chief change that has taken place in recent times has been the increasing use of the stereoscope for the measurement and interpretation of pairs of photographs taken in the air at short intervals of time.

We are early introduced to stereoscopic pairs, air bases, overlaps and time intervals, lateral and forward obliques, strips, and such details, all very clearly explained. The difficulties inherent in the method are not ignored; for example, the author remarks that at present "the problem of obtaining an accurate measurement of level during flight must be considered as definitely unsolved". In the same way, he points out that aeroplanes cannot, for surveying purposes, be flown economically on courses which are generally north and south. He points out, also, that there is a difficulty in interpreting the features of the ground and in identifying objects, because, at a great height, the landscape appears almost monochromatic. This leads to the dictum that much is to be lost by attempting the interpretation of single photographs; "it is a safe rule to use the stereoscope on all occasions".

Valuable information is given as to the scales that can be economically used for maps constructed from air photographs. The conclusions are that the largest scale is about 1 : 2000, that is, about 30 inches to the mile. The smallest scale which the method can produce is about 1 : 30,000, that is, about 2 inches to the mile. Very large scales and very small are equally unsuitable. The small scale above mentioned involves the use of a 7-inch lens at a height of 18,000 feet.

An interesting section is devoted to the description of the Canadian 'grid' method, in which high, oblique, single photographs are employed; each photograph shows the visible horizon near its top edge; this horizon line, corrected for curvature and refraction, is used as a line to measure from, and a suitable standard, perspective, straight-line grid is superimposed: the plan can then be drawn by simple rectification of the oblong spaces of the grid—an eminently simple and practical device for the mapping of a flat country like much of the territory of that great Dominion. These photographs are taken with a bare minimum of ground control, from a height, as a rule, of 5000 feet.

This case must, however, be looked upon as exceptional. In general, stereoscopic methods would nowadays be employed. In addition to more certain identification than single photographs can give, the method provides a means of fixing relative heights and of contouring. Much space is rightly devoted to an account of stereoscopic methods and instruments. Descriptions of instruments are always difficult to follow without constant reference to the instruments themselves, and it is no slur on this admirable book to say that these sections will be of special value to the student who has the instruments at hand for reference.

Mathematical sections deal with perspective and the theory of mapping from stereoscopic pairs. Some of this is rather difficult reading—from the nature of the case—and it may, perhaps, rather frighten the 'practical' man. It might have been relegated to an appendix. However, as the author remarks in his preface, the reader who mainly desires to learn practical methods can, if he likes, skip all the mathematical chapters, without losing anything of practical application. The book is, indeed, a very thorough piece of work, and is an indispensable textbook of modern practice in the application of air photography to surveying. This application is by no means so simple as might appear at first sight, and if anyone should think that he could conduct an air survey by the light of Nature, without considering past theoretical studies and practical experience, a reference to this book should go far towards undeceiving him.

C. F. C.

Viscometry.

A Monograph of Viscometry. By Dr. Guy Barr. Pp. xiv + 318. (London: Oxford University Press, 1931.) 30*s*. net.

THE author begins his preface by commenting on the striking disproportion between the small number of works devoted to the subject of viscosity and the enormous number of papers which deal with one or the other of its aspects. Such books as there are give a limited space only to methods of measurement, and the author has felt "that there was need of a book devoted entirely to viscometry, in which an investigator would be able to find some account of most of the schemes which have been applied and some indication of the theoretical and practical difficulties that affect each of them".

Such a book has certainly been lacking, and the author has been completely successful in supplying it and in filling a curious lacuna in the literature of physics. After a brief introductory chapter dealing with fundamental concepts and historical development, he proceeds to develop very fully the theory of viscous flow through cylindrical tubes, and of the corrections which have to be applied in deducing viscosity coefficients from measured rates of flow. Three chapters are devoted respectively to tube viscometers for absolute measurements, commercial absolute viscometers, and capillary viscometers for relative measurements. The treatment is extremely complete: all the conditions to be satisfied and corrections to be applied are set forth clearly; the reader will certainly, as the author suggests, get the impression that absolute viscosity measurements in the strict sense present "a problem calculated to tax the resources of the best equipped physical laboratories". His relief at finding that nowadays relative determinations will generally be adequate may be tempered on reading the chapter describing the instruments for this purpose, and on discovering that many precautions and corrections are necessary which have been neglected in the numerous investigations carried out with the—all-too-convenient—Ostwald viscometer.

The commercial viscometers are classed as 'absolute' because "their standardisation depends in the first place on dimension", although, in practice, calibration is generally necessary. They are treated as fully as the laboratory instruments with long tubes, and standard specifications of the Redwood, Engler, and Saybolt instruments, as well as conversion tables, are given in appendices.

A chapter is devoted to the transpiration method of determining the viscosity of gases; the equations for a compressible liquid, for which the pressure gradient is no longer constant, are deduced, and various types of apparatus described in detail.

Flow between parallel plates, which is rarely mentioned in the literature of viscosity, also receives attention. As the basis of a method of measurement, it shares with the concentric cylinder system the inconvenience that, while the mathematical treatment is simple for infinitely extended pairs of surfaces, the introduction of boundaries, necessary in practice, causes serious complications.

In the discussion of the falling sphere method, the corrections to Stokes's formula introduced by Oseen and the more recent work of Faxen are fully considered. The method is perhaps the most striking instance of the restrictions imposed by purely technical factors on the practical application of a theoretically simple procedure: in this case, the difficulty of obtaining accurate spheres other than the steel balls used for bearings.

"Rotational and Oscillational Viscometers" include many types which have been used occasionally only: for example, the circular disc oscillating in its *own* plane in Maxwell's classical investigation on the viscosity of gases, and in some early work on the variable viscosity of colloidal solutions. The various types of concentric cylinder instruments, which alone have found somewhat extended use, are all described and discussed fully.

The book concludes with a chapter on "The Study of Anomalous Systems", in which the peculiarity of disperse systems, namely, a decrease of the viscosity coefficient with increasing velocity gradient, and the instruments designed specially for studying it, are briefly but adequately described. The author unavoidably touches on the question whether a special name is required for this property and seems to favour "apparent viscosity". He remarks in this connexion: "The early successes of Bingham's hypothesis of plastic flow led many workers to adopt the term plasticity to distinguish the property in question, both of lyotropic sols and of suspensions, from the viscosity of normal liquids". This practice was almost entirely confined to the United States, where many systems were described as 'plastic', the published flow-pressure diagrams of which certainly do not conform to Bingham's fundamental assumption; in a few years the term will presumably go the way of 'colloidal behaviour', which at one time was so widely borrowed from J. Loeb.

The author has made an admirably complete selection from a peculiarly scattered literature and has presented it critically and lucidly. It deserves to be widely read, and while it is too much to hope that everybody who has to make viscosity measurements will study it with due care, it may induce a few workers to carry them out with the necessary care and precautions—or to refrain from publishing them.

The printing and illustrations conform to the general high standard of the publishers, and proof-reading has been done with exceptional care.

EMIL HATSCHEK.

Nature of Chemical Forces.

Radioelements and Isotopes: Chemical Forces and Optical Properties of Substances. By Kasimir Fajans. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 9.) Pp. x+125. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 12*s.* 6*d.* net.

PROF. FAJANS' Cornell lectures form a very small volume in comparison with those provided by former holders of the Baker lectureship, since they cover only 113 pages of text. The reason for this is a wish to avoid republication of material which is already in print. Thus a course of lectures on radioactivity and isotopy has been omitted, because these subjects are dealt with in existing books by the author and others; but one of the most interesting of current problems is discussed fully in a chapter on the origin of actinium. The conclusion is drawn that this element has an atomic weight of 227 and must, therefore, be entirely distinct from the radium and thorium series, where all the atomic weights are *even*, thus giving rise to radium lead, Pb^{206}, and thorium lead, Pb^{208}, which have both been separated in an almost pure state from minerals rich in uranium and thorium respectively. Strong confirmation of this conclusion is supplied by Aston's observation that lead actually contains the third isotope, Pb^{207}, and we may, therefore, now accept also the further deduction that actinium has its origin through protactinium in an odd-numbered isotope of U^{238}.

Apart from the twenty-four pages occupied by his interesting chapter, the book contains an introductory lecture on "The Development of Views regarding the Nature of Chemical Forces", and seven chapters on "Chemical Forces and Optical Properties". These chapters are naturally devoted in the main to a summary of the author's experimental work on the refractive indices of crystals of the alkali halides and related substances as evidence of the deformability of ions, but they also contain the arguments which he uses as evidence of the existence of transitional states between the ionic linkage, which is the common type in mineral salts, and the non-ionic linkage of organic compounds.

Arguments based on the feeble electrolytic conductivity of fused halides, such as aluminium chloride, carry little or no weight, since intermediate degrees of conductivity between those of fused sodium chloride and of liquid carbon tetrachloride must be expected in all those cases in which a covalent complex undergoes reversible ionisation. A more plausible argument can be based upon the difficulty of determining the type of linkage in compounds such as zinc sulphide and silver iodide, which crystallise on a diamond lattice, since it is not easy to admit that the reversible ionisation of covalent bonds is a normal state of affairs in a crystal; and at the absolute zero this process appears to be impossible. The argument is weakened, however, by including gaseous hydrogen chloride amongst the transitional compounds, since it is obvious that the proton cannot persist as a free ion, but must be enveloped by the planetary electrons of the halogen, thus giving rise to a definitely covalent compound. It differs from gaseous hydrogen, however, in the readiness with which (by reason of the stability of the octet of the chloride ion) the proton can be transferred to a molecule of water.

A similar condition appears to exist in stannic chloride, which has all the attributes of a covalent compound, until it is dissolved in water, when it is ionised reversibly, perhaps by co-ordination with the solvent as indicated by the equation:

$$SnCl_4 + H_2O \rightleftharpoons [SnCl_3{\cdot}OH_2]^+ + Cl^-.$$

Whilst, therefore, the *absence* of intermediate forms of linkage may still be open to question, more evidence appears to be required before their *presence* can be regarded as established.

The two concluding chapters deal with the adsorption of ions on salt-like crystals, with applications to volumetric analysis and to photochemistry. These applications have a direct practical value; but the theories on which they are based and which they serve to illustrate are also of fundamental importance, since the obscure notions of electrical double-layers, which were both puzzling and repulsive to students of a former generation, become both simple and clear when discussed in terms of an unequal distribution of ions of opposite signs. The book will therefore be read with interest, not only by those who had the privilege of hearing the lectures delivered, but also by many others who will be glad to have the most important of their contents set out in so concise a form.

Paper Making.

The Digestion of Grasses and Bamboo for Paper-Making. By W. Raitt. Pp. xi + 116 + 20 plates. (London: Crosby Lockwood and Son, 1931.) 21*s*.

THE rapid expansion in the demand for paper and for newsprint consequent on the spread of education, as well as the habit of wrapping everything up in several coverings of paper or cardboard, is a fact which, besides its special significance as an index of progress, causes concern to those who have to find new raw materials for the paper-maker. Commencing in the period of intellectual revival after the Napoleonic wars, when the consumption of paper per head in Great Britain was only an ounce or so per annum, the demand has continued until to-day it has been estimated at more than 70 lb. a head.

In America the consumption is still greater, and the world's annual requirements are in excess of twenty million tons. The English Education Act of 1870 is said to have multiplied consumption by ten within ten years. Little wonder that the demand has outstripped the supplies of raw materials, at first of rags and then of cereal straws first introduced in 1860. Esparto came to the rescue in 1860, but the economic radius of its collection was reached thirty years ago, and the production since has been very regular. Wood pulp first appeared about 1866–70 and has held the field until now, during a period in which a large part of the world's timber resources has been cut, so that to-day great anxiety is expressed for future supplies. The annual cut in the United States is four times the annual growth; in Canada only some twenty-five per cent of the original forest wealth is left. Obviously, if the expansion in demand continues, as it will, for cellulose has become a raw product of so many other industries, in particular artificial silk, which has almost unlimited potentialities, new sources of supply will have to be found.

It is obvious that trees are too slow growing to maintain supplies; some pulp wood is a forty years' crop; twenty-five to thirty years is required in Canada to bring a spruce tree to pulp wood size, though in the south with the loblolly pine it is now said to be possible to grow pulp wood in ten years.

The future obviously lies with the grasses, particularly the bamboo, if once satisfactory pulp can be obtained from it. In the past, troubles were experienced in the digestion and bleaching of bamboo cellulose, mostly because the work had been carried out empirically, without the scientific assistance of the chemist, and it is largely owing to the systematic work of Mr. Raitt that these difficulties have been overcome.

For twenty-five years, in part assisted by the Government of India, Mr. Raitt has made an exhaustive and scientific study of the subject, with the result that the problem of the utilisation of the bamboo has been largely solved. Culms of all ages, including the nodes, can be digested, mixed together, with a soda consumption of 16 per cent on the weight of bamboo, and a bleaching powder use of 8 per cent on the pulp at a pressure of 30 lb. of steam, the process only taking 5 hours. A yield of 45 per cent of unbleached and 42 per cent of bleached pulp is obtained by this process.

The book under review is a complete epitome of the subject based on Mr. Raitt's own practical experience; it deals with the analysis, the digestion in the autoclave, and all the practical problems arising out of the treatment in large scale operations, and contains an attractive account of the occurrence and growth of the bamboo. A section devoted to the microscopic features is illustrated with twenty plates.

The world's total standing crop of bamboo is enormous. In Burma alone an annual crop of 150 million tons is talked of, much of which could be easily exploited commercially, so that if suitable pulp really can be made from it, a supply which is inexhaustible can be obtained from materials which have no value for any other purpose.

E. F. ARMSTRONG.

The Teaching of Mathematics.

Craftsmanship in the Teaching of Elementary Mathematics. By F. W. Westaway. Pp. xvi + 665. (London and Glasgow: Blackie and Son, Ltd, 1931.) 15*s.* net.

SOME four hundred pages of this book are given to the elementary parts of mathematics, from the first four rules of arithmetic up to the standard of a school certificate. The treatment is varied, but often takes the form of outlined specimen lessons; it is full of useful hints about the details of teaching, and is sure to be welcomed by a large body of teachers.

Mr. Westaway's attitude is that of a moderate reformer. He is very far from wishing to impose stereotyped methods on teachers: so much so that sometimes a piece of good advice is given with insufficient emphasis—for example, "it is doubtful if the term infinity ought to be used below the Sixth". What he cannot abide is the slavish adoption of doubtful forms of traditional procedure. His standard of what a boy ought to know is very high; we read, for example, that fourth form boys are prone to forget the factors of $a^4 + a^2b^2 + b^4$. The excursions into logic are not very successful, though there will be general agreement with what is said about its restricted place in elementary teaching.

In spite of such blemishes, the book will undoubtedly be of great value to the inexperienced teacher; and not to him alone, for there is much that will be helpful to the master responsible for organisation. The importance of the teaching of the lowest sets is insisted upon, and there are useful suggestions about the non-specialists in the sixth form. There are interesting chapters on wave motion, map projections, and statistics, and some shorter ones on subjects like astronomy and optics; these will serve to remind the organiser of some topics that are often neglected.

Mr. Westaway's experience of the teaching of mathematical specialists would seem to have been unfortunate. He has sometimes been "almost bored to tears . . . with the petrifying stuff doled out . . . which is virtually the same as forty years ago". The development of calculus teaching with its applications to mechanics, the improvements in analytical methods and the freer use of projective methods in geometry, and the mitigation of 'identity' work in algebra and trigonometry, are a few indications that specialist teaching is not, as Mr. Westaway seems to think, being stabilised at the level of 1890.

Thus it may be expected that the specialist part of the book will be less valuable than the other. There are, it is true, still useful hints to be found, but the material and treatment smack of the nineteenth century rather than of the twentieth. For example, the "principle of continuity" is quoted from a textbook that appeared in 1893, and although we are told that pupils must understand the notion of a limit, we find, elsewhere, the archaism "when Q coalesces with P, the angle becomes a right angle". Again, the Argand treatment of complex numbers is prefaced by the reactionary proposal to "define the symbol $\sqrt{-1}$ as an expression whose square is -1".

Many references to other books are given, and there is an interesting questionnaire for young teachers which will tax the powers of many of their seniors.

Short Reviews.

Anthropology and Archæology.

Early Man: his Origin, Development and Culture. Lectures delivered for the Royal Anthropological Institute. By G. Elliot Smith, Sir Arthur Keith, Dr. F. G. Parsons, M. C. Burkitt, Harold J. E. Peake, Dr. J. L. Myres. Pp. xii + 176 + 12 plates. (London: Ernest Benn, Ltd., 1931.) 8*s.* 6*d.* net.

In 1929 the Royal Anthropological Institute inaugurated courses of open lectures of a popular character, of which the first series dealing with early man, delivered in the winter session 1929–30, is published in this volume. Of six lectures in all, three deal with the origin and descent of man from the point of view of the physical anthropologist, and three with aspects of the beginnings of culture. Of these latter, that by Mr. Miles Burkitt on "Most Primitive Art" is printed in abstract only, but compensation for the lack of a fuller development of his demonstration of the method of study by 'art groups' is forthcoming in the examples from French and Spanish caves and from South Africa, which have not been published previously.

On the physical side, Prof. Elliot Smith deals with the origin of man. Happily for his readers, while the volume was passing through the press, he was able to add to the lecture, as originally delivered, his conclusions on the place of Peking man in relation to other relics of early man, based on discoveries afterwards made at Chou Kou Tien. Sir Arthur Keith deals with the evolution of races in the past and in the present, and Dr. F. G. Parsons summarises the anthropological history of the modern Englishman, analysing the physical characters of different racial types that have gone to the make-up of that remarkable hybrid.

Of the remaining two lectures dealing with early culture, Mr. H. J. E. Peake on the beginnings of agriculture summarises the present position of research on the origin of cultivated grains, with special reference to wheat and barley, and discusses its bearing on the problem of the antiquity of civilisation in Egypt and Mesopotamia. The course of lectures closed with Prof. J. L. Myres's lecture on the discovery and early use of metals, which appears here in much extended form. Of two chapters, one deals with the 'precious' metals and the second with the 'useful' metals, with a wealth of illustration and commentary which ranges widely over the whole field of early culture and belief. The lecture is as delightful to read as it is informative.

Index of Potters' Stamps on Terra Sigillata "Samian Ware". By Dr. Felix Oswald. With a Supplement (to be consulted in conjunction with the Index) of Stamps obtained or recorded during the Period of printing the Index (with Corrections). Pp. xxiii + 428. (East Bridgford, Notts.: The Author, Margidunum, 1931.) 36*s.*

Dr. Felix Oswald's index to the potters' stamps on Terra Sigillata is an achievement in more senses than one. Owing to the difficulty of obtaining a publisher for a work of so highly specialised a character and the expense of private publication, the author has himself set up and printed the whole on a hand press. It has been the work of his leisure over a period of three years. The result is a credit to his knowledge of typography; and students of Roman provincial cultures are doubly indebted to him for carrying to completion this laborious but indispensable task, by which he supplements and completes the study of sigillata ware published by him in collaboration with Dr. T. Davies Pryce eleven years ago.

With the supplementary list of marks which have accrued in the past three years while the main body of the work was being printed, Dr. Oswald has now brought the list of potters' stamps completely up to date; but he has also added to the stamps previously published in the lists in the corpus of inscriptions, which goes up to 1906 only, the place and period of the potter and the form of the vessel on which the stamps occur, particulars essential for the archæologist but omitted from these lists. The index itself is of highly specialised interest, but as Dr. Oswald indicates in his preface, an examination of the stamps yields much information broadly of interest to archæologists, such as the movements of trade from Gaulish and German factories, the origin and place of work of the potters, their partnerships and nationalities, and even, in some cases, their personal characteristics.

An Introduction to the Sociology of Islam. By Reuben Levy. (Published for Herbert Spencer's Trustees.) In 2 Volumes. Vol. 1. Pp. viii + 410. (London: Williams and Norgate, Ltd., 1931.) 21*s.* net.

This volume is the first of a series to be published by the trustees of Herbert Spencer's will in continuation of his "Descriptive Sociology". Up to a point, Islam lends itself to the treatment which Spencer planned. Mohammedan communities have common characteristics based on their religion which make it possible to treat them as a unit. That unity, however, is no more than formal, and unless the treatment of the subject is to be allowed to expand to an almost inordinate length, local differences must be ignored, especially in outlying regions, such as Zanzibar and Malaya for example, where earlier custom and animistic belief have coloured practice. Mr. Levy has not passed over such differences entirely, but has been able to refer to them only in selected instances.

In his first volume now published, Mr. Levy, after an historical introduction which sketches the growth of Islam and its territorial extent at various periods of its history, analyses the effect of its religion on the life and organisation of society. He covers the grades of society, the status of the woman and the child, jurisprudence, and the caliphate and central government. The form of government in the independent Islamic provinces, ethics, philosophy, and science are being dealt with in a second volume. Students and others interested in Islam will be grateful for this convenient and compendious survey. Very full bibliographies appended to each chapter serve as a guide to closer study.

Biology.

Journals of Gilbert White. Edited by Walter Johnson. (Broadway Diaries, Memoirs and Letters.) Pp. xlviii + 463 + 4 plates. (London: George Routledge and Sons, Ltd., 1931.) 21*s*. net.

GILBERT WHITE's "Natural History of Selborne", 1789, is a book which stands alone as the work of a charming, kindly old bachelor, naturalist, and poet. It is simple and happy, full of the joy of life, and has a fine literary style of its own; it will probably be for all time the premier work on the natural history of any part of England. The "Natural History" was largely culled from White's *Garden Calendar*, published in full by Bowdler Sharpe in his edition of Selborne, 1900, and from the *Naturalist's Journal*, begun in 1768. The latter is now published for the first time, and it is ably edited, so that passages already used by White are eliminated. But why is it published at all? It was not written by White to be published—and we feel that he would have been very averse from doing so. It adds nothing to White's fame, gives no fresh picture of his life and times, and relatively few natural history observations of value to-day. It was proper to preserve it in the British Museum, but we feel that it would have been preferable to allow it to remain in its honoured obscurity.

An Introduction to Zoology. By P. W. Gideon. Pp. vi + 90. (Dharwar: Students' Own Book Depot, 1930.) 5.8 rupees.

THE title of the present book gives no indication as to its nature. It is really a laboratory guide, which in size and the arrangement of the plates recalls Howes's "Atlas of Biology", and is intended for use in the intermediate science classes of the Indian universities. There are twenty-one chapters, some general, but most deal with a series of animal types, from Amœba to the frog. Each chapter contains a general introduction, one or more plates of figures, and several pages of notes arranged in a schematic way. By means of these notes a very large amount of information is conveyed in a limited compass. Considering that it was printed in a small centre, it is well done, but it contains a number of typographical errors. The drawings are clear and well reproduced. In addition to the usual information regarding the types, there are also classifications of the phyla and main groups to which the different animals belong.

The book should prove useful to the students for whom it is intended, and has much to commend it. The danger lies in the student allowing its drawings and notes to replace his own, and in 'cramming' from it instead of relying upon fuller texts. The author has obviously spent considerable time and thought in planning the work, and it will not only assist the student in the laboratory but also help him to arrange his information and to revise his work.

Flora of West Tropical Africa: the British West African Colonies, British Cameroons, the French and Portuguese Colonies south of the Tropic of Cancer to Lake Chad, and Fernando Po. By J. Hutchinson and Dr. J. M. Dalziel. Prepared at the Herbarium, Royal Botanic Gardens, Kew, under the supervision of the Director. Published under the authority of the Secretary of State for the Colonies. Vol. 2, Part 1. Pp. iii + 292. (London: The Crown Agents for the Colonies, 1931.) 8*s*. 6*d*.

IN part 1 of vol. 2 of this "Flora", thirty-three families of Gamopetaleæ are considered. From the economic point of view none is of very great significance, but botanically speaking there are several of great importance, notably the Rubiaceæ and the Compositæ. These two account for seventy-three and seventy-two genera, and 465 and 192 species respectively. The former has also the most prolific genus in *Psychotria*, which is represented by fifty-two species in this region. Altogether the thirty-three families present 420 genera and nearly 1600 species; of the latter 102 are new, and there are two new varieties and forty-nine new combinations.

The co-operation of Miss M. B. Moss was obtained for the preparation of the Myrsinaceæ and the Loganiaceæ and of Mr. A. Bulloch for the Solanaceæ.

An interesting fact in plant distribution is the considerable number of species common to this tract and to India, especially the south-west of that country. Strangely, however, *Avicennia officinalis* Linn., which is present in the mangrove swamps of India and East Africa, is not found; the genus here being represented by *A. nitida* Jacq.

Plant Physiology: with Reference to the Green Plant. By Prof. Edwin C. Miller. Pp. xxiv + 900. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 35*s*. net.

IN the preface of this book, which he describes as an advanced text in plant physiology, the author points out that the various European textbooks usually fail to deal adequately with the work of American and English plant physiologists. In this book American and English work is very adequately covered, whilst continental work is by no means neglected.

The field of plant physiology is very well covered; a beginning is made with the cell, the entry of water and solutes are then considered and the loss of water from the plant, metabolism, translocation, respiration, growth. Directional growth responses (tropisms) receive very scant attention. The treatment of every subject is comprehensive and clear and the citations of literature, especially modern work, very full, but little attempt is made at a critical appraisal of this great mass of material which, to many students, may prove bewildering rather than illuminating.

Manual of Bacterial Plant Pathogens. By Charlotte Elliott. Pp. ix + 349. (London: Baillière, Tindall and Cox, 1930.) 22*s.* 6*d.* net.

This volume is the outgrowth of a card-index on bacterial parasites of plants accumulated by the author and is presented in the form of short summaries of the characters of the organisms and of the disease produced, together with remarkably complete bibliographies of each pathogen.

The book is divided into three parts; the first part, which forms three-quarters of the whole volume, consists of a list of all known bacterial pathogens arranged in alphabetical order, the classification adopted being E. F. Smith's modification of Migula's system. The second part comprises a list of organisms described as commonly found in association with pathogens, but not themselves parasitic, while the third part consists of a chart of the chief characters of the organisms arranged in chronological order of discovery. This last would have been of much more use if the arrangement had been alphabetical, as in the body of the text.

As a source of reference, particularly to the literature, the book will prove of great value to all plant pathologists. R. H. S.

Pflanzenmikrochemie: ein Hilfsbuch beim mikrochemischen Studium pflanzlicher Objekte. Von Dr. A. Tunmann. Zweite vermehrte und verbesserte Auflage bearbeitet von Prof. Dr. L. Rosenthaler. Pp. xxiii + 1047. (Berlin: Gebrüder Borntraeger, 1931.) 75 gold marks.

The new edition of this well-known book on plant micro-chemistry has been considerably enlarged under the editorship of Prof. Rosenthaler of Bern.

To the general section of the work has been added a section upon micro-manipulation in which, as also in the description of methods of counting and measuring under the microscope, Dr. Ehlers of Jena has collaborated. Sections are also added upon urea, compounds of uronic acid, vital staining, membrane pigments in the mosses, pigments of fungi and bacteria, etc. The citations of literature in the footnotes continue to be very extensive, and the account in small type, which accompanies the different substances discussed and analyses their distribution in the plant kingdom, also remains a very satisfactory feature of this comprehensive and valuable laboratory reference book.

Physiology.

(1) *Ultra-violet Radiotherapy.* By Dr. W. Kerr Russell. (Modern Treatment Series.) Pp. 130. (London: Jonathan Cape, Ltd., 1930.) 5*s.* net.

(2) *Therapeutic Uses of Infra-red Rays.* By W. Annandale Troup. Pp. viii + 58 + 16 plates. (London: The Actinic Press, Ltd., 1930.) 5*s.* 6*d.* net.

The electromagnetic waves which have found a place in therapeutics extend over a considerable portion of the spectrum, from the γ-rays of radium and the X-rays of short wave-length, through the ultra-violet to the infra-red rays, of long wave-length. In 'light' treatment, the ultra-violet rays play an important part, although their sources used in practice usually emit heat waves also: in 'heat' treatment, the action is due to the long infra-red waves, although the source used may emit visible light rays at the same time.

Light and heat treatment have been employed in a great variety of diseases with benefit in many cases, but as with other kinds of treatment, experience is necessary, and overdosage has unpleasant after-effects. The value of the treatment can only be determined by observation of the results obtained, which depend on the technique adopted as well as on the variable responses of different patients. Hence precise descriptions of technique and the results observed in different diseases are of value in enabling physicians to select those cases which are likely to be benefited by the treatment.

In both the little books before us, the authors describe their technique and their results. Dr. Kerr Russell considers that ultra-violet radiotherapy is almost a specific in certain diseases, and a useful adjuvant to other methods of treatment in many others. Dr. Annandale Troup's book is the first published in Great Britain devoted specifically to the therapeutic uses of infra-red rays; he prefers a low temperature generator, which he describes in detail. The rays are of value in chronic rheumatic conditions, and in sprains and other injuries they can be used in conjunction with ultra-violet radiotherapy.

These books should be of value to those employing this treatment and to others who wish to have some knowledge as to the type of case which it may be expected to benefit.

Bread: a Collection of Popular Papers on Wheat, Flour and Bread. By Harry Snyder. With Biographical Sketch by Andrew L. Winton. Pp. x + 293 + 20 plates. (New York: The Macmillan Co., 1930.) 10*s.* 6*d.* net.

Harry Snyder, who died at Minneapolis four years ago, had many friends and admirers in Great Britain. In the United States he was known as the champion of pure white flour and the outstanding man of science in the milling industry. This book contains a biographical appreciation of him by Andrew L. Winton and a series of papers on bread and cognate subjects which are considered of such value as to be of wide interest.

Snyder's theme was the rightful place of bread in the human diet: his conclusions are as valid to-day as when they were first written. The papers form a most valuable source of information on all that concerns bread and flour and wheat, and they are worth a place on the shelves of everyone interested in preserving this source of our food in a pure state. It is a matter which will always require watchful care; Snyder himself did not a little in attacking fallacies concerning food values which were being exploited by the aid of generous advertising. E. F. A.

Psychology.

The Mental Defective: a Problem in Social Inefficiency. By Dr. Richard J. A. Berry and Dr. R. G. Gordon. Pp. xi + 196 + 8 plates. (London: Kegan Paul and Co., Ltd., 1931.) 8*s.* 6*d.* net.

It is almost impossible for a lay mind to form any conception of the tremendous financial drain on the country's resources caused by the socially inefficient or higher grade mental or moral defective. Dr. Berry and Dr. Gordon have set out, in their book, to give a plain and straightforward account of the various grades of mental defective, so that the lay mind may understand the most difficult of social problems, the elimination of the defective from our midst.

The authors provide us with three preliminary chapters—the two on the evolution of brain and the making of mind being particularly well set out, although it is very doubtful if the most educated layman will understand what the authors mean when they describe the "synaptic junction between the axon of the connectant or internuncial neurone and the dendrons of the effector neurone". The anatomy is really too complicated for a layman. The photographs of the higher-grade defectives give a false impression. It is notoriously difficult to pick out defectives from photographs, if not actually impossible.

The best chapter in the book is that dealing with policy. This chapter ought to be read by all members of county councils dealing with the defective in their midst. The running of model colonies for defectives and, more important still, for border-line cases who are socially inefficient is a step in the right direction, but one which, we feel, will take a long time to penetrate to the right quarter.

Brain and Mind. By Arthur Lynch. Pp. 36. (London: The Pioneer Press, 1931.) 6*d.*

When philosophical conclusions are categorically expressed in the first person, it shows that their author is in earnest. Yet individual convictions, however strong, can scarcely pretend to carry universal assent. Philosophers, in particular, are hardened people: the very history of their subject compels them to be sceptical as to the decisive value of any particular system. To base a philosophical theory on the assertion that "psychology is the matrix of the sciences" is nothing new in itself. Scores of psychological schools are attempting the same thing from various angles; while in the more abstract domain of thought, the Russellian and the Brouwerian interpretations of mathematics and logic, in spite of their conflicting results, have shown some remarkable specimens of analysis of mental processes. The claims of Col. Lynch need therefore strong justification: the position of their author will be much clearer if he himself confronts his conclusions with those of other schools of thought. Otherwise an unassuming critic is bound to find in them some vague reminiscences of earlier readings. T. G.

The Will to Live: an Outline of Evolutionary Psychology. By J. H. Badley. Pp. 267. (London: George Allen and Unwin, Ltd., 1931.) 10*s.* 6*d.* net.

The author gives us what he considers is a useful dissertation on psychology in general, suitable for boys and girls who have just left, or are about to leave, school. We think a better title might have been chosen; comparatively few children of school-leaving age show any great interest in 'the will to live', but might be very interested in modern points of view in psychology simply told. The book is very well laid out and, generally speaking, presents a very readable account of psychology. We should prefer to see the word 'complex' used in its narrower meaning; in ninety per cent of cases when the word complex is used in modern psychology it refers to what the author would prefer to term a 'buried complex'. We think the author might have given a rather fuller account of Adlerian theories, for they appeal considerably more to the lay mind as a distinctly healthier view than either those of Freud or even Jung.

Agriculture.

Principles of Tropical Agriculture. By Dr. H. A. Tempany and G. E. Mann. Pp. 328 + xxiii. (Kuala Lumpur: The Incorporated Society of Planters, Malaya, 1930.)

Most books published in English on agriculture in the tropics seem to assume that the greater part of the tropical zone has a high and constant rainfall, and that the so-called 'planting crops' form the chief agricultural enterprises in the hotter parts of the world. The result is to give a very unreal picture of tropical agriculture. The present book is no exception to this rule. It has been written as a textbook of general principles to be taught to students in Malaya. For this purpose it is, on the whole, very well suited, for the conditions with which it chiefly deals are those found in this typical wet tropical area. On the other hand, the portions dealing with the far more frequently occurring dry tropical conditions are very perfunctory, and it is doubtful whether the book should be recommended to a student whose future interest is likely to lie in such areas.

One at least of the authors has had very wide experience in the West Indies, Mauritius, Java, and Malaya, and hence, naturally, the chief tropical data cited are from these areas. It is rather a pity, however, that these have not been supplemented to a greater extent from the work done and information obtained in West and East Africa and, particularly, in India—especially as regards soil conditions and manurial methods found useful there, even with the type of crop and condition with which the book chiefly deals.

For the narrow purpose for which it has been chiefly written, the book will probably be found of great use, and an advance on anything hitherto available; but as a general manual of the principles on which tropical agriculture is based it will be found of comparatively little service. H. H. M.

The Culture of the Orange and Allied Fruits. By Prof. H. Clark Powell. (South African Agricultural Series, Vol. 8.) Pp. 355 + 83 plates. (Johannesburg: Central News Agency, Ltd., 1930.) 21*s.* net.

In 1913 the exports of citrus fruit from South Africa amounted to 70,000 cases; by 1929 this had risen to 1,200,000. At the present time only 22 per cent of the citrus trees in the Union of South Africa are more than eight years old. Citrus groves are established from the Zoutpansberg, in the north of the Transvaal, to Uitenhage, in the extreme south, and Clan William, in the extreme west of the Cape of Good Hope. Such are the very varying climatic and soil conditions under which this young industry is established. There is no well-defined citrus area such as exists in Florida and California. So far as possible, the author has drawn on South African experience, and much information has been collected from the successes and failures of the past. Where South African experience does not exist—and a large amount of research and investigation is shown to be still necessary—the author has of necessity to draw on work done elsewhere.

The book deals in a thoroughly practical manner with all aspects of citrus growing, and should prove a great help to the grower and the industry in general, besides being a valuable addition to citrus literature. A short account is given in the concluding chapters of citrus culture in other parts of the world.

Economics.

Youth and Power: the Diversions of an Economist. By C. R. Fay. Pp. ix + 292. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 10*s.* 6*d.* net.

In this book Mr. C. R. Fay discourses on a wide range of subjects, including topics so varied as the outlook of youth, trade unions, Adam Smith and foreign trade, unemployment, immigration, and the psychology of revolt. Its scope is thus better indicated by the sub-title, "Diversions of an Economist", rather than by the main title. A special interest is attached to Mr. Fay's reflections, since he has had exceptional opportunities of studying conditions in Great Britain, Canada, and the United States. In discussing unemployment, for example, he is thus able to contrast conditions in various countries. In France there is a great degree of economic stability, due largely to her agricultural democracy, but in Great Britain technological unemployment, which is distinctively American, has been added to various pre-War causes. These, playing upon Britain's peculiar post-War situation, have produced a position in which one industry after another is depressed. The present problem, in his view, is one of readjustment to a new world balance which calls for an unusual degree of co-operation between employers and employed. The book as a whole is very readable and should interest the general reader as well as the professional economist.

Britain and World Trade: Quo Vadimus and other Economic Essays. By A. Loveday. Pp. xxi + 229. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 10*s.* 6*d.* net.

This volume consists of a series of essays written at various dates and now collected in book form. The subjects discussed are: post-War economic tendencies up to 1925; gold and prices; Britain and world trade; economic progress 1925–29; tariff level indices, and an essay entitled "Quo Vadimus?" in which present-day economic trends are examined. Mr. Loveday is head of the Economic Intelligence Service of the League of Nations Secretariat, Geneva, and is thus well qualified to discuss these problems. He points out that Great Britain's share in world trade has declined and continues to decline. Whereas in 1913 she claimed 13·9 per cent of all exports, in 1928 this had fallen to 11·2 per cent. He considers that the forces determining economic development to-day demand a revision of industrial methods and a modification of industrial technique which have perhaps been less fully accomplished in Great Britain than elsewhere, though mobility of demand and the rapid progress of science render suppleness of industrial mechanism more necessary than ever. The book suffers from the form in which it is composed, and would have been improved if rewritten into a homogeneous whole.

Geography and Travel.

The Groundwork of Modern Geography: an Introduction to the Science of Geography. By Dr. Albert Wilmore. Third edition, revised and enlarged. Pp. xxii + 533 + 27 plates. (London: G. Bell and Sons, Ltd., 1931.) 7*s.* 6*d.*

A book which has now reached its third edition, in addition to five reprints of the earlier editions, requires no technical criticism; it has obviously filled a long-felt want. We have approached it from the point of view of one who from boyhood has wandered about England and later in many other lands, having been taught to use his eyes and understand something of their geography, geology, flora and fauna, etc., and has in turn tried to impart some of this knowledge to the next generation. With such interests one is never alone; indeed, the trouble is to find time to do all the things that tumble over one another in their urgency when in new country. What a treasury of other people's learning and experience is disclosed by Dr. Wilmore; his simple classifications, the succession of chapters on land forms, make all so clear; so that one can without great difficulty puzzle out some of the riddles of our own Lake District, not unassociated in our memories with the genial enthusiasm of Dr. Marr, and even attempt the more complex conundrums set us in the High Alps.

Climate on holiday means fine weather, yet we are able to realise the need for rain and appreciate Charles Kingsley's reasons for declining to pray for the rain to cease. The book should be better known; it can add enjoyment to every holiday spent in the hills, whether we go to the Alps in summer or to the English Lakes at wet Eastertide, and it need scarcely be said that it should form one of the few books included in the restricted luggage for a cruise, that is, if the voyager wishes to behold with seeing eyes.

The fine illustrations are not the least attractive part of the work. E. F. A.

Der Kilimandjaro: sein Land und seine Menschen. Von Dr. Walter Geilinger. Pp. 182 + 95 Tafeln. (Bern und Berlin: Hans Huber, 1931.) 15 francs; 12 gold marks.

The author, a doctor in Zurich, visited East Africa in 1928–29 and ascended Kilima Njaro, the highest of African mountains. His book contains a short, interesting account of the country and its people, and conveys a pleasing impression of the author's ecstatic enjoyment of the beauties and wonders seen during his tour. He combines his own observations with information from general literature, in the list of which British authorities occupy a fair share. Special features are dealt with in a series of useful appendices, including those on the flora, topography, and geological history of Kilima Njaro. The author's main interest was in the flora and forest trees and the contribution of the vegetation to the scenery of the district.

The text is general and popular, and gives a good picture of the present conditions of the country. The most valuable feature of the book is its illustrations, including 156 photographs and 4 coloured plates. Most of the photographs are by the author and are of the trees, more conspicuous plants. the natives, the glaciers and ice formations on Kilima Njaro, the giraffes, antelopes, and other big game. The illustrations form a graphic and useful record of the natural history of the mountain and its surrounding plains. The name of the mountain is spelt Kilimandjaro on the title page and in the text and Kilima Njaro on the cover. The one drawback of the book is the absence of an index, which would have been especially useful in regard to the flora.

Alarms and Excursions in Arabia. By Bertram Thomas. Pp. 296 + 24 plates. (London: George Allen and Unwin, Ltd., 1931.) 15*s.* net.

The geographical area covered by Mr. Thomas's book is wider than the title indicates. Of the 'adventures' which he records—and no other name would describe them so exactly—two out of the five have Mesopotamia as their setting and the three others southern Arabia, after he had been appointed Vizier of the Sultan of Oman and Muscat. Although the interest of the first two is essentially that of a record of a difficult military and political situation, Mr. Thomas's insight into the character of the tribal Arab gives it an added value for those who appreciate the significance of racial characteristics in their bearing on the task we have undertaken in Mesopotamia. Of his work and travels in Arabia the scientific results have already been published in the *Geographical Journal* and elsewhere. Here Mr. Thomas gives his readers the lighter side—fighting and politics — and here and there intriguing thumb-nail sketches of customs and beliefs. His book throws an interesting sidelight on the conditions in which his valuable additions to our geographical and ethnological knowledge of Arabia have been made. The recent award of the Burton Memorial Medal of the Royal Asiatic Society to the author is a fitting and well-deserved recognition of his work in the Great Sandy Desert.

Geology.

Central Asiatic Expeditions. The Permian of Mongolia: a Report on the Permian Fauna of the Jisu Honguer Limestone of Mongolia and its relations to the Permian of other parts of the World. By Prof. Amadeus W. Grabau. With a Chapter on the Relations of the Jisu Honguer Formation to the General Geology of Mongolia, by Dr. Charles P. Berkey and Frederick K. Morris. (Natural History of Central Asia, Vol. 4.) Pp. xliii + 665 + 35 plates. (New York and London: G. P. Putnam's Sons, 1931.) 42*s.* net.

With the exception of a chapter on the general geology of Mongolia by C. P. Berkey and F. K. Morris, this work is devoted to a detailed account of the fauna of the Jisu Honguer limestone of southern Mongolia, with a discussion of its age and relationship to similar faunas of other regions, more particularly to Russia and India. Brachiopods are the predominating group in the fauna; of these, no less than 99 species and varieties are recognised, belonging principally to the spiriferids, the productids, and the streptorhynchids, with the remarkable form *Richthofenia.* The Mollusca are relatively few in number, there being only 19 species and varieties of gasteropods and 17 of lamellibranchs. Noteworthy features are the rarity of corals and Polyzoa and the absence of Foraminifera, echinoderms, trilobites, and cephalopods. To account for this limitation of the fauna, combined with signs of dwarfing shown by many of the brachiopods, the author suggests that the salinity of the water was below normal, and compares the conditions with those now existing in Pechili Bay, a nearly enclosed area freshened by the waters of the Yellow River, where some groups of organisms usually abundant in the open sea are rare or wholly wanting.

The Jisu Honguer is correlated with the Uralian of Russia and the Productus Limestone of India. By most geologists the Uralian is regarded as of Upper Carboniferous age, but Prof. Grabau gives reasons for assigning it to the Lower Permian.

Lehrbuch der Geologie. Teil 3: *Geologische Landerkunde.* (*Regionale Geologie.*) Von Prof. Dr. F. X. Schaffer. Lieferung 1. Pp. vii + 96. (Leipzig und Wien: Franz Deuticke, 1930.) 6 gold marks.

The third volume of the "Textbook of Geology", by Prof. Schaffer, Director of the Geological and Palæontological Department of the Vienna Museum, is devoted to regional geology. The first part includes the general introduction, illustrated by a map of the world showing the author's conclusions as to the distribution and character of the main earth-forms. He divides them into three main groups; the Epeirogens are the continental areas; the Orogens are the mountain bands, in which he includes all the North Atlantic, the western part of the Southern Ocean, and the south-western part of the Pacific. His third group includes the Pelagogens, or the areas of the Pacific, South Atlantic, and Indian Ocean which he regards as having been permanent. All the eastern Pacific, he considers, has been an ocean since the pre-Cambrian, and he supports this view by the opinion of Holdhaus that the insect faunas of the Polynesian islands are oceanic—a conclusion rejected by other authorities on the entomology of that region.

Most of the present part is occupied by summaries of the geology of the Pacific Ocean and its islands, of the Australonesian Orogen, based largely on Stanley's works on New Guinea, and by accounts of New Zealand, Australia, and the Antarctic continent and islands. The chapter on India is begun. The author has visited Australia, and his chapter on the Australian region shows general recognition of the predominant influence of block-faulting and of the Great Valley of South Australia as a rift valley. Prof. Schaffer briefly considers the artesian basin of east-central Australia and accepts the view that the wells are discharging an accumulation of fossil water or of magmatic water, and he remarks that many of the wells have already shown a great decline in productivity. In the account of New Zealand he tabulates the classifications of Park, Marshall, and Morgan.

Chemistry.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. 11: *Te, Cr, Mo, W.* Pp. xii + 909. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 63*s.* net.

THE eleventh volume of Dr. Mellor's "Comprehensive Treatise" includes the element tellurium, held over from the previous volume on sulphur and selenium, and the half-brothers of the oxygen family, chromium, molybdenum, and tungsten, but without uranium. All these elements raise interesting problems of valency; but the section on the valency of tellurium is unfortunately already out of date, since the evidence cited on p. 32 for the coplanar configuration of the four radicals in the telluronium salts has been obsolete since the end of 1928, whilst positive evidence of the tetrahedral configuration was provided at the end of 1929. The chromium ammines are catalogued with characteristic thoroughness under ninety subheadings, and stereo-isomerism is suggested as a possible explanation of the existence of multiple forms of certain members of the series, but the index contains no references by which general phenomena, such as co-ordination, isomerism, or stereo-isomerism, can be discovered. On the other hand, the interesting oxy-salts, which are so characteristic of this family of elements, can be traced quite readily by referring to entries under chromyl, molybdenyl, and uranyl compounds.

As his task approaches completion, however, it becomes increasingly clear that Dr. Mellor's principal achievement is to provide a monumental index to the literature of inorganic chemistry during the preparative period of its development, and thus to ensure that nothing of importance is lost or permanently forgotten. This programme calls for page after page of closely packed references and a highly condensed text, with the result that the more modern problems of valency and chemical properties in their relation to the electronic structure of atoms and molecules must necessarily play only a subsidiary part in the scheme. The treatise is therefore, in the main, a record of detailed facts accumulated during a century of arduous work, and the author is to be congratulated on the inclusion of so many recently acquired details, for example, of crystal structure, rather than to be criticised for the fact that these are scattered at such distant intervals amongst the results of earlier work.

Fundamentals of Organic Chemistry. By Prof. Harry F. Lewis. (International Chemical Series.) Pp. viii + 390. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 13*s.* 9*d.* net.

IN the preface to this book, the author directs attention to the lack of a recent American textbook of organic chemistry based on what he calls the "Atomic Linking Theory". This somewhat misleading expression is intended to denote a theory based upon the Lewis-Langmuir conception of electronic linkages rather than upon the mere spatial orientation of the molecules as developed from the work of Kekulé, van 't Hoff, and others. But the author soon encounters difficulties, and on page 10 he confesses that "the arrangement of electrons in ethylene and acetylene is not well understood". He is therefore obliged to fall back upon a study of old-fashioned linkages and groupings, and abandons the idea of discussing electronic linkages. Very little stress is laid, however, upon the use of three-dimensional formulæ and the description of optical activity is rather inaccurate. Thus the expression "straight chains of carbon atoms" is used, and an optically active compound is described as one "having the property of bending the plane of polarised light". The chapter on the characteristics and analysis of compounds is a mere outline and would be more useful if it were illustrated with diagrams.

Nevertheless, the book has some good features. Thus, in many of the problems set, reference to original papers is necessary in order to obtain numerical data, which are to be used in plotting graphs, and the student acquires the habit at an early stage of consulting the original records. Emphasis is also laid upon technical developments of recent date, for example, new fermentation processes, new methods of cracking hydrocarbons, the catalytic oxidation of naphthalene, and technical applications of Friedel and Crafft's reaction. Many illustrations of plant are given.

Quantitative Pharmaceutical Chemistry: containing Theory and Practice of Quantitative Analysis applied to Pharmacy. By Prof. Glenn L. Jenkins and Prof. Andrew G. DuMez. (McGraw-Hill Publications in Pharmacy.) Pp. xxiii + 408. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 17*s.* 6*d.* net.

This book bases a four years' course of quantitative analysis for students of pharmacy on the various methods of assay described in the United States Pharmacopœia and National Formulary. It may be questioned whether such a course, even for pharmaceutical students, will give the groundwork which is desirable, seeing that the methods are intended only for standardised articles of a high degree of purity. So far as it goes, however, the course is judiciously arranged; the typical processes are, in general, adequately explained and questions and problems are set at the conclusion of the exercises. The details of some of the processes should have been criticised for the edification of the student, who may be left with the impression that it is usual, in the electrolytic assay of mercury, to employ a cathode weighing 700-800 gm. when the expected increase in weight is about 0·3 gm., or that in the determination of nitrogen by the Kjeldahl process there is no likelihood of loss of ammonia by the addition of strong soda solution to the diluted acid solution in an open flask.

The book is well printed and is remarkably free from typographical errors. A few loose statements are apparent; for example, it is explained that a 0·2 per cent solution of sodium chloride just acidified to litmus paper with nitric acid must not be heated since chlorine may be lost thus: $6HCl + 2HNO_3 \rightarrow 3Cl_2 + 4H_2O + 2NO$. A more serious error is that the student is directed to determine colorimetrically the *p*H of alcoholic solutions. The technique of repeated ether extractions should have included the more usual and convenient practice of blowing off the ether layers instead of running off the aqueous layer. J. R. Nicholls.

Chemical Composition: an Account of the Methods by which Atomic Weights and Molecular Formulæ have been Determined. By Dr. A. K. Goard. Pp. viii + 304. (London: Sidgwick and Jackson, Ltd., 1931.) 5*s.*

Twenty-seven years ago, Miss Ida Freund wrote a book on " The Study of Chemical Composition " which at once acquired a permanent value by reason of the fact that it was made up very largely of appropriately selected quotations from original sources. Miss Freund's book (which has long been out of print) was, however, too expensive to be used extensively by students, and was mainly a source of information and inspiration for those who were responsible for the teaching of chemistry in schools or universities.

It appears certain that Dr. Goard must have been amongst their number, since he has set himself the task of handing on, in a more elementary form and at a much lower price, the doctrines which formed the subject of the larger work. He has carried out his task in a way which appears to be entirely satisfactory, since the shortness of many of his chapters must be very encouraging to his readers; but for a real test of success it would be necessary to discover what impression the book has made on the author's own classes at Marlborough, or on other juvenile readers who have been introduced by it to a section of chemical theory which can be made very dull, but can also form the subject of a rather fascinating story.

The reviewer is too hardened a chemist to make this test in his own person, but would commend the book to those who are in a position to use it for this purpose, since he is certain that nothing but good can come from closer contact between the beginner of to-day and the scientific pioneers of yesterday.

Lehrbuch der physikalischen Chemie. Von Prof. Dr. Karl Jellinek. Fünf Bände. Lieferung 10 (Band 4): *Die Lehre von der Statik chemischer Reaktionen (Schlussteil) und die Lehre von der chemischen Kinetik.* Erste und zweite Auflage. Pp. 288. (Stuttgart: Ferdinand Enke, 1931.) 26 gold marks.

Prof. Jellinek's detailed treatise provides the worker in physical chemistry with a survey of the theory and experimental investigations which is at the same time exhaustive and comprehensible. Great care is taken not to pass over points of difficulty, and all the equations used are deduced in full, numerical applications in most cases making their significance perfectly clear. Unlike some treatises, it takes full account of work done in Great Britain and the United States, so that it is international in character. The references to the literature are very complete, and it is clear that the author has made extensive use of original papers.

The present volume extends the treatment of liquid solutions begun in the preceding one, and deals with equilibria in weak electrolytes. The activity function is used throughout, and since such matters as neutralisation curves, buffer solutions, and indicators are included, the volume contains much of interest to biochemists as well as to investigators in pure physical chemistry and technical workers. The text is very clearly printed, and numerous curves and diagrams are included.

The book may be strongly recommended as forming a part of what is undoubtedly the most important and authoritative treatise on physical chemistry of the time. Although the detailed treatment makes it suitable for the specialist, the careful explanations given of all the theories are such as could usefully be read by students able to understand German.

Solvents. By Dr. Thos. H. Durrans. (Monographs on Applied Chemistry, Vol. 4.) Second and revised edition. Pp. xv + 180. (London: Chapman and Hall, Ltd., 1931.) 10*s.* 6*d.* net.

The term ' organic solvent ' has acquired an altogether new meaning during the past year or so in connexion with the various sections of the plastic industry, particularly cellulose lacquer and artificial silk. The older solvents like acetone have been manufactured by new methods in much greater quantities and at much lower prices; newer solvents are being made and applied to industry all the time, so that, as is often said, what were last year's laboratory curiosities are this year sold in tank waggons. Progress in the new field on the manufacturing side has been largely due to the use of processes involving catalysts, which have led to new syntheses from simple raw materials such as alcohol.

The fact that a new edition of this book has been called for within a year is a proof both of the interest taken in the subject and of the clarity and utility of the work. The method again adopted is to deal with the fundamentals in the first section of fifty pages and to devote Part 2 to the individual solvents in considerable detail. The chapter on plasticising solvents has been considerably extended and now contains notes on forty-one substances suggested for this purpose.

The book is readable, commendably crisp, and will be of value to all who use such solvents.

E. F. A.

Practical Physical Chemistry. By Prof. Alexander Findlay. Fifth edition, revised and enlarged. Pp. xii + 312. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 7*s.* 6*d.* net.

The fifth edition of Prof. Findlay's "Practical Physical Chemistry" may be regarded as celebrating the half-jubilee of the book, which was first issued in 1906. Throughout this period its general character has been maintained, but its usefulness has been increased by the introduction of new experiments from time to time. In the present edition the preface tells us that these new experiments deal with gaseous dissociation, vapour pressure of liquids, viscosity of highly viscous liquids, potentiometric methods, and the use of indicators for the determination of hydrogen ion concentration, whilst attention has been directed to the concept of the activity of strong electrolytes and to the phenomenon of salt effect. The vapour pressure of salt hydrates and the freezing points of binary mixtures have also received brief treatment.

The new edition does not call for any further comment, except for a word of congratulation to the author on his success in inhibiting the physicochemical phenomenon of 'ageing' from which books on chemistry are liable to suffer severely.

Die Glykoside: Chemische Monographie der Pflanzenglykoside. Von Dr. J. J. L. van Rijn. Zweite ergänzte und neubearbeitete Auflage von Prof. Dr. Hugo Dieterle. Pp. viii + 620. (Berlin: Gebrüder Borntraeger, 1931.) 48 gold marks.

The first edition of Dr. van Rijn's book was published so long ago as 1900; it has now been revised and rewritten by Dr. Dieterle.

The chemistry of the individual glycosides which have been found in plants is described in the order of plant families, a method of arrangement which in our opinion, as indeed the author confesses, leaves much to be desired, as it makes the book merely a catalogue of individual substances and does not bring out any general group relationship among the glycosides or assist the reader to study their significance. For each substance the method of preparation, the physical properties, and the constitution of the non-sugar section or aglucone is indicated; a reference is also made to the physiological activity. The work is costly, and suitable for reference in the library rather than for the inspiration of the research worker. E. F. A.

Physics.

Lectures on Theoretical Physics delivered at the University of Leiden. By H. A. Lorentz. Authorised translation by Dr. L. Silberstein and A. P. H. Trivelli. Vol. 3: *Maxwell's Theory,* edited by Dr. H. Bremekamp; *The Principle of Relativity for Uniform Translations,* edited by Dr. A. D. Fokker. Pp. xi + 326. (London: Macmillan and Co., Ltd., 1931.) 21*s.* net.

This, the last, volume of Lorentz's "Lectures on Theoretical Physics" contains a translation of two courses, namely, "Maxwell's Theory", edited in the Dutch by H. Bremekamp and published in Leyden in 1925, and "The Principle of Relativity for Uniform Translations", edited by A. D. Fokker and published in 1922.

The first section contains chapters on the electromagnetic field, electrostatics, stationary currents, induction currents, and the electromagnetic theory of light. The second section, on the restricted theory of relativity, contains chapters on the principle of relativity, the various transformation formulæ and their interpretation, the mechanics of a particle, the inertia of energy, and electromagnetic phenomena in moving bodies.

Although the work treats of very familiar and almost old-fashioned material, it treats them in a manner which is both stimulating and refreshing, the simplicity and generality of the style being reminiscent of Lorentz at his best. The various topics are dealt with in sufficient detail to bring out all the underlying physical principles and their bearing on the mathematical formulations, and they are woven together so as to form a complete and comprehensive text on the subject.

As with the first two volumes, the translators have not always been too happy in their choice of words and phrases, but on the whole the book is a worthy companion to its predecessors, and does honour to the great master whose thoughts it expounds. It can be strongly commended to all who are interested in the subjects with which it deals and, in particular, to students and teachers in need of an introductory textbook to this side of modern physics. G. H. L.

Magnetism and Electricity. By E. Nightingale. Pp. xvi + 294. (London: G. Bell and Sons, Ltd., 1931.) 4*s.* 6*d.*

The high standard set in the author's "Heat, Light, and Sound" is fully maintained in the present work, which covers roughly the school certificate or matriculation range. For students following a school course it would be difficult to imagine a more efficient or attractive presentation of a subject which, thanks largely to the universal interest in wireless, may be regarded as the most popular branch of science, but is often handicapped by heavy or unimaginative treatment. The historical development is prominent throughout. This, as is nowadays generally realised, adds greatly to the reality and interest of science. Here, moreover, instead of the great pioneers being left as little more than names, they are made to 'live' by judicious sketches of their life and times, with portraits, numerous extracts from their original papers, and reproductions of their diagrams and apparatus. The lesser known experimenters receive due recognition, in which connexion Bennett's work and original illustrations are notable. Equally with the historical aspect a practical line of study is followed, aided by a wealth of simple diagrams and numerous ingenious and up-to-date modifications or improvements of the usual experiments. Practical applications to everyday life are emphasised.

The quantitative side has been made to appear integral with theory. Each chapter is provided with a summary, simple questions, and an ample number of questions grouped together, drawn from papers of the various school certificate authorities; worked numerical examples are added. A concluding chapter deals briefly with modern ideas and advances, such as conduction through gases, wireless, and photoelectricity. The book is altogether admirable—a maximum is accomplished in a minimum of space. N. M. BLIGH.

Electricity for Everybody: Handbook for 1931; an Electrical Compendium incorporating a Gazetteer of Electricity Supplies, a Directory of Electrical Contractors, and a Diary from April 1931 to March 1932. By R. Borlase Matthews. Pp. lxxxvii + 470. (London: Electrical Press, Ltd., 1931.) 5*s.* net.

Now that electricity supply is available to many, a demand has arisen for accurate knowledge about the various uses to which this supply can be applied for domestic and factory purposes. This book will be useful in this connexion. It contains a useful diary, a calendar, and a section dealing with general principles which can be readily understood by anyone with a little technical knowledge. There is a section dealing with electric lighting, heating, cooking, and power in the home, due stress being laid on the economic and æsthetic factors. The costs of electricity in public and private buildings and in factories are discussed, and simple methods of computing them are given.

Mr. Borlase Matthews is a specialist in the many uses to which electricity can be put on a farm or in a garden. It is used to increase the comfort and hence the utility of live-stock. It also increases their productivity. The heating and lighting of apiaries increases the productivity of each hive by from 15 lb. to 17 lb. of honey per annum. Electric heating of greenhouses for forcing is very readily done, and an even temperature is easily obtained by a thermostatic control. The soil heating of frames and hot beds by means of electric cables is extending in Great Britain. It is much better than using the variable heat given out by manure.

Post-Primary Science. By W. F. F. Shearcroft. Book 1: First Year's Course. Pp. 194. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1930.) 2*s.* 6*d.*

THIS is the first of three books designed to cover the first three years of a five-year course, leaving two years for a more specialised study. The object is to overcome the difficulty, so painfully obvious to every teacher, that science tends to be studied in water-tight compartments, and progress in one branch is hindered by ignorance of another, ending generally in a knowledge of a little heat and a little chemistry.

Here science is generalised in the extreme by a treatment of measurements, heat, light, sound, and magnetism and electricity, with a trace of mechanics, all merging into each other. The presentation is in the simplest possible style, and in a manner likely to interest pupils from the age of eleven years, for whom the book is intended. The scientific method is the keynote throughout, and the course, being primarily experimental, should certainly train the pupil to think. The provision of a table of contents would be an advantage, an index not being a satisfactory alternative. N. M. BLIGH.

An Introduction to Quantum Theory. By Dr. G. Temple. Pp. 196. (London: Williams and Norgate, Ltd., 1931.) 12*s.* 6*d.* net.

THIS book is concerned more with the ideas upon which quantum mechanics is based than with the applications of the theory to physical problems. The book opens with a general discussion of the principle of duality between waves and particles, followed by a chapter on the theory of photons, in which the idea of a wave function for a single light quantum is introduced. A wave theory of matter is then developed along unusual lines. Electric charge is treated as a fluid which obeys hydro-dynamical laws, and by means of certain special assumptions its behaviour is shown to be governed by a wave equation equivalent to that of Schrödinger. Thus, without interpreting any of the symbols in terms of probability, a considerable number of the results of wave mechanics can be deduced, including the energy levels of a hydrogen atom and the splitting in a magnetic field. The treatment is complicated and involves a considerable amount of mathematics, and therefore can scarcely be recommended to a beginner.

The author then shows that it is necessary to introduce the idea of probability in dealing with collision problems, and in dynamical problems involving the interaction of two or more particles. There follow chapters on quantum algebra and matrix mechanics, attention being concentrated on the formal side of the theory, and very few examples being given. As would be expected from the author's own researches, there are interesting chapters on the relativity wave equation and on the spinning electron.

Quartz Resonators and Oscillators. By P. Vigoureux. Pp. 217 + 13 plates. (London: H.M. Stationery Office, 1931.) 7*s.* 6*d.* net.

WRITTEN round the practical use of quartz in vibrating systems, this monograph will be of interest to many classes of readers. It describes the preparation of suitable pieces of crystal from the natural material—apparently by no means a difficult operation—the connexions and mathematical theory of circuits involving these, and the physics of quartz. We should like to direct special attention to the illustrations, and particularly to the photographs of the electrical discharges which vibrating crystals can set up in a partial vacuum, and of the interference fringes seen with a crystal oscillator close to optical flat. It would be difficult to devise more beautiful demonstrations of the modes of vibration of rods and plates. Including as it does an extensive bibliography, the book serves a useful purpose in co-ordinating existing results, and can scarcely fail to stimulate further research. K. G. E.

Engineering.

(1) *Cross-Country Flying.* By Major Oliver Stewart. Pp. ix + 116 (12 plates). (London: Constable and Co., Ltd., 1931.) 6*s.* net.

(2) *Flying as a Career: a Popular Guide for all proposing to obtain a Position in the new Industry as a Pilot, Navigator, or Aircraftsman.* By Major Oliver Stewart. Pp. ix + 81 + 12 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 3*s.* 6*d.* net.

(1) MAJOR STEWART is a writer of the kind that seems to be prevalent in aviation, to its great advantage. He has the ability to explain the most abstruse problem to the non-scientific reader by selecting the essentials, and presenting them simply yet accurately. His book, " Cross-Country Flying ", deals with the use of the compass, air speed indicator, turn and drift indicator, bubble inclinometer, etc., in the air, and the general use of maps, course plotters, and calculators on the ground. He avoids the complicated mathematical theory upon which much of it is based, without descending to such a simplicity as to offend the intelligence of the reader.

There are chapters on the regulations laid down by law to be observed when flying, and a sufficient explanation of meteorology and instructions for the use of wireless communication to enable the pilot to make use of the broadcast services in this respect. A chapter on bad weather flying is unfortunately only too appropriate in Great Britain at the present time.

(2) " Flying as a Career " deals in a strictly impartial manner with the various possibilities in aviation to-day. The author is quite rightly severe in his condemnation of the Royal Air Force ' Medium Service ' system as a ' blind alley ' occupation. Aspiring aviators and their parents can read this book with considerable advantage.

The Light Aeroplane Manual. By F. D. Bradbrooke. Pp. ix + 251. (London: Chapman and Hall, Ltd., 1931.) 10*s.* 6*d.* net.

THIS is an exceedingly well written book but with an entirely misleading title. The term ' Manual ' suggests the practical outlook, and detailed descriptions of light aeroplanes and their engines, together with hints on their use and maintenance, are expected. Actually the book is a simple and remarkably correctly written treatise on the theory of flight, both from the point of view of why an aeroplane flies and, appreciating this, how to fly it properly. The author has skilfully avoided the all too common pitfall of making a statement scientifically incorrect in order to simplify it. He has not dealt with the more complex mathematical and physical outlook, but as the book is obviously intended for the user rather than the producer of an aeroplane, his action is justified.

The chapter headed " Types of Aircraft " is rather a disappointment, in that it is merely a description of some present-day aeroplanes, which will serve to make the book out of date rapidly, remembering the rate at which aircraft design is progressing to-day. A more general discussion upon the broad classification of types, into which modern aircraft is automatically dividing itself, would have been more in keeping with the rest.

The book should certainly be read by all aircraft owners who are ambitious to be something more than mere aerial chauffeurs, and should be useful to elementary students of aeronautics.

The Mechanical Properties of Wood: including a Discussion of the Factors affecting the Mechanical Properties, Working Stresses for Structural Timber, and Methods of Timber Testing. By Prof. George A. Garratt. Pp. ix + 276. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 17*s.* 6*d.* net.

THIS American publication deals with a subject that is receiving more and more attention from forest utilisation officers, wood technologists, architects, and manufacturers, for all find that it is very necessary that reliable information should be available upon the mechanical properties, not only of a few woods, but also of all the important commercial timbers. Moreover, it is necessary that there should be an international understanding about any research that is being carried out.

The book under notice, whilst primarily a textbook for students, will also be found of value to other people interested in timber and its manufacture. The author has divided his work into four parts. Part 1 treats of the relation of wood to stresses and strains, which are included under the three general headings tensile, compressive, and shearing, each of which is then dealt with separately and subdivided as necessary. Illustrations and tables add materially to the interest of the descriptions. Part 2 deals with factors affecting the mechanical properties of wood, such as knots, checks, shakes, cross grain, decay, etc. Preservative treatment is given full consideration, time of felling and its effect on timber, and various other pertinent matters.

Part 3 deals with working stresses for structural timbers. This part will be found of great use to architects and engineers, for it goes very carefully into the question of working stresses for joists, planks, beams, stringers, round posts, wooden columns, etc., with tables showing the comparative strengths of various American timbers. Part 4 treats of timber testing, forms of material tested, size of specimens in relation to tests, moisture determination, machine for static tests, speed of testing machine, with numerous descriptions of tests. At the end of each part is a list of references to questions dealt with in the respective part. The work has a good index.

Charts and Data on Marine Boiler Design: a Summary of the Standard Formulæ in Chart Form with Tables and Notes. By H. C. Walker. Pp. xii + 55. (London: Chapman and Hall, Ltd., 1931.) 25*s*. net.

Though to-day in all naval vessels, and in a considerable number of mercantile vessels, water-tube boilers are used, the standard form of boiler for ships, both small and large, has been that with a cylindrical shell and internal cylindrical furnaces, from which the gases pass into vertical combustion chambers and through nests of tubes. Such boilers are sometimes referred to as return-tube boilers, as the smoke returns to smoke-boxes fitted at the same end as the furnace mouths; but to all marine engineers they are just known as marine boilers. The design of this type of boiler involves the consideration of the strength of cylinders, of flat plates, of corrugated furnaces, and of riveted joints; and the dimensions of the various parts are governed by rules laid down in an official document, "Standard Conditions for the Design and Construction of Marine Boilers", published by H.M. Stationery Office. From the formulæ given in these rules the calculations are made. To obviate the necessity for these calculations, Mr. Walker has prepared a series of 17 charts and 25 tables, from which, once his methods are grasped, readings are the work of a few moments only, and the possibilities of error are practically eliminated. The size of the volume, 13 in. × 10 in., has enabled the charts to be of a sufficiently large scale; they are printed on stout paper, and have been rendered easy for reference. The author has thus provided a reference book which should be of much use for all concerned with the design of marine boilers.

Machine Drawing and Design: a Textbook of Intermediate Standard for Engineering Students. By W. Abbott. Pp. 208. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1930.) 7*s*. 6*d*. net.

This volume is divided into two parts. Part 1 contains the more important details of machinery, such as fastenings, shafts and fittings, bearings, gearing, valves, parts of engines and turbines, with simple explanations of the principles of design. It is assumed that the subjects of mechanics and the strength of materials are being studied conjointly. Part 2 is devoted entirely to exercises, and includes some examples taken from university and Whitworth scholarship examination papers. Most of the drawings are presented in pictorial form, thus preventing the mere copying of orthographic projections and enabling the appearance of the object to be readily understood. The designs included are representative of good modern practice.

There is evidence throughout the volume that the author has taken pains to produce an excellent and well-graded course suited to the requirements of intermediate students. Those interested in the teaching of engineering who are acquainted with Mr. Abbott's former work on "Practical Geometry and Engineering Graphics" will welcome the present useful and practical addition to the literature of engineering drawing.

Civil Engineering Design. By Arthur A. Fordham. Pp. xi + 212 (45 plates). (London: Chapman and Hall, Ltd., 1931.) 21*s*. net.

This book is intended to be of service in the drawing office to students taking courses in civil engineering who have acquired a knowledge of strength of materials, theory of structures, etc. The volume contains twelve designs completely worked out with the necessary calculations and drawings. These include a steel frame building with grillage foundations, steel dock gates, two steel roof principals, one of which is a two-hinged braced arch, five bridge designs, including both steel and reinforced concrete, a masonry dam and an earthen dam. These designs have been carefully worked out and will be useful to the student in showing how principles are applied in practice; also by modifying specified dimensions the illustrated designs may be used as models for his own designs.

There are not too many volumes on this subject published in Great Britain; most of the great mass of material at our disposal is scattered in periodicals and transactions of engineering institutions. The present volume will therefore be appreciated by many busy teachers who have to provide data for students' designs. It is unfortunate that the size of the book—12½ inches by 10 inches—required to present the drawings properly, and its weight, which is about 4 lb., make it clumsy to handle and lead to a good deal of wasted space in the text. In view of the excellence of the matter, however, this must be regarded as a minor blemish.

Mathematics.

Numerical Mathematical Analysis. By Prof. James B. Scarborough. Pp. xv + 416. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1930.) 25*s*. net.

Most of the ground of Prof. Scarborough's book on numerical analysis is covered adequately for English readers by Whittaker and Robinson's "Calculus of Observations", and the new work interests us chiefly for its revelation of differences between the American material and our own.

The best feature of the book is the attempt wherever possible to frame estimates of reliability. In one case the author is led to an important conclusion, for he finds that in spite of its complication Simpson's three-eighths rule carries an inherent error more than twice as large as his one-third rule ; the comparison is between the actual errors that must occur in individual cases, not between upper limits to these errors in general, and it follows that the more elaborate rule has nothing whatever to recommend it.

Like the account of quadrature, the account of the numerical integration of differential equations is thorough ; four distinct methods are compared and illustrated, and the author's commentary is helpful. But the treatment of other topics is scantier. What are we to say, for example, when the last word on interpolation is with Stirling and Bessel and there is no mention of Everett ? There is an adequate chapter on the root-squaring method of solving an algebraic equation. For simultaneous equations, since the labour involved in the computation of a numerical determinant is not exposed, the tediousness of the Newton-Raphson process is not made evident, and while the iterative process is explained for sets of equations to which it is obviously applicable, nothing is said of the way in which sets of functional equations in general can be prepared for iterative solution. Although probability and statistics are outside the range of the volume, a discussion of normal and probable errors and of estimates of precision is included, to lead up to a chapter on the construction of empirical formulæ which is one of the most important in the book.

The explanations throughout are clear. The author attracts confidence by the honesty with which he applies the standard methods, sometimes to unfavourable cases, and teaches the computer to learn by experience. E. H. N.

(1) *Les méthodes de solution approchée des problèmes de la physique mathématique.* Par Nicolas Kryloff. (*Mémorial des sciences mathématiques*, Fascicule 49.) Pp. 69. (Paris : Gauthier-Villars et Cie, 1931.) 15 francs.

(2) *Angenäherte und symbolische Lösung der Differentialgleichungen der mathematischen Physik und Technik.* Von Prof. Dr. N. M. Kryloff. Pp. 162. (Kharkov and Kiev : State Technical Publishers, 1931.) 3 Kps.

(1) One of the most valuable methods for the approximate solution of the differential equations of mathematical physics is that due to Lord Rayleigh and W. Ritz. This starts by applying the calculus of variations to a certain quadratic form and finally obtains a solution in terms of a convergent series of functions ; a limited number of terms of this series gives an approximation to the exact solution. However, the method as left by its authors was not fully developed, and a great deal of work has been done by Prof. Kryloff, who has written more than thirty papers on the subject. An essential part of his contributions is to show how to estimate the number of terms which must be taken to make the error less than an arbitrary assigned amount. Great variety is possible in the treatment ; in fact, it might be said that each type of equation has its own appropriate method. The account given by Prof. Kryloff in this tract shows that the subject is far from exhausted and offers opportunities for further research.

(2) Another side of the subject is dealt with in the second of the above books of Prof. Kryloff. Unfortunately, this is in the Ukraine language, but there is a summary in German. This book makes considerable advances in the use of the Heaviside operational methods. In particular, it combines them with the methods of approximation on which Prof. Kryloff has worked so long.

H. T. H. P.

Leçons sur la théorie mathématique de la lutte pour la vie. Par Prof. Vito Volterra. Rédigées par Marcel Brelot. (*Cahiers scientifiques*, Fascicule 7.) Pp. vi + 214. (Paris : Gauthier-Villars et Cie, 1931.) 60 francs.

This book deals with one of the newest branches of applied mathematics, namely, the application of differential and integro-differential equations to biological problems of the survival of the fittest, such as the effect of a change in the rate of fishing upon the proportion of the different species of fish, some of which prey upon others.

The first part of the book assumes that the causes have immediate effects. This assumption, though probably far from the truth, has the advantage of allowing a fairly simple and complete mathematical treatment in terms of differential equations. Three fundamental laws are deduced, those of fluctuations, conservation of means, and perturbation of means, which seem of considerable practical importance. The second part of the book endeavours to extend the results of the first to the case where the causes produce delayed effects.

This work is connected with Prof. Volterra's researches on integro-differential equations and their applications to mechanics. In view of the simplifying hypotheses adopted, the results are not likely to be accepted by biologists until they have been confirmed experimentally, but this work has as yet scarcely begun. H. T. H. P.

Miscellany.

Armadas of the Sky : the Problem of Armaments. By Paul Murphy. Pp 120. (London : The Houghton Publishing Co., 1931.) 5*s*. net.

This is a semi-philosophic discussion upon the possible methods of waging war in the future, bearing in mind the uses made of aircraft in the late War, and endeavouring to visualise their probable development by the time the next war breaks out. The reader is left, as it is suspected the author himself is, somewhat breathless, if not entirely drowned, in the sea of argument and counter-argument. The conclusion that appears to emerge from the welter of facts intermixed with visions is that the use of aircraft plus radio communication will so radically alter methods of war that it is impossible to foresee what will happen. In the absence of this knowledge, it is absurd to prepare for a limited number of possibilities only, and impossible to be ready for every one, because of the magnitude of the task. This is rather hard on the professional fighters, who are apparently preparing for a war to be fought on lines similar to the last one, not so much out of ignorance or lack of vision, as because it is the only concrete thing that they have to work upon.

A long chapter is devoted to a dramatic description of the first twenty-four hours of an imaginary war of the future. The capitals of both of the combatants are immediately crippled by the enemies' air fleets, and we are left with the impression that the continuation of the war is impracticable, because of the destruction of the centres of organisation. This holocaust occurs principally because of the rapidity of the blow, which is made possible, first, by the lack of cumbersome mobilisation of armed forces as in previous wars, and, secondly, by the facilities with which orders can be transmitted by wireless.

The author develops a rather ingenious subdivision of methods of use of gas in aerial warfare, which can either be used for killing, temporarily incapacitating a population, or rendering an area uninhabitable. A good many aircraft designers of to-day would not agree with one of his premises, that civil air transport aeroplanes can be used immediately for war purposes; also, that the airship is inferior to heavier-than-air craft in every respect, both in its war and peace applications.

Equality. (Halley Stewart Lectures, 1929.) By R. H. Tawney. Pp. 303. (London: George Allen and Unwin, Ltd., 1931.) 7*s.* 6*d.* net.

"The lever which lifted political and religious boulders will snap when used to move economic mountains" expresses a pessimistic outlook which does not appear to be shared by Prof. Tawney. Nor does he believe that our present social and economic maladjustments are the inevitable results of original sin. "It is more contemptible to be intimidated by distrust of human nature than to be duped by believing in it." His book is an interesting examination of political and economic equality as an ideal, and involves an analysis of the causes, social and psychological, which have resulted in our present degree of inequality. The chapter on "Equality and Culture" is a good tract for the times, and reiterates the useful truth that, if the Kingdom of Heaven is not eating and drinking, "neither is civilisation the multiplication of motor-cars and cinemas, and of any other of the innumerable devices by which men accumulate means of ever-increasing intricacy to the attainment of ends which are not worth attaining".

Critique of Physics. By L. L. Whyte. Pp. xi + 196. (London: Kegan Paul and Co., Ltd., 1931.) 10*s.* 6*d.* net.

The main purpose of this inspiring book is to propose a new structural method of physics where relativity and the quantum theory are shown as special cases of a more general limitation on the classical frame. The proposed method, which the author calls 'unitary theory', is a deductive theory of measurement and of the relations holding between measured quantities, based on a theory of the structure of rods and clocks, in which all theoretically significant lengths, times, or masses appear as functions of one primary length, time, or mass.

It can be gathered, therefore, that the author's method does not arise out of experimental necessities, but is shaped merely on logical postulates based on a searching analysis of the assumptions of modern physics. Without adequate mathematical and experimental developments, it would be difficult to pass a final judgment on the author's endeavour. But he is himself aware of the provisional character of his suggestions, and likes to call his method heuristic rather than scientific. At any rate, if it inspires physicists to look with a constructive suspicion at the postulates of their theories, and try to remedy their obvious logical defects, the labours of the author will not have been in vain.

T. G.

A Defence of Philosophy. By Ralph Barton Perry. Pp. 56. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1931.) 4*s.* 6*d.* net.

Prof. Perry says there is a sort of gentlemen's agreement not to ask ultimate questions. "People do not as a rule insist upon knowing the meaning of things, further than to assign them a place in their world of familiar objects." Yet philosophy differs from other studies in that it continues to press inquiry beyond the point where it customarily stops. "It sets no limits to the questions it asks, save to insist that they shall really be questions." When it is objected that if inquiries are carried too far the methods of science have to be left behind, the philosopher's reply is that he will use what methods he can. Yet the questions which he asks are all familiar in kind: What is real? Why did it happen? How do I know? What ought I to do? Everyone philosophises up to a point; the difference between the metaphysician and the rest of the world is one of degree only, and lies in the thoroughness and obstinacy with which the latter pursues his quest. The philosopher is the intellectual frontiersman, who attempts to domesticate the wild areas which lie beyond the cultivated fields of science. Students of science will read this lecture of Prof. Perry's with interest and with a large measure of agreement.

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Letters to the Editor.

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Determination of the Yard in Terms of the Wave-length of Light.

IN the issue of NATURE for May 9, p. 726, a short account is given of an investigation by Dr. A. E. H. Tutton of the length of the yard in terms of the wave-length of light. This being the first occasion on which the value of the yard in wave-lengths has been directly determined, considerable interest naturally attaches to the result.

In the complete account of his work which has now been published,[1] Dr. Tutton arrives by calculation, from the means of several determinations made in the red line of hydrogen and in the strong yellow line of neon, at a value for the length of the yard in terms of the standard cadmium red line which is in good agreement with that derived from the accepted value of the metre in terms of this line, taken in conjunction with the known ratio of the yard to the metre.[2] Unfortunately, however, he gives no adequate investigation of the probable error of his result, which the internal evidence of his paper clearly shows is very large. In fact, from the nature of the procedure adopted it could not be otherwise.

The method consists in actually counting, to the nearest tenth of a band, the number of interference bands corresponding to three intervals each $\frac{1}{16}$ in. in length—that is, a potential accuracy of the order of 1 part in 50,000—and then stepping up to the yard by a process which, apart from any further errors which may be involved, is one of sheer multiplication. Actually the various individual counts of the separate sixteenths of inches in H_α exhibited differences between themselves amounting to as much as 1·6 bands, with an average difference from the mean in each group of 0·44 band, or nearly 1 part in 10,000. Only two counts were made in Ne_e, the average difference between corresponding pairs being 0·5 band.

As a test on the accuracy of the building-up process, the following comparison is informative. On pp. 312, 316, Dr. Tutton gives the final values he obtained for the length of the yard as—

$$1 \text{ yard} = 1{,}393{,}290{\cdot}5\ \mathrm{H}_\alpha$$
$$1 \text{ yard} = 1{,}562{,}408{\cdot}6\ \mathrm{Ne}_e$$

respectively. From the ratio of these two figures, taking the value of Ne_e as 5852·488 A., the value of H_α can be calculated as

$$\mathrm{H}_\alpha = 6562{\cdot}865 \text{ A.},$$

a result which, though somewhat high, is in tolerable agreement with expectation. The building-up process can, however, add nothing to the accuracy of the original counts, and if we take from pp. 301 and 303 the aggregate mean counts of the three separate $\frac{1}{16}$ in. lengths in the two radiations, we get $16{,}266{\cdot}5\ \mathrm{Ne}_e = 14{,}504{\cdot}3\ \mathrm{H}_\alpha$, from which, using the same value of Ne_e, as above, we find

$$\mathrm{H}_\alpha = 6563{\cdot}536 \text{ A.},$$

showing a difference of 1 part in 10,000 as compared with the result derived from the same data after building up to the yard length.

Incidentally, this more direct calculation gives a value for H_α too far removed from the range of values found for this line by other observers to be acceptable, and it is thus clear that the agreement of Tutton's results with expectation, both as regards the wave-length value of the yard in Ne_e and as regards the derived value of H_α, must be entirely fortuitous, both the original counts and the building-up process being liable to errors of the order of 1 part in 10,000. There are other points in Dr. Tutton's paper which might be criticised, but in these circumstances there is no necessity to enter into details.

At the conclusion of his paper, Dr. Tutton generously records his acknowledgments in respect of certain facilities which I was happy to be able to afford him; and having been to this small extent associated with the work, I the more regret having thus to direct attention to the uncertainty of the results. Had they differed from expectation as much as these remarks show that they easily might have done, the necessity would scarcely have arisen, but their chance agreement with expectation involves a risk that they may be accepted at their face value without sufficient scrutiny. It is very important that the wave-length value of the yard should be determined with all attainable precision. Preparations for such a determination at the National Physical Laboratory are well advanced, and it is expected that the results will become available for publication during the course of next year.

J. E. SEARS, JR.

Standards Department, Board of Trade,
6 Old Palace Yard, Westminster, S.W.1,
Oct. 26.

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[1] Tutton, *Phil. Trans.*, A, **230**, 293; 1931.

[2] Sears, Johnson and Jolly, *Phil. Trans.*, A, **227**, 281; 1928.

IN rendering due thanks to Mr. Sears, at the conclusion of my paper, for the facilities granted to me for the use of the interferential comparator, which I had the honour to devise and see constructed and installed at the Standards Department of the Board of Trade, in the time of the late Deputy-Warden of the Standards, Major P. A. MacMahon, nothing was further from my intention than to imply any responsibility on the part of Mr. Sears for the results communicated to the Royal Society in my paper. Indeed, he was from the first unsympathetic towards my interferential method. While in Major MacMahon's time the statutory periodic comparisons of the Imperial Standard Yard with its official copies were carried out with my interferential comparator, the interferometric portion was afterwards dismantled, and the instrument used for purely mechanical and microscopic comparisons. Much valuable time had to be spent at the outset of my work in cleaning, refitting, and readjusting the interferometric part, and by the Office of Works electricians in replacing perished electrical fittings, especially those of the thermostat, which maintains the whole comparator room at the official temperature of 62° F. and which had become positively dangerous from disuse. Fortunately, all the base-line work, the actual counting, band by band, of the interference bands (10,846 in yellow neon Ne_e light) in the one-eighth of an inch, was able to be carried out on my own interferometer, an improved copy of that at the Standards Department, in my private laboratory at Cambridge.

The specific criticisms of Mr. Sears are all fully dealt with in the paper. It is unfair to assume an error of one in ten thousand, the true facts being stated on page 318, where it is shown to be less than 0·03 of an interference band, corresponding to about four wave-lengths in the final result. Not two but six counts in yellow neon light are recorded, two on each of three separate sets of Grayson-ruling (half wave-length) fiducial marks, and double this number of counts were actually made with identical results.

As regards the accuracy-test of the building-up process, the calculation of the H_α wave-length given by Mr. Sears is also unfair, as it is made clear in the paper (p. 321) that the hydrogen results are not relied on, being influenced by the fact that the red line H_α is a doublet, and therefore only used in general confirmation of the neon results. It is the final result with yellow neon Ne_c light, 1,562,409 wave-lengths in the yard, which is alone relied on, the Ne_c line being unresolvably single and its wave-length a standard constant, so that the number of wave-lengths of cadmium red Cd_r light in the yard, 1,420,210, calculated by use of this constant and the standard wave-length of Cd_r, is unimpeachable.

It is, indeed, important that the value of the yard in standard wave-lengths should be known with the greatest possible accuracy, and no one will welcome more than myself the result of the determination by Fabry and Perot's method now in progress at the National Physical Laboratory. My own being a totally different method, it must surely be an advantage if the two different methods eventually turn out to give results in practical agreement.

A. E. H. Tutton.

Electron Exchange Phenomena in the Excited Atom.

In an interesting paper recently published,[1] H. S. W. Massey and C. B. O. Mohr have calculated the relative electron excitation probabilities in the case of helium.

These calculations, while following up the previous work of Oppenheimer, Born, and Dirac, take into particular account electron exchange phenomena in the excited atom.

Their final results show that in the case of 200 volt electrons in helium the relative probabilities to be expected are as follows :

Transition .	$1S-2S$.	$1S-2P$.	$1S-3P$.	$1S-3D$.
Singlet . .	0·03	0·09	0·0015	0·00025
Triplet . .	0·001	0·00002	$0{\cdot}0_71$	$0{\cdot}0_61$

It so happens that we have been engaged in an experimental investigation involving this very point, some of our results being published in the *Proceedings of the Leeds Philosophical and Literary Society* in March 1931, and in the *Philosophical Magazine* for November 1931.

Our experiments agree, approximately at any rate, with the above results so far as the 1^1S-2^1P and 1^1S-3^1P transitions are concerned, but *we have failed to find any evidence at all of any transition corresponding to* $1S-2S$ singlet or triplet.

It is clear that we should have found it, if present, according to the relative intensity predicted by Massey and Mohr.

It may not be without interest further to point out that Jones and Whiddington[2] found that in the electron excitation of H_2 there was a marked maximum in the probability of an observed loss of about 9·0 volts in the neighbourhood of 16 volts velocity of impacting electrons. The suggestion made at the time was that this loss was an excitation resulting in the emission of the optical continuous spectrum.

This notion is strengthened if regarded in the light of the work of Massey and Mohr, since the loss in the case of H_2 seems by analogy as likely to be a triplet excitation, the continuous spectrum being produced by transitions to a supposed unstable 1^3S state.

R. Whiddington.
J. E. Roberts.

Physics Laboratories,
University of Leeds, Nov. 11.

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[1] *Proceedings of the Royal Society*, vol. 132; 1931.
[2] *Philosophical Magazine*, vol. 6, p 899; 1928.

The Atomic Weight of Fluorine.

Messrs. H. S. Patterson, R. Whytlaw-Gray, and W. Cawood have published[1] some preliminary results on a new revision of the molecular weight of methyl fluoride which seems to lead to the value 19·010 for the atomic weight of fluorine. I should like to point out that the references given in favour of this value are by no means trustworthy. In the first place, the work of McAdam and Smith[2] on the analytical ratio, sodium fluoride to sodium chloride, was a preliminary one. The only two transformations carried out give, after correction to a vacuum, fluorine = 19·019 (instead of 19·010). Smith and van Hagen[3] conclude more recently that "the experience of these authors shows that the reaction in question did not proceed smoothly", and that "the errors of experience—traces of water in sodium fluoride and conversion incomplete to sodium chloride—would have increased the value of the atomic weight of fluorine". Germann and Booth[4] have determined the normal density of silicon tetrafluoride, but, as Clarke has pointed out,[5] "do not go so far as to compute from this figure the molecular weight of the fluoride". By comparison with the deductions of Jacquerod and Tourpaian,[6] Clarke obtains for the molecular weight 104·47 and hence for the atomic weight of fluorine 19·09 (not 19·010). Van Laar, on the other hand, assuming that the critical constants for silicon tetrafluoride as determined by Moissan are incorrect, has calculated the molecular weight as 104·13 and hence they find 18·995 for fluorine.

The most recent work of Smith and van Hagen has proved that the ratio of fluorine to another halogen, say chlorine, may be established analytically much more readily by an indirect comparison—say, by converting a sample of a suitable compound to the choride and another sample of the same preparation to the fluoride by an independent method. With borax as such an intermediate compound, Smith and van Hagen have established many cross-ratios between sodium fluoride and sodium chloride, sulphate, nitrate, and carbonate. With the most probable values for chlorine, nitrogen, sulphur, and carbon we get for fluorine 19·002, 19·001, and 19·000. Only the conversion from borax to sodium carbonate, which would be incomplete, gives fluorine 19·006. The other exceedingly reliable values support the value 19·000 as found by Moles and Batuecas.[7]

Aston, using the new mass-spectrograph and with boron trifluoride, deduces 19·000 as the atomic weight of fluorine, in agreement with our conclusions.[8]

With reference to the criticisms on our work on the normal density of methyl fluoride, I should like to point out that the gas was prepared by two different methods : by the reaction of potassium fluoride with potassium methylsulphate and by the action of methyl iodide on silver fluoride. The mean values for the density from the two methods agree by 1·7 part in 10,000. For the compressibility measurements, only the gas from the second source, which will certainly not be contaminated with methyl oxide, was employed.

The method of Collie (decomposition of tetramethyl ammonium fluoride by heat) has been tested in my laboratory by Gonzalez.[9] By heating the salt to 160° over phosphorus pentoxide in a vacuum for several weeks, it was not possible to obtain an anhydrous product. Traces of water are retained by the fluoride, and by heating this salt to 180°, decomposition and at the same time a secondary reaction with production of ammonia, nitrogen oxide, and methane take place. Purification of the evolved gas with potash, ferrous sulphate, sulphuric acid, and phosphoric anhydride and repeated liquefaction and fractionation give a gas fraction with constant density and constant boiling point which contains about two per cent methane.

If we use the constant litre weight found by Gonzalez, 1·5363, and the results of Patterson, Whytlaw-Gray, and Cawood at 21°, to calculate the coefficient of thermal expansion of methyl fluoride, we get the normal value 0·0037. On the other hand, van Laar,[10] with the critical constants as determined by Collie with the impure gas, has calculated the compressibility coefficient 1·0094, which approaches the value deduced by Patterson, Whytlaw-Gray, and Cawood, namely, 1·0109. It seems very probable that the methyl fluoride used by the latter workers was contaminated with some two per cent of methane.

It appears to be highly improbable that the atomic weight of fluorine should exceed 19·000. A detailed paper will appear soon elsewhere. E. MOLES.

National Institute of Physics and Chemistry,
University, Madrid,
Oct. 15.

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[1] NATURE, **128**, 375, Aug. 29, 1931.
[2] *Jour. Am. Chem. Soc.*, **34**, 592; 1912.
[3] Carnegie Institution, Report No. 267, p. 47; 1918.
[4] *Jour. Phys. Chem.*, **21**, 81; 1917.
[5] "Recalculations on Atomic Weights", 4th edition, pp. 273 and 315.
[6] *Jour. Chim Phys*, **11**, pp. 1 and 273; 1913.
[7] *Jour. Chim. Phys.*, **18**, p. 353; 1920.
[8] *Proc. Roy. Soc.*, A, **115**, p. 503; 1927.
[9] *Anales Soc. esp. Fis Quim*, **20**, 539; 1922.
[10] "Zustandsgleichung", p. 46.

Respiration of Healthy and Leaf Roll Potatoes.

IN the study of virus diseases of plants, comparatively little attention seems to have been paid to the effect on metabolism. This is particularly surprising in the case of potato leaf roll where the retardation in growth, pallor of the foliage, and the accumulation of carbohydrates in the leaves at the expense of the tubers, point to the disease effecting profound changes in normal metabolism. In the belief that this modified metabolism would be reflected in the rate of respiration, a comparative study of the respiration (as measured by the weight of carbon dioxide evolved per gram fresh weight and dry weight) of healthy and leaf roll potatoes has been made at various stages in the life-cycle.

Briefly, the work has shown that the respiration of the immature healthy tuber is higher than on maturation in storage, and again rises with the development of sprouts. On the first unfolding of the leaves there is an enormous rise in the respiration rate, followed by a gradual, though slight, fall as new tubers are produced. The cycle of events is much the same in the infected potato, but with important differences in detail. The infected immature tuber respires at a higher rate than the healthy tuber when first lifted, then falling, on storage, to a level slightly below that of the healthy mature tuber. On sprouting, the respiration rate lags behind that of the healthy tuber until the sprouts break into leaf, when the great increase in carbon dioxide production noted in the healthy plant is exceeded by the diseased one. This higher rate of respiration of infected foliage is evident, therefore, before any rolling or excess accumulation of starch occurs in the leaves, but not necessarily before sugars begin to accumulate. It remains at a higher level than the respiration of the healthy plant during the rest of the growing period. It is of interest to recall that Thung, though mainly working with detached leaves floating on water, also found a higher rate of respiration in leaf roll than in healthy leaves.

Anaerobic respiration in nitrogen is unaffected by the virus; the tuber—whether diseased or not—producing 70-80 per cent of the carbon dioxide evolved under aerobic conditions. The growing plant is able to emit as much carbon dioxide anaerobically as it does aerobically, whether infected or healthy. The changes in respiration during the life of a potato could therefore be represented by much the same curve for anaerobic as for aerobic conditions. It is higher in the diseased immature tubers, about the same in diseased and healthy after prolonged storage, lower in diseased sprouting tubers, but much higher than the healthy plant once leaves have developed.

Glasshouse plants growing in pots have been used throughout this work, whilst tubers in different stages of maturity have been obtained from plants growing under normal field conditions. No explanation of these results can be offered at present, but it is hoped that further studies will not only throw some light on the nature of the metabolic disturbances caused by the leaf roll virus, but also provide a new angle from which to view the inter-relationship of respiration, available respirable material, and growth in normal plants.

T. WHITEHEAD.

University College of North Wales,
Bangor, Nov. 6.

Eurytemora thompsoni, A. Willey: A New European Record.

IT is a common, but none the less mistaken, conception that the be-all and end-all of the systematist is the discovery of new species. In reality, the discovery of well-known species in remote parts of the world has a far greater fascination and is infinitely more important. It is perhaps no exaggeration to state that the world-wide distribution of common species of animals and plants is the basis of one of the most fundamental conceptions of the whole of the science of biology, since on it rests almost our only data for observing the influence of environment.

In June of the present year, on visiting a brackish-water pool, removed but not far distant from the sea at South Lancing, Sussex, I came across numerous specimens of a species of *Eurytemora*, a well-known genus of copepod.

Close investigation showed that the species was not British or even European, and it was, in fact, *Eurytemora thompsoni*, Willey, of which no other record existed beyond that of Prof. Arthur Willey, of McGill University, who took it from the stomach of a fish caught in a weir near the low-tide level at Scotsman Bay, Nova Scotia.

The species had also been found, but not recorded so far, by Prof. Smirnov, of Leningrad, in the brackish waters of the Sea of Okhotsk. A truly remarkable distribution as it stands, but it is more than likely that the species exists in many other brackish-water localities, but so far it has escaped detection.

A full description of the species has just been published in the November part of *Annals and Magazine of Natural History* A. G. LOWNDES.

Marlborough College,
Wilts, Nov. 14.

Uteroverdin.

ONE of us [1] has recently isolated oocyan—the blue-green pigment of the shells of many birds' eggs—and characterised it as an ether-soluble pyrrol pigment closely related to the bile pigments. We have now found a second example of this class of substances in the green pigment of the dog's placenta, the properties of which are very similar to those of oocyan. This pigment was examined in 1871 by Etti,[2] and considered to be biliverdin; it is formed by the transformation of the blood-pigment in the extravasates of the dog's placenta.[3] While the methoxyl content of the ester of oocyan indicated a molecule with only three pyrrol nuclei, the analysis and methoxyl content of the methyl ester of uteroverdin (as we will call the substance) show that we are dealing with a substance with four pyrrol nuclei. From its composition ($C_{35}H_{38-42}N_4O_6$) it appears that it is the dimethyl ester of a dehydrobilirubin or dehydromesobilirubin. The values for C, H, and N (not, however, the methoxyl content) of the ester of oocyan agree also with the formula $C_{37}H_{42}N_4O_8$; that is to say, with that of the trimethyl ester of a substance which differs from uteroverdin only in possessing one more carboxyl group. A further investigation of oocyan by one of us (R. L.) is in progress.

Oocyan differs from the synthetic tripyrrenes of H. Fischer[4] in its absorption and in giving a clearly positive Gmelin reaction. Attempts are being made to pass from bilirubin to this new class of substances, to which probably belong one or other of the green oxidation-products of bilirubin, obtained by very different methods, hitherto considered to be 'biliverdin'.

We do not know yet what is the significance of the fact that the decomposition of hæmoglobin in the dog's placenta—and in other cases of blood extravasates in the uterus—leads to such pigments instead of to bilirubin. It has not, up to the present, been possible to demonstrate an enzymic formation of uteroverdin by placenta tissue or tissue extract, any more than in the case of bilirubin.

R. LEMBERG.
J. BARCROFT.
D. KEILIN.

Biochemical and Physiological Laboratories
and Molteno Institute, Cambridge.

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[1] R. Lemberg, *Liebigs Ann.*, 488, 74; 1931

[2] Etti, *Malys Jahresberichte*, p 233; 1871: p. 287; 1872.

[3] On the histological findings, see B. Schuck, *Zeit fur Kinderheilkunde*, 28, 231; 1921. N. Lieberkuhn and H. Strahl, *Arch. fur Anat. und Physiol.*, p. 196; 1889.

[4] H. Fischer and E. Adler, *Zeit. fur physiol. Chem.*, 200, 209; 1931.

Properties of Aerosols.

MESSRS. W. Cawood and H. S. Patterson's letter[1] describing "A Curious Phenomenon shown by Highly Charged Aerosols" is very interesting from the viewpoint of spontaneously electrified aerosols, as well as from that of aerosols electrically charged from an independent source such as they used.

The work of W. A. D. Rudge,[2] showing that most aerosols initiate static charges owing to the movement of the constituent particles through the gaseous dispersion medium, has led to the theory of A. Stager,[3] who experimented with driven snow-dust on the Jungfrau, that in a spontaneously charged aerosol the smaller particles become charged in one sense and the larger ones in the other sense. On *a priori* grounds this theory does not seem capable of satisfying the facts save where the disperse phase of an aerosol consists of particles of but two sizes. For, where particles of several sizes were involved, any dimension except the smallest and largest would be both 'larger' and 'smaller' by alternative relation with respectively juxtaposed sizes. On the other hand, the phenomenon observed by Messrs. Cawood and Patterson seems to confirm selectivity of charge-sign dependent on variation in particle size in so far as electrification due to an independent source can be compared with self-electrification of an agitated aerosol.

In Messrs. Cawood and Patterson's experiments both types of electrification would, presumably, exist, and although one does not know what degree of spontaneous electrification would arise on, say, *p*-xylene-azo-β-napthol under the conditions they imposed (Blacktin and Robinson[4] find that 0·0011 oz. av. per cubic foot of coal dust of fineness 83·5 per cent through 200 I.M.M. sieve, whirled at 45 feet per second, rapidly initiates a potential of more than 4000 volts), it may well be that 'clusters' might be formed in their chamber, (*a*) merely on fanning without independent electrification, or (*b*) partially due to the additional spontaneous electrification as a significant superposed factor. If the former proved correct, a great step would have been taken in establishing the sign-particle size theory of spontaneous electrification in aerosols.

It may be worthy of note that if, as Messrs. Cawood and Patterson suggest, globular lightning may owe its origin to an effect analogous to the phenomenon they observe, the "very much higher potential" involved would be of spontaneous, rather than independent, origin. This would be a tentative reason for expecting the phenomenon they observed to show itself as producible merely through controlled spontaneous electrification without the necessity for introducing an independent source of electrification.

S. C. BLACKTIN.

1 Adelaide Road,
Andover, Hants, Nov. 5.

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[1] NATURE, 128, 150, July 25, 1931.

[2] *Phil. Mag.*, 25, 481; 1913.

[3] *Ann der Physik*, 76, 49; 1925.

[4] Safety in Mines Research Board, Paper No. 71. London: H.M. Stationery Office.

Carbon Contacts.

IN his delightful article on the Hope-Jones clock, in NATURE of Oct. 17, Prof. Boys refers to the difficulty of obtaining sure and certain contact for electrical purposes with light pressure. This difficulty may be overcome by using carbon contacts. I have had a station voltage regulator in operation for some twenty years with carbon contacts and the result has been quite satisfactory, the carbon being pure and free from ash. The microphone provides another instance of such contact operated in circumstances which are delicate. Probably there are many instances in the laboratory where carbon contacts for working apparatus through relays would be of service.

C. TURNBULL.

Electricity Works,
North Shields, Oct. 31.

THE contact difficulties to which I referred were those of fifty years ago with light or hesitating contacts backed by insufficient volts. I did not intend to imply that at the present time with new materials and abundant volts contacts need give any trouble. I have for a long time recommended Acheson graphite made at Niagara, from which all other matter has been volatilised, and this, I expect, is what Mr. Turnbull has used. There are also the more modern mercury in nitrogen contacts which are admirable where the larger movement necessary to operate them and the slight time delay do not matter.

Where there is much self induction in the circuit to be broken, plenty of capacity as a shunt across the break is desirable, and thanks to wireless dealers this can now be obtained for fewer shillings than the cost in pounds at the earlier date. I used at Oxford when weighing the earth in place of a capacity a pair of electrolytic cells in series with platinum electrodes which I still have, the current coming from a pair of secondary cells. At each break every second a bunch of microscopic bubbles of the electrolytic gases were evolved, but the spark was absolutely quenched. Such a device is the electrical analogue of the water ram. Not one contact ever failed. I consider it better than a true capacity.

C. V. BOYS.

Electrical Conditions in Stratified Clouds.

IN preparing a paper on "The Physics of High Altitudes" for the Dublin meeting of the British Association in 1908 (Climate and Health Committee), I spent some days on one of the central heights of Madeira observing atmospheric electrical conditions during the placid season of summer weather.

The wind was steadily N.N.E., and except for ascending masses of vapour the inflowing sea-breeze from solar generation had wasted before reaching my station 5700 feet from the sea. The mountain collar cloud formed with great regularity, and varying slightly with barometric pressure became a stationary mass, perhaps 500 feet thick, at an altitude between 2500 feet and 3000 feet.

The upper surface waste of constant evaporation was steadily recuperated by the arriving cloud vapour, visible or condensed, which spread out as a lower layer of the collar.

Now this collar cloud took, always in calm weather, a distinctly stratified form, and on one or two occasions when in exceptionally high barometric conditions the collar rested at an unusual height—6000 ft. or 7000 ft.—I was able to fly my kites into close proximity with the arriving vapour masses which were to maintain the collar in structure and position.

These arriving masses were always electrified, that is, clothed with an envelope of positive electricity varying in intensity as indicated by Thomson's portable electrometer, to which my kite was attached by a wire conductor twisted with the string; and the vapour masses, thus clothed, seemed on arrival at the cloud under-surface, itself positively electrified, to hesitate and to be kept apart, thus giving a clue to the stratified appearance which it is here my object to illustrate.

By and by distinct coalescence would occur, but the cloud never lost entirely the stratified arrangement of its component layers. My kites were made of thin glazed lining, for paper would collapse under aqueous vapour, and I was able, with an improvised oiled silk receptacle fitted with spirit and provided with a spreading unlighted wick, to provide the waste of substance accomplished by the burning match or water dropper.

MICHAEL GRABHAM.

Madeira, Oct. 6.

The Band Spectrum of AsH.

THESE bands were obtained by photographing a carbon arc, the negative electrode of which had been drilled and filled with arsenic, run in an atmosphere of hydrogen at a potential of 110 volts. No bands were obtained with the arsenic in the positive electrode. The electrodes were composed of Acheson graphite. The spectrograph used was a Hilger three-metre quartz prism instrument.

Three bands were found. Two, the origins of which were at 32,380·2 cm.$^{-1}$ and 31,636·9 cm.$^{-1}$, had very wide spacing between the lines, and appeared to be typical hydride bands. The other band was unresolved and was probably due to As_2. The head of the band was at 31,802·6 cm.$^{-1}$.

The AsH bands were shaded to the red and consisted only of *P* and *R* branches. The lines of the band at 32,380·2 cm.$^{-1}$ were fitted by the formula

$$\nu = 32{,}380{\cdot}18 - 11{\cdot}186\, M - 4{\cdot}474\, M^2 + 0{\cdot}0485\, M^3 + 0{\cdot}01027\, M^4,$$

but since the origin lies in the head of the band we have not yet been able to assign definitely the true quantum numbers. There was no sign of doubling in any of the lines. The electronic transition is, therefore, probably of the type $^1\Sigma - {}^1\Sigma$.

The other hydride band is badly confused by the As_2 band, and no analysis has yet been attempted. Further work will be carried out in the near future.

GEORGE E. KIMBALL.
JOHN R. BATES.

Frick Chemical Laboratory,
Princeton University,
Princeton, N.J.,
Oct. 14.

Branching of Lightning.

SCHONLAND and Allibone, in NATURE of Nov. 7, contribute what seems to be conclusive instrumental evidence that lightning discharges proceed from a negatively charged cloudbase. Confirmation (if any were required) may be obtained optically by the observation of very distant flashes, on the assumption that lightning consists primarily of direct electronic movement.

If the discharge is sufficiently far away, the subtended angular motion is so small that it is possible, in the duration of the flash, actually to see which way it is moving. I have noted several such discharges, particularly under the favourable conditions prevailing in sub-tropical China, and in every case the flash could be seen to start from the cloud and 'grow' downwards.

J. L. P. MACNAIR.

Military College of Science,
Royal Arsenal, Woolwich, S.E.18,
Nov. 17.

Esperanto in Scientific Literature.

UNTIL quite recently the use of Esperanto for scientific purposes was usually regarded as a matter of jest. This is still the attitude of many who, while they readily appreciate how immensely valuable an easy but complete, precise, and euphonious international language would be, do not realise that Esperanto not only possesses these claims in theory, but has also been tried out in practice with most encouraging results. Several entire papers have been published in Esperanto from the Institute of Physical and Chemical Research at Tokyo, and other Japanese (and also European) institutions issue bulletins in this language. Esperanto may certainly be considered a satisfactory medium for composition on physical and chemical themes, as during the last three decades various commissions, societies, and individuals have carried out translations and compiled lists of technical terms which have been officially accepted. Consequently, a complete system of chemical nomenclature and a very complete physical and chemical vocabulary have now been available for several years.

An efficient medical language has been developed lately through an international society of medical men, and a monthly review which has flourished since 1923. In the more general field of biology, however, the language has been much less widely employed, though here again various individuals have performed notable spade-work in the compilation of technical vocabularies and in working out systems of nomenclature. A group has recently been formed to take stock of the existing material and to develop its use by the translation of biological papers. I shall be glad to send particulars to anyone interested in the subject.

R. M. MORRIS-OWEN.

Balliol College, Oxford.

Research Items.

Folk-Tales of the Cochita, New Mexico.—A collection of tales told among the Cochita Indians of New Mexico, collected by Ruth Benedict, is published as *Bulletin* 98 of the Bureau of American Ethnology. As the tales were recorded in a house open to all, they form a selected group; for there is a taboo against telling certain tales to whites, just as there is a taboo against whites seeing masked dances or dancers. The tales fall into certain classes, such as stories of the katcinas, hero tales, true stories, and the like. Some are obviously of European origin; but the great majority are fictional. Under the influence of the study of the European folk-tale, which is obsolete, the significance of the fictional story among primitive peoples is often overlooked. The fictional story, notwithstanding its imaginative character, deals with incidents, situations, and problems which are real in the culture of the people. Among the katcina stories, that of the quarrel between two sisters is the origin story of the Cochita; but owing to the prejudice against telling it to the whites, only the culminating incident is given. In the hero tales, the heroes are insignificant, poverty-stricken, and ridiculed boys who are successful in overcoming their enemies and mockers. The Twin Heroes, the protectors of the helpless and the institutors of custom, are mischievous and irresponsible; the Arrow Boy does not hunt and spends all his time courting girls; the Poker Boy is ugly and untidy, and so forth. Montezuma, though a mythological culture hero, is ridiculed as a half-wit. The novelistic tales are fictional versions of Pueblo life, excepting in two respects, one difference being a contest over food stores, the other, marriage to multiple wives, polygamy being absent both in the old culture of the Cochita and at the present time under Roman Catholic teaching. Throughout the stories, the initiative and independence of the women is strongly marked.

Song of an American Oriole.—From observations made in the neighbourhood of Pinole, California, Alden H. Miller is of opinion that his countrymen have not given proper credit to the song of Bullock's oriole, *Icterus bullocki* (*Wilson Bulletin*, June 1931). At any rate he gives an interesting story of the relationship of the song to territorial claims. In spring the male bird precedes the female by one to two weeks, and establishes a singing post. When the hen arrives she combines in the defence of the territory, but the cooperation is imperfect until the nest is built, in the sense that the hen drives away females only, and the cock, males only. Indeed, the female during this period may actually court strange males in the reserved territory (which scarcely seems to be playing the game), but the attachment of the male is equally diffuse. The song of the hen oriole in defence of the territory and in association with males is in every way comparable to the songs of the cocks, and may be regarded as a true territorial song. The songs of the sexes are similar in rhythm, pitch, and quality, except that the final notes of the female's song are slightly harsher, of somewhat less range, and show modifications of rhythm. Before or during nest-building the songs of females may, on occasion, be even more abundant than the songs of the males.

Musculature of Crustacea.—The main portion of the Report for 1930 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool edited by Prof. James Johnstone and Dr. R. J. Daniel (Liverpool University Press: 1931), is taken up with a continuation of Dr. Daniel's researches on muscles of certain Crustacea: "The Abdominal Muscular System of *Homarus vulgaris* (L.) and *Palinurus vulgaris* (Latr.)": "The Abdominal Muscular System of the Shore Crab (*Carcinus mœnas*) and of the Zœa I and Magalopa Stages": and "Comparative Study of the Abdominal Musculature in Malacostraca. Part I. The Main Ventral Muscles of the Typical Abdominal Segments." In this last paper the author compares all the types investigated both in the present work and in previous reports. *Paranaspides lacustris, Praunus flexuosus, Meganyctiphanes norvegica, Crangon vulgaris, Homarus vulgaris,* and *Palinurus vulgaris* have all been examined. The main conclusions are that the ventral muscles of the Decapoda chosen may be derived from the Paranaspides type by the addition of true transverse and dorso-lateral muscles; those of *Praunus flexuosus* and *Meganyctiphanes norvegica* being very much specialised. In the case of *Carcinus mœnas* it was found that both in the first zœa and in the megalopa the musculature of the abdomen is very simple and anticipates that of the adult crab, where the abdomen is so much reduced.

Respiration of Wheat at Low Temperature.—The commercial importance of frost resistance in Canadian agricultural practice has led recently to a large number of studies of the physiological mechanism underlying hardiness or resistance to frost injury. Newton and Brown (*Canad. Jour. Research*, 5, 333) have investigated the degree of catalase activity shown by juice pressed from wheat plants of various hardy and non-hardy varieties. Under the conditions employed, the activity is greatest in the juice of hardy plants. On the other hand, a subsequent investigation of the rate of respiration of similar varieties of wheat by Newton and Anderson (*Canad. Jour. Research*, 5, 337) showed that the plants of hardy varieties have a smaller respiration rate at temperatures below the freezing point, which agrees with a previous observation that their reserves of sugar are maintained at a higher level during winter than are those of non-hardy varieties. The difference in respiration rate is not, however, observed at higher temperatures.

A Satellite Missing from Ever-Sporting Stocks.—A cytological study of certain ever-sporting races of garden stocks—singles which throw doubles—by Dr. J. Philp and Prof. C. L. Huskins (*Jour. of Genetics*, vol. 24, No. 3), has revealed a striking explanation. The strains were obtained from Miss E. R. Saunders, who has done much genetical work on the genus. Examination of the somatic chromosomes ($2n = 14$) shows that one pair (A) in the pure single and pure double strains has a subterminal fibre-attachment constriction and a trabant or satellite attached to the short arm. In ever-sporting singles one of the A chromosomes lacks the trabant. Such plants are heterozygous for the recessive doubleness, these factors being carried in the A chromosome but not in its satellite. Pollen grains which contain the chromosome lacking the satellite do not function in fertilisation, while this condition is lethal in only part of the female gametes. On this basis the long-known ever-sporting behaviour is explained in general accord with Frost's earlier hypothesis. The authors also show that in a trisomic mutation called 'Crenate' by Frost, which behaves as a trisomic for singleness-doubleness, three A chromosomes are present, two of them having a satellite. Frost's variety 'Snowflake' and its trisomic mutants are found to have long meiotic chromosomes, a confirmation of observations by Lesley and Frost. It is suggested that this condition has arisen from the normal by a mutation which delays slightly the onset of chromosome contraction in the heterotypic prophase.

Timber of the British Douglas Fir.—*Bulletin* No. 10 (August 1931) from the Forest Products Research Laboratory at Princes Risborough treats of the timber of home-grown Douglas fir, now termed *Pseudotsuga taxifolia*, following the International Rules of Botanical Nomenclature, instead of *P. Douglasii*, the name which has been so long in use in Europe. The bulletin has been written by Mr. B. J. Rendle, and comprises the investigations carried out by him with the view of indicating "to growers and users the possibilities and limitations of the timber". Mr. Rendle's investigations have shown several most interesting and reassuring factors on the subject of the home-grown wood of Douglas. The logs investigated came from Benmore and Kilmun in Argyllshire, Taymount in Perthshire, Longleat in Wiltshire, and Highclere in Hampshire. The age of the trees varied between fifty and sixty years, except in the case of Highclere (thirty-five to forty years). This implies that in no case had the trees reached maturity, and consequently contained a high proportion of the rapid-grown timber of the early years as compared with the slower-grown material of later life. It is believed from the examination of the latter that maturer trees would show a greater percentage of the better-class timber. The wood can be readily seasoned, both in the open and in the kiln. For the private proprietor of woods an important outcome of the tests has been that Douglas pit-props have approximately a strength equal to home-grown Scots pine and to that of imported Baltic and French timber, and this in spite of the rapidity of growth in early years. This rapid growth and the question of slowing it down in order to obtain a larger number of rings to the inch (not less than six or seven and preferably ten) is one of the economic problems which will require settlement according to the objects for which the woods are formed: that is, to give a quick and early return, to provide as large an amount of mature timber as possible, or to achieve a middle course. It is mainly a sylvicultural problem. Mr. Rendle's study has been systematic and thorough. The bulletin deals with investigations on structure, seasoning, strength, preservation, working qualities and grade, and uses.

Southern Rhodesian Geology.—The geology of the country around the well-known Shamva Mine, north-east of Salisbury, is described by R. Tyndall-Biscoe in *Bulletin* 18 of the Geological Survey of Southern Rhodesia (pp. 87 and geological map, 1931). The greater part of the area is made up of Archæan rocks, the oldest of which consist of highly metamorphosed basic volcanic rocks (greenstones) with interbedded strips of recrystallised sediments. The "Shamva Grits" follow, including arkoses and greywackes, and conglomerates that carry pebbles of the older series. Both sets of basement rocks are invaded by gneissic granite and associated intrusions. It is fairly well established that the gold-bearing quartz-reefs and other gold deposits of the region are to be correlated with the later stages of this igneous cycle. It is concluded that the gold of the Shamva Mine was originally a constituent of the magma which solidified to form the two granite stocks now exposed to the north-east and south of Shamva. The next recognisable episode was the intrusion of dolerite dykes and sills. In part these belong to the late Karroo, but as dykes of three or four different ages are known it is likely that some were injected during earlier geological periods. An excellent series of chemical analyses by E. Golding deserves special mention. These continue to confirm a geochemical generalisation that has already been noted in these columns, namely, the unusual abundance of strontium and paucity of barium in the rocks of Southern Rhodesia.

Atmospheric Ionisation.—Prof. J. J. Nolan and Dr. P. J. Nolan have published in the *Proceedings of the Royal Irish Academy* (vol. 40) an account of their observations on the state of ionisation of the air at Glencree, in the Wicklow hills. This station can be regarded as uninfluenced by large towns, except when the wind blows directly from Dublin, and to a less extent from smaller places to the east. The data obtained for different winds thus provide information about both clean and contaminated air, and show clearly the effect of the city in producing condensation nuclei, probably products of combustion, in large numbers. The smaller ions are less affected, and after eliminating, so far as possible, all disturbing influences, it was found that about five hundred were present in a cubic centimetre with a positive charge, and 375 with a negative charge; the disparity of the concentrations was diminished by rain. The ratio of concentrations also shows a diurnal variation corresponding to that of the vertical field in the air, and there is evidence that the rate of formation of ions fluctuates in a similar way. An appendix to this paper contains the results of all the observations made between October 1928 and December 1930, and should prove valuable for comparison with readings taken at other stations.

Distillation of Dry Liquids.—It has been observed by several investigators that dry liquids boil with difficulty. The abnormal behaviour observed with liquids after intensive drying might be due, in part at least, to the slowing down of the rates of evaporation and condensation of liquids after such treatment. In the October issues of the *Journal of the Chemical Society*, J. W. Smith records experiments with intensively dried ethyl bromide. This was contained in a bulb connected with a second empty bulb, a wide tube containing phosphorus pentoxide being sealed to the tube connecting the first two bulbs. In this way no obstruction to the vapour was introduced. All air was removed from the apparatus. It was found that the time of non-ebullitional distillation increased markedly with drying, and it was difficult to obtain ebullition with the very dry liquid even with violent shaking in a bath at quite a high temperature. The effect was not removed by a period of heating of the liquid, which is considered to indicate that polymerisation is probably not responsible for the change, since this polymerisation might be expected to be broken down by heating. No change in the vapour pressure of ethyl bromide due to intensive drying could be detected, this result being in contradiction to those of Smits, who found an increase, but after a longer period of drying than that used by Smith. No separation into fractions by distillation could be achieved. The change in rate of distillation is very slight in the first period of the drying, but then increases sharply, afterwards decreasing again. The results are interpreted as showing that intensive drying does not disturb the internal equilibrium of a liquid, but that the effects are due to some form of superheating, probably induced by the removal of nuclei of some type during the treatment with phosphorus pentoxide.

Heat Insulation of Furnaces.—The issue of *Chemical and Metallurgical Engineering* for July contains an account by Messrs. J. B. Barnitt, research engineer of the Aluminium Company of America, and R. H. Heilman, fellow of the Mellon Institute of Industrial Research, of their search amongst the aluminium compounds for a material which would withstand temperatures of the order of 1000° C. and at such temperatures have a low heat conductivity. They find that aluminium monohydrate, bauxite monohydrate, and a waste product from the extraction of pure aluminium material from bauxite are the most promising materials, and that their heat conductivities, which all increase with rise of temperature, are in the ratios of 15 : 9 : 6. The latter is cheap but heavy, the bauxite monohydrate is less expensive than the aluminium monohydrate, but will not stand such high temperatures as the latter. If the heat insulating material is required in brick form and not as a powder, the authors find that bauxite monohydrate, with certain additions to increase its strength at high temperatures and decrease its shrinkage, is best, and blocks of this material 12 in. by 36 in. and of various thicknesses are now on the market.

Distance Thermometers.—In an illustrated pamphlet of 40 pages, Messrs. Negretti and Zambra discuss the relative merits of gas, vapour, and liquid thermometers for use at a distance from the observing station, and come to the conclusion that mercury in steel thermometers with dial scales are the most serviceable. The errors to which such thermometers are subject are considered, and conclusions are drawn as to the best methods of eliminating them. The capillary tube connecting the bulb to the Bourdon tube which carries the pointer has its bore reduced to 0·005 in., so that the error due to it may in most cases be neglected. Fatigue of the Bourdon tube material has been overcome by the use of a special steel and a section which distributes the stress in the material more uniformly.

Astronomical Topics.

The Leonid Meteors.—A Science Service bulletin, dated Nov. 16, reports a fairly active shower of these meteors in the early hours of Nov. 16, observed by seven students of Columbia College, Dubuque, Iowa, under the direction of Rev. J. Theobald, professor of mathematics. In spite of a slight haze, 289 meteors were observed in six hours; the maximum rate of fall was 90 per hour at 4.45 A.M. (that is, 10.45 U.T.). These meteors came about eighteen hours before the slightly less active shower observed in England by Mr. Prentice and Mr. King.

Drs. Johnstone Stoney and Downing, in their work on the return of the meteors in 1899, introduced the terms "ortho-Leonids" and "clino-Leonids"; the former are a comparatively compact clump, which are seen only in the years round about the comet's perihelion-passage. Since the earth takes only five or six hours to traverse the ortho-stream (Olivier, "Meteors", p. 36), one or other, or perhaps both, of the displays described above must have belonged to the clino-Leonids; these are scattered around the whole of the long elliptical orbit, but more thickly in the neighbourhood of the comet. When the ortho-stream is entered, the hourly rate sometimes goes up to thousands. Even in the comparatively poor displays of thirty-three years ago, 800 meteors were recorded in a few hours, both in 1898 and in 1901.

Father O'Connor reports that arrangements were made at the Stonyhurst College Observatory to keep the sky under observation during the nights of Nov. 15–18. Rain or clouds prevailed almost the whole time, but it cleared up somewhat about 4.0 A.M. on the morning of Nov. 17. "Between 4.15 A.M. and 6.0 A.M. I observed 13 Leonids, of which four, observed at 4.32, 5.2, 5.3, and 5.42, were considerably brighter than first magnitude stars. The one at 5.3 in particular was exceedingly bright, and distinctly illuminated the surrounding country."

The Mass of Saturn's Ring.—H. Slouka contributes a paper to *Scientia* for August in which he traces the history of investigations on Saturn's ring, beginning with Galileo's well-known anagram announcing the triple nature of the farthest planet. Next comes Cassini's detection of the great gap in the ring, and Laplace's investigation of its stability. Bessel was the first to make any attempt to determine the mass of the ring, which he did from the observed motion of the apse of Titan's orbit: he gave the two values 1/213 and 1/118 of Saturn's mass; both are now known to be much too large, and his revision made things worse instead of better. Clerk-Maxwell, after proving that the rings must be composed of cosmic dust, made an estimate of the number and size of the particles, from which he deduced the very low value 1/50,000,000 for its mass. Tisserand, from the motion of the apse of Mimas, found the large value 1/620; Meyer revised Tisserand's work, using improved values of the constants; he first gave 1/1960, but reduced this later to 1/26,700. H. Struve's exhaustive researches on Saturn's system are well known; he found it impossible to assign an accurate value for the ring's mass; he proved that it could not exceed 1/314, but regarded 1/26,700 as more probable.

The estimate which H. Slouka considers the most reliable was made by Louis Bell from a study of its albedo, based on the photographs taken by Wood in 1916 in light of different wave-lengths; he deduced that the thickness of the rings does not exceed 15 km., and is still less in the less luminous regions; he gave 1/1,000,000 as a maximum value of the mass.

The general conclusion is that an exact determination of the mass is impossible, but that most of the gravitational determinations are much too high. The research is made more difficult by the fact that the polar flattening of Saturn acts on the satellites in the same manner as the ring, but with much greater effect.

Theories of the Birth of the Planetary System.—Most upholders of the tidal theory postulate that another sun made a near approach to our own, and that its immense tidal action caused a filament of matter to leave the sun, which afterwards broke up into the different planets. Dr. H. Jeffreys suggested, a year or two ago, that an actual collision of the two suns would give a better explanation of some features of the solar system. A report by Science Service, Washington, D.C., dated Oct. 27, describes a lecture given to the Washington Academy of Sciences and the Society of Sigma Xi, by Prof. Willem de Sitter. He prefers the collision theory to the purely tidal one, on the ground that it gives an easier explanation of the rotations of the sun and planets. He supposes that in addition to the matter of the planets there was a large amount of diffused gas expelled from the sun. Much of this was later reabsorbed by the sun, but it had in the meantime acquired moment of momentum from the other star, which it imparted to the sun in the form of rotation. The gaseous medium also helped to make the planetary orbits more circular.

Anniversary Meeting of the Royal Society.

SIR F. GOWLAND HOPKINS delivered his first anniversary meeting address as president of the Royal Society on Nov. 30. Referring to the Society's activities during the past year, Sir Frederick remarked that the Council is well satisfied with the change of policy initiated last year, whereby it was decided to expend accumulated trust funds on the active support of current fundamental researches. While the Council no longer has accumulated funds at its disposal, it is proposed to do all that is financially possible in support of individual research.

This year the following grants have been made: From the Messel Fund: £800 a year for five years to Dr. Honor B. Fell, of the Strangeways Research Laboratory, for the support of her valuable work on tissue culture; also £150 for the current year, and, after the termination of his 1851 Exhibition Scholarship, £600 a year for two years, to Dr. M. L. Oliphant, of the Cavendish Laboratory. From the Caird Fund: £2200 to Prof. O. W. Richardson for the purchase of optical apparatus of high resolving power. From the Donation Fund: £400 to Dr. L. S. B. Leakey towards the cost of his East African Archæological Expedition. From the Darwin Fund: £500 a year for four years to Mr. C. S. Elton for research on wild vole populations, together with an additional grant of £250 for capital outlay and field equipment. Dr. S. Adler's researches on kala-azar continues to receive support from the Anonymous Bequest Fund.

During the year the Society has received three bequests—£10,000 under the will of Sir Otto Beit, £3000 from the estate of Dr. A. Muirhead, and about £250 from that of Dr. C. W. Andrews. These bequests were left without restrictions, and have been added to the General Fund.

Sir Frederick also stated that arrangements have been completed with the University of Cambridge for building and equipping a cryogenic and magnetic research laboratory at Cambridge, towards which the Royal Society is contributing £15,000. The laboratory will be known as the "Royal Society Mond Laboratory" as an acknowledgment that the Society was able to forward the enterprise through a benefaction received from Dr. Ludwig Mond.

We print below extracts from the remarks made by the president in bestowing the Society's medals.

Presentation of Medals.

COPLEY MEDAL, AWARDED TO SIR ARTHUR SCHUSTER.

Sir Arthur Schuster was the first to show the important information to be got by measuring quantitatively the magnetic deflection of cathode rays. He showed how, by combining this measurement with the potential difference which generates the rays, it was theoretically possible to determine without ambiguity the velocity, and the ratio of charge to mass, of the particles constituting the corpuscular stream. We owe to him other almost equally fundamental contributions to the study of electric discharge in gases. Thus, he showed that the passage of a luminous discharge put the gas temporarily into a conducting state, due to the presence of charged ions: these ions were able to diffuse into a space screened from the discharge by a wire gauze partition, and they could then be put into evidence by showing the conductivity of the gas under electromotive forces of a fraction of a volt. Sir Arthur was the first to show by experiment that in Crookes's radiometer the reaction was not on the sun but on the glass case of the instrument, thereby connecting the action with the residual gas. He has also made many important contributions to terrestrial magnetism. In spectroscopy he formulated independently the Rydberg-Schuster law. He invented the periodogram method of looking for periodicities in statistical material, a method which has been widely adopted by workers in many branches of inquiry, extending even into economics.

ROYAL MEDAL, AWARDED TO SIR RICHARD GLAZEBROOK.

For fifty years Sir Richard Glazebrook has been closely identified with research on physical standards, and particularly electrical standards. For many years he conducted researches associated with the absolute measurement of resistance, current, and inductance, and the results of this work is reflected in the present remarkable accuracy of electrical measurements. The name of Sir Richard Glazebrook is also world-known on account of his directorship of the National Physical Laboratory; it is largely due to his influence on the researches at that Institution that aeronautical science has made such vast progress. Physical science is also indebted to him for that great work, the "Dictionary of Physics", and in international science he has played a conspicuous part.

ROYAL MEDAL, AWARDED TO PROF. W. H. LANG.

Prof. Lang's work on the fossils of the Old Red Sandstone is of high scientific importance. It has led to the discovery and description of a new and unexpected group of plants in which root, stem, and leaf are not differentiated. For the first time it thus becomes possible to trace in a circumscribed group the probable origin of these structures from a source in which they did not exist as distinct members. The work was begun in collaboration with the late Dr. Kidston, and continued by Prof. Lang after the death of his colleague in 1924. Prof. Lang's previous intensive studies on the morphology of the liverworts and ferns had eminently fitted him to provide a morphological point of view which has given most important results.

DAVY MEDAL, AWARDED TO PROF. A. LAPWORTH.

Prof. Lapworth's work has been largely concerned with the application of physical methods to the investigation of the reactions of organic chemistry. His study of the bromination of acetone yielded results of primary importance in relation to the reactivity of carbonyl compounds and has formed the basis of many subsequent investigations. His researches on the addition of hydrocyanic acid to organic compounds, besides leading to results of theoretical and synthetical importance, made clear the mechanism of the formation of cyanhydrins. His investigations of the effect of small quantities of water in diminishing the activity of acids in alcoholic solution indicated the existence of the oxonium ion and added considerably to our knowledge of catalysis by acids. Among his more notable synthetical achievements are the synthesis of zingerone, derived from the pungent principle of ginger, and of homocamphor. His work on the mutual influence of groups in the same molecule, his recognition of induced alternate polarity, and his classification of reagents as anionoid or kationoid have played an important part in the development of the present state of knowledge of the reactivity of organic compounds.

SYLVESTER MEDAL, AWARDED TO PROF. E. T. WHITTAKER.

Prof. E. T. Whittaker is one of the best known of British mathematicians, his work showing extraordinary versatility. He has written five books, on entirely different subjects, and numerous papers which touch on almost every branch of mathematics. All his books show, besides their more technical qualities, powers of arrangement and exposition of a most unusual order; and the "Modern Analysis" and "Analytical Dynamics" have had a considerable influence on mathematical thought. Prof. Whittaker has made important additions to the theory of the solution of differential equations, ordinary and partial, by definite integrals; to the theory of Lamé and Mathieu functions, the functions of the elliptic and parabolic cylinders, and the integral equations associated with them; to the theory of interpolation; and to the theory of the solution of dynamical problems by trigonometrical series. He has also in recent years made a number of interesting contributions to the pure mathematics of relativity, electromagnetism, and quantum theory.

HUGHES MEDAL, AWARDED TO PROF. W. L. BRAGG.

Prof. Bragg's recognition of the fact that the Laue diffraction spectra could be considered as produced by reflection from the planes of the crystal lattice, besides being a great simplification of a difficult geometrical problem, was the starting-point of two important and fruitful lines of physical investigation, namely, the measurement of X-ray wave-lengths and the elucidation of crystal structure. Work on the first of these led to Moseley's discoveries and their subsequent developments. Bragg's concentration on the second has resulted in a wonderful extension of our knowledge of the structure of crystals, both simple and complex, and of inter-atomic distances and linkages. His work may truly be said to have laid the foundations of a chemistry of the solid state.

The Wellcome Research Institution.

ON Wednesday, Nov. 25, Lord Moynihan of Leeds, president of the Royal College of Surgeons, laid the corner stone of the new buildings for the Wellcome Research Institution, which are to occupy a site at the corner of Euston Road and Gordon Street, immediately north of University College.

The architect is Mr. Septimus Warwick, F.R.I.B.A., who has designed the building to meet the requirements of the different research laboratories and museums. The building materials are practically all of British origin.

Lord Moynihan, in the course of his remarks, outlined the development of the various research laboratories and museums founded by Dr. Wellcome, who, in the year 1894, founded his laboratories for physiological research, which were followed two years later by laboratories for chemical research.

On the recapture of the Sudan by Kitchener, Dr. Wellcome was one of the first civilians to visit that country, and he there saw, and for some time watched, conditions as they then were; and he found great opportunities for public service. It was in the year 1899 that he founded the Tropical Research Laboratories in Khartoum, the first director of which was Sir Andrew Balfour, who served there for twelve years. Attached to that research institute was a floating laboratory, which cruised through all the waterways of the Nile within reach, giving the opportunity there for continued research, and for carrying the benefits of research to the people who live far south.

Dr. Wellcome's activities continued also in Great Britain. In the year 1913 he established the Bureau for Scientific Research, and the Historical Medical Museum. In 1914 he established the Museum of Medical Science, including Tropical Medicine and Hygiene, and in 1920 he founded the Entomological Field Laboratory. All these institutions, or many of them, suffered, however, under one great disadvantage, which all research students will appreciate at once: they were separate from one another, giving no opportunity for that hour to hour, or minute to minute, consultation which is one of the great advantages of having collective research under one roof; but from to-day we see the possibility of that being altered. Under the roof of the Wellcome Research Institution the following subjects are to be studied: medical zoology, parasitology, entomology, tropical medicine and hygiene; there will be physiological and chemical research laboratories, the historical medical museum, and a museum of modern medicine. It will be agreed that this is a formidable and very impressive list. Dr. Wellcome's activities, however, have not been confined to Great Britain. He also gave great help towards the foundation of the Gorgas Memorial Laboratory, near the Panama Canal.

One of the conspicuous features of Dr. Wellcome's life-work has been at once its relevance and its opportunism. In all his investigations of tropical diseases he begins in an almost virgin country, and the harvest gathered has been such that not only have many lives been spared and much suffering saved, but also vast tracts of country have, for the first time, been made fit for human habitation.

At home, as all of us will agree, the great need of medicine to-day lies in the direction of increasing the opportunities for medical research, and not less in the opportunities for creating those competent to undertake medical research. Physical observation alone, from the time of Hippocrates through our great students, Sydenham, Addison, and James Mackenzie, has revealed many secrets which have been so long hidden in connexion with diseases that lay within the orbit of pure investigation, and the conquests of mere observation have been innumerable and of a value beyond all reckoning. Upon it a virile and beneficent art has found its opportunities extended and its thought affected by the encouragement and adoption of methods which are seeking to change a practical art into an applied science. Difficulties, of course, have been found all along the way, but experiment in medicine is for ever inevitable.

As a result of experiment in medicine we are, happily, gradually replacing anatomy by physiology, and if disease is, in many respects, merely altered function, then we are about to create a science, new to the human race, of comparative function in health and in disease. But experiment has done even more for us than that. It has strengthened the arm of medicine, and it has made the tests more severe for the acceptance of evidence which has been derived by the methods of observation.

Medicine depends, of course, not only for its present stability but also for its future advance, upon a large number of ancillary sciences. Those sciences are to be studied in the new building. The effect, therefore, on medicine will be considerable, but it is hoped something better even than that will come out of the work done in this institution, and similar institutions; that is, to create in the minds of the leaders of the profession what Sir Walter Morley Fletcher would call "The Religion of Research". Lord Moynihan said he hoped that the date would not be far distant when those who are to serve upon the teaching staffs of hospitals throughout Great Britain will be permeated by "The Religion of Research", and in time to come all members of the teaching staffs will themselves have undergone, in institutions similar to this, a discipline of research.

In concluding, Lord Moynihan said that by his constant thought Dr. Wellcome has done as much as any man has ever done in Great Britain to make it possible to advance both the science and the art of medicine.

By placing the Museum of Medical Science, including tropical medicine and hygiene, and the Historical Medical Museum under one roof, there is no doubt that in London there will be a combination which will be unequalled in the world.

The associated Physiological Research Laboratories will remain at Langley Court, Beckenham, and the Field Entomological Laboratory at Claremont, Esher.

Plant Breeding in Germany.

THE acceptance by Dr. Baur of the invitation of the Royal Horticultural Society to give the Masters Lectures in 1931 has resulted in the publication, in the *Journal of the Horticultural Society*, vol. 56, Part II, of two lectures which contain, in the first place, a most effective short statement of the present position of evolution, and in the second, a very interesting summary of the work in plant breeding that is being carried out, under Dr. Baur's direction, in the Kaiser Wilhelm Institut für Züchtungsforschung at Müncheberg.

Dr. Baur concludes that the experimental study of genetics has shown clearly that "inheritance of acquired characters in the sense of Lamarck does *not* exist". He argues that the main cause of what Darwin called hereditary variation is the combination of characters provided for by biparental inheritance, but differs from Lotsy because he considers that such variations are too limited to supply the needs of progressive evolution. Continued breeding of *Antirrhinum* has led him to the conclusion that the frequency of mutation is no less than 1·3–7 per cent, though such mutations are mainly recessive and therefore only distinguished on extensive and continued breeding trials. Most of these mutations are small, and a striking mutation is usually associated with loss of vitality. Dr. Baur concludes that through the selection of small mutations the differentiation of species out of parent species can be explained, and that wider differences may gradually arise because two such new forms, as they become separated by an increasing number of such 'small-point mutations', tend also to become infertile to one another.

Dr. Baur's account of the work of the Kaiser Wilhelm Institute is full of interest. The extensive breeding work, coupled with patient testing, which permits the isolation of a lupin free from poisonous alkaloids, after a million and a half plants have been examined, is a striking example of selection work. The recombination of Mendelian characters is carried out on normal lines, but on an extensive scale, with wheats, grapes, etc.; whilst new experiments are proceeding with attempts to induce variations artificially by chemical methods, as has been done so successfully in recent years by X-rays.

University and Educational Intelligence.

CAMBRIDGE.—The Vice-Chancellor has received a letter from the Trustees of the British Museum offering the sum of £2000 for the use of the Scott Polar Research Institute. This sum represents the greater part of the balance remaining of the sum which was subscribed to meet the cost of publishing the scientific results of Capt. Scott's *Terra Nova* expedition.

LONDON.—The title of professor has been conferred on the following: Mr. F. W. Twort (bacteriology), in respect of the post held by him at the Brown Animal Sanatory Institution; Dr. H. A. Harris (clinical anatomy), in respect of the posts held by him at University College and University College Hospital Medical School; Dr. F. A. P. Aveling (psychology), in respect of the post held by him at King's College

The title of reader in eugenics has been conferred on Miss E. M. Elderton, in respect of the post held by her at University College.

OXFORD.—On Nov. 17, Congregation passed a decree recording the grateful thanks of the University to Prof. J. Mark Baldwin, for a gift of £1000 for the capital endowment of the Edward Bagnall Poulton Fund, established for the encouragement of research in the subject of evolution. This fund has already been of much service in assisting work of the kind indicated.

At the same meeting of Congregation the thanks of the University were accorded to the Royal Astronomical Society for a generous gift to the Lewis Evans Collection of a set of more than fifty astronomical and mathematical instruments.

SHEFFIELD.—Prof. J. H. Andrew, professor of metallurgy at the Royal Technical College, Glasgow, has been appointed to the chair of metallurgy in the University in succession to Prof. C. H. Desch, who has been appointed superintendent of the Department of Metallurgy at the National Physical Laboratory.

ON Nov. 29 the Cinema Hall, which is maintained by the Empire Marketing Board at the Imperial Institute, South Kensington, reopened with a series of cinematograph displays, many of which are travel films of geographical interest. In future an admission charge of one penny is being made for each session. Monthly programmes of the films and lectures may be obtained on the payment of two shillings, being subscription for one year.

THE following scholarships will be offered by the Institution of Naval Architects Scholarships for competition in 1932: Naval architecture, Martell scholarship (£130 a year for 3 years); Denny scholarship (£75 a year for 4 years): Marine engineering, Parsons scholarship (£150 a year for 3 years); Denny scholarship (£75 a year for 4 years). The Denny scholarships are open to boys less than nineteen years of age from public or secondary schools who have not yet begun their apprenticeship, and are tenable at the University of Glasgow. The remaining scholarships are open to apprentices less than twenty-three years of age, and are tenable at the Royal Naval College, Greenwich, the University of Glasgow, Armstrong College (University of Durham), the University of Liverpool, and the City and Guilds (Engineering) College, London. Particulars may be obtained from the Secretary of the Institution of Naval Architects, 2 Adam Street, Adelphi, London, W.C.2.

Birthdays and Research Centres.

Dec. 6, 1858.—Prof. Hans Schinz, professor of systematic botany, formerly director of the Botanical Gardens and Museums of the University of Zurich.

At present I am engaged on the fifth edition of the "Flora of Switzerland", and on a flora of South West Africa, and I am also working on the Swiss Myxomycetes.

Dec. 7, 1855.—Prof. Henry Louis, consulting mining and metallurgical engineer, and emeritus professor of mining in Armstrong College, University of Durham.

Since my retirement from active work in the Armstrong College, University of Durham, my opportunities for engaging in actual researches have been somewhat limited. I am, however, continuing to take a keen interest, though now more in an advisory capacity, in researches bearing upon the subjects with which my work has been principally identified. One of the most important of these is probably the work that is being carried out by the Support of Workings Committee of the North of England Institute of Mining and Mechanical Engineers, of which I am secretary. Whilst the direct object of this Committee is a study of the conditions producing falls of ground in collieries, which are to-day the most serious source of mine accidents, its operations necessarily throw much light upon other important points, such as surface subsidence, the subsidence of the immediate roof of colliery workings, and the best form of support to be employed in such workings. I need scarcely say that this last aspect of the question is very closely connected with my metallurgical work, because it is becoming more and more evident that the replacement of timber by steel is playing an increasingly important part in the solution of this problem.

I am, of course, able to give a certain amount of time to reporting upon, and the valuation of, mineral deposits. Necessarily, much of this work, although involving a good deal of research, and not infrequently geological research of a tolerably high order of difficulty, is confidential, and must always remain unpublished. I have, however, in the press, a book on "Mineral Deposits" which will, I hope, embody the results of some personal observations. From the very nature of the work these observations must, of course, be somewhat out of date when published, but I hope that they may, nevertheless, be found of value.

Dec. 9, 1855.—Dr. F. A. Dixey, F.R.S., Hon. Fellow, late subwarden and bursar of Wadham College, Oxford.

I am, at present, examining the evolutionary relationships of various lepidopterous groups, as disclosed by the study of their structural characters; together with the phenomena of sexual and seasonal polymorphism and of mimicry in various forms, exhibited within the same groups.

Observations in the field on all bionomic details in the life of insects, in relation with their environment, whether organic or inorganic, are worthy of attention. Special consideration should be given to their means of protection against the attacks of predaceous organisms; the evidence of absolute or relative immunity conferred by their own defensive qualities; and the various influences which may affect the vigour of the assaults made upon them by their enemies. These interactions are all important from the evolutionary point of view, and the value of many of them can only be appraised by direct observation in the field, prompted by work done in the laboratory and museum.

Dec. 10, 1855.—Mr. H. N. Ridley, C.M.G., F.R.S., former Director of Gardens and Forests, Straits Settlements.

I am now turning my attention specially to the geographical distribution of plants and animals in various regions of the globe, with the view of showing the relationship of the present constituents of the floras and faunas of different countries to the previous geological history, and especially to the former distribution of land and water. Though the accounts of the floras of various regions have been extensively compiled geographically, so that comparisons may readily be made in most areas, this has been seldom the case in the matter of faunas, which have not often been treated geographically, and this would be most desirable. I am also continuing my researches into the flora of Borneo and the Malay islands.

Dec. 10, 1878.—Dr. W. K. Spencer, F.R.S., H.M. Inspector of Schools.

As my time for research has been limited, it has been necessary to confine myself to the palæontology of a small group of animals, the starfish and brittle starfish. The advantages of work upon a small group with which one can become well acquainted are now becoming evident.

The evidence of evolution afforded by the group shows that recent starfish are only remnants of an originally very diverse Palæozoic fauna, and that the lines which are able to initiate new inventions leading to greater command over environment are those which survive. I hope shortly to put forward a new classification of starfish based on observations of progressive evolution.

The distribution of Palæozoic starfish shows correspondence with that of other Palæozoic fauna, leading to conclusions regarding the currents of these older seas and the land boundaries. The form and ornament of isolated ossicles of Chalk starfish form a valuable accessory in zonal determination. The many groups of fossil animals and plants afford abundant opportunity to the non-professional scientific worker willing to concentrate on a small field.

Dec. 11, 1860.—Dr. Leonard Huxley, editor of the *Cornhill Magazine*.

Tuberculosis, yellowjack, malaria, typhus—these are a few names to remind us that science has sent her spies out against the great and terrible enemies ambushed along the path of life, and that her workers follow in battalions to consolidate the victories of knowledge. Great are the material gains, great, too, the relief of mind. The formless dragons of the dark are stripped of half their terrors. These are great and imposing victories: others no less great and imposing are on the horizon. But meantime there are certain elusive and disabling plagues, so common as to be vulgar, so repulsive, when not actually dangerous, as to earn more contempt than commiseration, so universal as to produce vast cumulative loss. What honour would not the long-suffering multitude accord to their deliverer from that 'horrid cold', that 'vile 'flu', to which they are so fatalistically accustomed to-day?

Dec. 12, 1855.—Mr. A. W. Clayden, formerly principal of University College, Exeter.

I am chiefly interested in the observation of cloud forms and their relation to weather.

If observations on the variations of the lapse rate, similar to those carried on at Duxford and elsewhere, could be made near the western seaboards of the British Isles, say Penzance and southern Ireland, the results would be interesting and might very well be important.

An interesting point which does not appear to have been much studied is the condensation of water vapour at low temperatures. Rime sometimes takes one dominant form, sometimes another. The crystals in one shower of fine snow are frequently of one type, while those of another shower show quite a different figure.

Dec. 12, 1866.—Prof. E. W. MacBride, F.R.S., professor of zoology in the Imperial College of Science and Technology, South Kensington, London.

The following problems are being investigated under my supervision:

(1) An attempt to repeat the experiments of Metalnikoff, which indicate the inheritability of acquired immunity.

(2) An attempt to repeat Kammerer's experiments on *Salamandra maculosa*, which indicate the responsiveness of its skin-colour to the background.

(3) An attempt to repeat Kammerer's experiments on *Alytes*, indicating the re-adaptation of this terrestrial type to aquatic life.

(4) An investigation by experimental methods of the late stages in the development of echinoderm larvæ. During these stages the possibility of evolving 'suppressed complexes' is indicated.

(5) An investigation into the action of various reagents on the eggs of the frog in producing abnormalities in late larval development.

Societies and Academies.

London.

Mineralogical Society, Nov. 4 (Anniversary Meeting).—**F. C. Phillips**: On crystals of brookite tabular parallel to the basal plane. Small yellow-brown rectangular plates in heavy residues from Middle Jurassic sandstones of N.E. Yorkshire are shown by optical and X-ray examination to be brookite of normal optic orientation but unusual crystallographic habit, being tabular parallel to the basal plane. They are associated in the residues with brookite of normal habit, abundant anatase, and rutile.—**T. Ito** and **T. Shiga**: On scorodite from Kiura Mine, Bungo, Kiushiu, Japan. The mineral occurs as small dark-brown and green crystals associated with vivianite, fluorite, and quartz in druses in veins of arsenopyrite intruded into limestone. Chemical analysis on carefully selected material gives a result consistent with the formula $FeAsO_4 . 2H_2O$. Forms present are (001), (100), (011), (120), (111), (201), (211), and (322). The crystals are orthorhombic with $a : b : c = 0·865 : 1 : 0·972$. The habit is pyramidal equidimensional. The 111 faces show abundant vicinal faces belonging to two principal zones $\{01\bar{1}\}$ and $\{10\bar{1}\}$.—**W. Campbell Smith**: On a new meteoric stone from Suwahib, Arabia. The stone was found in 1930 on the sand near Buwah, in Suwahib, by one of the Arabs accompanying Mr. Bertram Thomas on his journey across the Rub' al Khali. As found, it weighed just over 238½ gm. It is coated with limonite and shows no definite crust. It is a black chondrite belonging to Prior's Cronstad type, with more than ten per cent of nickel-iron. The density is 3·52.—**Edward S. Simpson** and **D. G. Murray**: A new siderolite from Bencubbin, Western Australia. A mass weighing 119·5 lb. (54 kgm.) was found in 1930 near Bencubbin, about 150 miles north-east of Perth. It consists of a skeleton of nickel-iron (68·8 per cent) with enclosed crystals up to 1 cm. across, of greyish-white enstatite (13·5 per cent) and dark olivine (12·5 per cent). In the metallic portion Fe : Ni = 15 : 1. The meteorite is classed as a mesosiderite with an unusually high proportion of nickel-iron.—**A. R. Alderman**: The meteorite craters at Henbury, Central Australia. The locality is known locally as the Double Punch-bowl, from the two largest adjoining craters. It is situated seven miles west-south-west of Henbury cattle station on the dry Finke river, and about fifty miles south of the McDonnell Ranges in the very centre of Australia. Within an area of 500 yd. by 500 yd. thirteen craters were mapped. The largest is oval in outline, measuring 220 yd. by 120 yd. across, and with a depth of 50-60 ft. The other craters are roughly circular, with diameters ranging from 10 yd. to 80 yd. The walls consist of powdered rock and shattered blocks of Ordovician sandstone and slaty rock. Owing to the craters acting as collecting pans for rain-water in this arid region, the spots are prominently marked by the growth of mulga trees, acacias, and coarse grass. Scattered around the craters are numerous pieces of metallic iron, usually angular in shape, and ranging from a fraction of an ounce to 52½ lb. in weight. In one area of 6 ft. by 6 ft. more than a hundred fragments were collected. Only two masses (one of 13 lb.) were found within the crater walls; and in one of the smaller craters a bore-hole to a depth of 8 ft. through fine silt down to coarse rock fragments yielded no mass of iron. Fragments of iron rust are also abundant; and some glassy material, suggesting fusion of the country rock, was found. These craters, which are very similar, were evidently formed by the impact of a shower of meteoric irons at some remote period.

Geological Society, Nov. 13.—**E. J. Wayland**: The Katwe crater-lake, Uganda. Lake Katwe occupies the bottom of an explosion crater of the caldera type and is the source and centre of a flourishing native-managed salt industry. Lake Edward oscillates in accordance with the sunspot cycle, while Lake Katwe does not. While the level of the former is above the water-table, that of the latter is determined and maintained by it. Although the volcanic vent passes through the saturation zone, its upper parts are more or less completely sealed off from the surrounding ground-water by deposits of the less soluble salts thrown out of solution at successively lower levels as temperature decreased with time. Within the tube so formed, aqueous circulation is produced by the temperature gradient, and the most soluble of the salts, derived at depth from decomposing alkali lavas, are thereby brought to the surface and, as a consequence of solar evaporation, are deposited in the shallow lake.—**Arthur Holmes** and **Henry Francis Harwood**: Petrology of the volcanic fields east and south-east of Ruwenzori, Uganda. Towards the close of the period in which the Kaiso lacustrine beds were deposited, volcanic activity broke out along a series of belts extending north and south of Fort Portal and north and south of the Kazinga Channel. The first phase (Lower to Middle Pleistocene) is represented by sub-aqueous tuffs. Post-Kaiso rifting movements followed, and were succeeded in turn by a second phase of vulcanism, in which explosion vents were blown through the rift-valley floor, the bordering scarps, and the adjoining plateau. The rocks of this stage include tuffs and agglomerates, ejected blocks, and volcanic bombs. Throughout the area the earlier tuffs appear to represent melilite-basalts. The tuffs are followed by others having compositions transitional towards that of leucitite. The later cognate ejected blocks include melanocratic varieties of potash-nephelinite and leucitite. Accompanying them are bombs of leucitite and olivine-leucitite, some of the latter being sufficiently rich in olivine to be regarded as a volcanic equivalent of kimberlite. The volcanic belts together constitute a co-magmatic region of a highly individualised kind.

PARIS.

Academy of Sciences, Oct. 26.—**P. Villard**: The reduction of soda. Caustic soda is reduced to sodium by heating with manganese (or ferromanganese) at 700° C. Some potassium was also obtained from caustic potash. The manganese can be replaced by chromium (800° C.), iron (750° C.), cobalt, nickel (600°-750° C.), or tungsten. No reduction was observed with zinc.—**Léon Guillet, Albert Roux**, and **Jean Cournot**: New remarks concerning the influence of occluded gases on the mechanical properties of metallurgical products. The authors have repeated the experiments of Guichard, Claussman, Billon, and Lanthony and arrive at a different conclusion. They consider it is impossible to agree with the statement that the hardness of electrolytic iron is completely independent of the proportion of hydrogen present in the metal.—**P. Vincensini**: Isotropic congruences and minimum surfaces.—**Gaston Julia**: The trend of iterated series in the neighbourhood of boundaries of convergence.—**Maurice Gevrey**: The determination of the integrals of systems of linear partial differential equations of the elliptic type.—**Arnaud Denjoy**: The Riemann definition of the Lebesque integral.—**J. Le Roux**: The conditions of application of the principle of relativity.—**J. Rossignol**: The problem concerning cylindrical vortices of finite section.—**Henri Quillery**: A method for securing fixed ratio of air to petrol in carburettors.—**Th. Got**: The calculation of the critical velocities of rotating shafts of constant section and non-negligible mass, carrying perfectly centred thin discs.—**D. Barbier**: Remarks on the dynamical parallaxes of double stars.—**J. Dufay**: The spectrum of the eclipsed moon. The moon, when passing through the earth's shadow, is illuminated only by the rays refracted by the earth's atmosphere, and hence the study of its spectrum allows the observation on an unusual scale of the effects produced by diffusion and selective absorption of our atmosphere. Photographs taken during the eclipse of Sept. 26 showed the solar line $C(H\alpha)$, two oxygen bands (one very strong), and others not identified.—**René Gindre**: The photometric study of the eclipse of the moon, Sept. 26, 1931.—**A. Danjon**: Photometric and colorimetric study of the total eclipse of the moon of Sept. 26, 1931.—**Ernest Esclangon**: Remarks on the preceding note.—**L. Eblé** and **E. Salles**: Some measurements of gravity in the Paris region.—**Dalloni**: A scientific expedition to Tibesti.—**B. Décaux** and **Ph. Le Corbeiller**: A self-maintained electrical system utilising a neon tube. If a battery, a neon tube, and a condenser are mounted in series, flashes in the tube separated by periods of longer duration are noted. As an example, with an e.m.f. of 200 volts, a condenser of 6 microfarads showing a leak resistance of 20 megohms, a neon lamp of the night-light type gives flashes every 20 seconds. A theoretical explanation is given.—**Edgar Pierre Tawil**: The origin of the third fundamental frequency of oscillating piezo-electric quartz.—**G. Bruhat** and **J. Thouvenin**: The realisation of a quarter wave plate for the ultra-violet with the aid of oblique quartz.—**R. de Mallemann**: Molecular dissymmetry.—**Pierre Lambert** and **Ion Agarbiceanu**: The magnetic change of the absorption lines of nitrogen peroxide.—**H. Forestier** and **M. Galand**: The study of beryllium ferrite and the ferric oxide arising from its decomposition. The variation of the magnetic properties with temperature and the X-ray study (Debye-Scherrer method) lead to the conclusion that the mechanism of formation of the ferric oxide attracted by a magnet, starting with beryllium ferrite, is the same as that of Malaguti's oxide, formed by the dehydration of certain natural and artificial oxides of iron. The atom of beryllium in the ferrite has the same function as that of the molecule of hydrogen in the hydrate $Fe_2O_3 . H_2O$.—**Ch. Marie** and **N. Marinesco**: The volume contraction produced by the hydration of proteins. The contraction of volume produced by the solution of gelatin proves that strong compressions exist between the dispersing medium and the particles of the dissolved body. The variation of this contraction with the hydrogen ion concentration allows the swelling and viscosity of the same colloid to be interpreted with regard to its isoelectric point.—**P. Mougnaud**: The note of MM. Carrière and Janssens relating to the estimation of fluorine. The author still considers the precipitation of calcium fluoride in ammoniacal solution is too inaccurate for practical use.—**Jacques Maroger**: The reconstitution of the painting technique of Jean Van Eyck. Details are given of the preparation of an oil medium which can be regarded as a reconstitution of the medium used before the beginning of the nineteenth century.—**Jean Chevrier**: Researches on the electrical field of the air at Djesireh.—**E. Chemin**: The protein crystals in some marine species of *Cladophora*.—**A. Famin**: The action of temperature on the nucleus and karyokinesis in *Vicia faba*.—**Marc Bridel** and **Mlle. A. Kramer**: The constitution of asebotoside (asebotine): its identity with phlorizoside (phlorizine). The comparative study of the glucoside extracted from the leaves of *Kalmia latifolia* (asebotoside) and the glucoside extracted from the bark of apple and pear trees (phlorizoside) has proved the complete identity of these two substances. It follows that the name asebotoside should disappear from chemical literature.—**Pierre Chouard**: Analogies between the development of the young plant and the annual push of the leaves in the Liliaceæ.—**A. Vandel**: The existence of two species of *Spiloniscus*, hitherto confused, and their reciprocal relations.—**J. André Thomas**: The action of sea water, in which carotene has remained, on the experimental development of the sea urchin *Paracentrotus lividus*. The carotene employed, although theoretically insoluble in water, communicates properties to sea water affecting the experimental development of the egg of the sea urchin.

CRACOW.

Polish Academy of Arts and Sciences, Oct. 5.—**Ladislas Natanson**: General propositions connected with Fermat's principle and certain other associated theorems.—**St. Rafalowski**: The Raman bands in water. In the case of a solution of hydrochloric acid it has been found that the extreme components of a band weaken as the concentration in acid increases, whilst the middle component widens. This is not in agreement with the statement of Rao (see also NATURE, 128, 546, Sept. 26, 1931).—**K. Dziewonski** and **Zb. Reicher**: Studies on 2-benzylfluorene.—**A. Gawel**: The granites of the Carpathian flysch of Krosno in the neighbourhood of Sanok.—**J. Kuhl**: The formation of kaolin and of alunites in the eastern part of the Ste. Croix mountains (Montagnes du Poivre) in the neighbourhood of Sandomierz.—**E. Malinowski** and **Mlle. A. Smólska**: The mosaic strain of *Petunia violacea*.

Diary of Societies.

FRIDAY, December 4.

Royal Society of Medicine (Otology Section), at 10.30 a.m.
Institution of Water Engineers (at Institution of Civil Engineers), at 10.30 a.m.
Royal Society of Arts (Indian Section), at 4.30.—Sir George Birdwood Memorial Lecture.
Royal Society of Medicine (Laryngology Section), at 5.
Physical Society (at Imperial College of Science and Technology), at 5.
British Psychological Society (Æsthetics Section) (Annual Meeting) (at Bedford College), at 5.30.
Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6.
Institution of Electrical Engineers (Meter and Instrument Section), at 7.
Society of Chemical Industry (Manchester Section) (at Engineers' Club, Manchester), at 7.
Royal Photographic Society of Great Britain, at 7.
Junior Institution of Engineers (at Royal Society of Arts), at 7.30.—Dr. S. L. Pearce: Presidential Address.
Geologists' Association (at University College), at 7.30.
Railway Club (at 57 Fetter Lane), at 7.30.
Institute of British Foundrymen (Middlesbrough Branch) (at Cleveland Scientific and Technical Institute, Middlesbrough), at 7.45.
Royal Society of Medicine (Anæsthetics Section), at 8.30.
Royal Institution of Great Britain, at 9.

SATURDAY, December 5.

Royal Institution of Great Britain, at 3.
Gilbert White Fellowship (at 6 Queen Square, W.C.1), at 3.
Institute of British Foundrymen (Lancashire Branch) (at College of Technology, Manchester), at 4.

MONDAY, December 7.

Cambridge Philosophical Society (in Cavendish Laboratory, Cambridge), at 4.30.
Royal Society of Edinburgh, at 4.30.
Royal Geographical Society, at 5.
Royal Institution of Great Britain, at 5.—General Meeting.
Society of Engineers (at Geological Society), at 6.
Institution of Electrical Engineers (Informal Meeting), at 7.
Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.
Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.
Institution of Rubber Industry (at Engineers' Club, Manchester), at 7.
British Kinematograph Society (at Gaumont Theatre, Wardour Street), at 7.45.
Royal Society of Arts, at 8.
Society of Chemical Industry (London Section) (at Chemical Society), at 8.

TUESDAY, December 8.

Manchester University Chemical Society (at Manchester University), at 5.
Royal Institution of Great Britain, at 5.15.
Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.
Institute of Marine Engineers, at 6.
Institute of Metals (Swansea Local Section) (at Y.M.C.A., Swansea), at 6.15.
London Natural History Society (Ramblers' Section) (at London School of Hygiene and Tropical Medicine), at 6.30.
Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.
Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.
Institution of Heating and Ventilating Engineers (Associate Members' and Graduates' Section—Manchester and District Branch) (at Engineers' Club, Manchester), at 7.
Royal Photographic Society of Great Britain, at 7.
Institution of Automobile Engineers (Coventry Centre) (at King's Head Hotel), at 7.30.
Institution of Electrical Engineers (Scottish Centre) (at 39 Elmbank Crescent, Glasgow), at 7.30.
Institute of Metals (North-East Coast Local Section) (jointly with Society of Chemical Industry) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.
Institution of Welding Engineers (North-Western Branch) (at College of Technology, Manchester), at 7.30.
Royal Anthropological Institute, at 8.30.
Royal Society of Medicine (Psychiatry Section), at 8.30.
Pharmaceutical Society of Great Britain, at 8.30.
Institution of Electrical Engineers (East Midland Sub-Centre) (jointly with Institute of Fuel) (at University College, Nottingham).

WEDNESDAY, December 9.

Institution of Engineering Inspection (at Royal Society of Arts), at 5.30.
Institution of Civil Engineers (Informal Meeting), at 6.
North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.
Institution of Electrical Engineers (Hampshire Sub-Centre) (at Municipal College, Portsmouth), at 7.30.
Royal Society of Arts, at 8.30.—Sir Henry Maybury: Roads and Road Transport (Trueman Wood Lecture).

THURSDAY, December 10.

Royal Society, at 4.30.
London Mathematical Society (at Royal Astronomical Society), at 5.
Royal College of Surgeons of England, at 5.—Col. W. P. MacArthur: The Surgeon and Old-time Plague (Thomas Vicary Lecture).
Royal Aeronautical Society (at Royal Society of Arts), at 6.30.
Institute of Marine Engineers (Junior Section), at 7.
Royal Photographic Society of Great Britain, at 7.
Institute of Metals (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.
Institute of Chemistry (at Derby Technical College), at 7.15.
Institute of Metals (London Local Section) (jointly with Institute of British Foundrymen) (at 83 Pall Mall, S.W.1), at 7.30.
Society of Chemical Industry (Bristol Section) (jointly with Chemical Engineering Group) (at Bristol University), at 7.30.
Institution of Electrical Engineers (Dundee Sub-Centre) (at University College, Dundee), at 7.30.
Institution of Mechanical Engineers (Yorkshire Branch) (Annual General Meeting) (at Hotel Metropole, Leeds), at 7.30.
North-East Coast Institution of Engineers and Shipbuilders (Tees-Side Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough) (jointly with Institution of Electrical Engineers—Tees-Side Sub-Centre), at 7.30.
Optical Society (at Imperial College of Science and Technology), at 7.30.
Institution of Welding Engineers (at Institution of Mechanical Engineers), at 7.45.
Royal Society of Tropical Medicine and Hygiene (at London School of Hygiene and Tropical Medicine), at 8.15.
Royal Geographical Society, at 8.30.—H. G. Watkins: The British Expedition to Greenland.
Diesel Engine Users' Association (at Caxton Hall).
Institution of Mechanical Engineers (Glasgow Centre) (at Glasgow).—Ll. B. Atkinson: Thomas Hawksley Lecture.

FRIDAY, December 11.

Andersonian Chemical Society (at Royal Technical College, Glasgow), at 3.15.
Biochemical Society (at London School of Hygiene and Tropical Medicine), at 3.30.

Royal Astronomical Society, at 5.—Prof. Freundlich: On the Gravitational Deflection of Light (Total Solar Eclipse, 1929, May 9).

Royal Geographical Society, at 5.

Royal Society of Medicine (Ophthalmology Section) (at Royal Eye Hospital, St. George's Circus), at 5.

Malacological Society of London (at Linnean Society), at 6.

Institution of Chemical Engineers (at Chemical Society), at 6.

Institution of Mechanical Engineers, at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.

Society of Dyers and Colourists (jointly with Manchester Literary and Philosophical Society—Chemistry Section) (at 36 George Street, Manchester), at 7.

Institution of Electrical Engineers (London Students' Section), at 7.

Geologists' Association (North-East Lancashire Group) (at Blackburn Technical College), at 7.

Illuminating Engineering Society (at Royal Society of Arts), at 7.—Sir Francis Goodenough: Presidential Address.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow), at 7.15.

Society of Chemical Engineers (South Wales Section) (at Thomas' Café, Swansea), at 7.30.

Junior Institution of Engineers, at 7.30.

Royal Institution of Great Britain, at 9.

Oil and Colour Chemists' Association (Manchester Section) (at College of Technology, Manchester).

SATURDAY, December 12.

Geologists' Association (Demonstration at Natural History Museum), at 2.30.

North of England Institute of Mining and Metallurgical Engineers (at Newcastle-upon-Tyne), at 2.30.

Royal Institution of Great Britain, at 3.

Public Lectures.

SATURDAY, December 5.

Mathematical Association (London Branch) (at Bedford College for Women), at 3.—J. W. N. Sullivan: Mathematics and Culture (Presidential Address).

Horniman Museum (Forest Hill), at 3.30.—Prof. J. R. Ainsworth-Davis: Insect Pests and their Enemies.

MONDAY, December 7.

University of Leeds, at 5.15.—Prof. G. Barger: Ergot and Ergotism.

TUESDAY, December 8.

Imperial Institute, at 2.15.—Major H. Lockwood Stevens: Unknown Nepal.

WEDNESDAY, December 9.

Imperial Institute, at 2.15.—Miss Margaret Green: Our Voluntary Hospitals and the Nurse's Vacation.

Royal Institute of Public Health, at 4.—Prof. E. L. Collis: The Health of the Industrial Worker.

School of Oriental Studies, at 5.15.—A. W. G. Malcolm: Medicine in Africa.

Belfast Museum and Art Gallery, at 8.—E. E. Evans: The Beginnings of our Civilisation.

THURSDAY, December 10.

Imperial Institute, at 2.15.—Comdr. the Hon. S. Hay: A Midshipman's Experiences in the Pacific.

Science Museum (South Kensington) (in connexion with Exhibition of Modern Glasses), at 4.45.—E. A. Coad-Pryor: Glass in the Foodstuffs Industry.

King's College, London (at 16 Russell Square, W.C.1), at 5.30.—S. P. Turin: Russian Imports and Exports.

Battersea Polytechnic, at 7.—Dr. H. Phillips: The Walden Invasion: the Mechanism of the Substitution of Groups in Saturated Organic Compounds.

SATURDAY, December 12.

Horniman Museum (Forest Hill), at 3.30.—Dr. W. G. Ivens: Negroid Peoples of the Pacific Islands.

Official Publications Received.

British.

North-East Coast Institution of Engineers and Shipbuilders (Incorporated). Report of the Council, 1930–1931. Pp. 18. (Newcastle-on-Tyne.)

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1930. Part 3. Pp. v+92+5 plates. (London: H.M. Stationery Office.) 2*s.* net.

Canada: Department of Mines: Geological Survey. Memoir 166: Geology and Ore Deposits of Rouyn-Harricanaw Region, Quebec. By H. C. Cooke, W. F. James and J. B. Mawdsley. (No. 2267.) Pp. ix+314. 45 cents. Memoir 167: Fort William and Port Arthur, and Thunder Cape Map-areas, Thunder Bay District, Ontario. By T. L. Tanton. (No. 2268.) Pp. ii+222. 30 cents. (Ottawa: F. A. Acland.)

Canada: Department of Mines: National Museum of Canada. Bulletin No. 67: Annual Report for 1929. Pp. 58. (Ottawa: F. A. Acland.)

Public Library, Museum and Art Gallery of South Australia. Records of the South Australian Museum. Vol. 4, No. 3, June 30th. Pp. 275-408. (Adelaide.)

Society of Biological Chemists, India. Biochemical and Allied Research in India in 1930. Pp. 20. (Bangalore: Indian Institute of Science.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1397 (Ae. 518—T. 3057): Airscrews at Negative Torque. By C. N. H. Lock and H. Bateman. Pp. 6+5 plates. 6*d.* net. No. 1398 (Ae. 519—T. 3068): A Method of Testing the Strength of Aircraft Hulls. By I. J. Gerard. Pp. 7+9 plates. 1*s.* 3*d.* net. No. 1399 (Ae. 520—T. 3090): Range of Aircraft with Air-Cooled Radial Engine using Altitude Control. By A. E. Woodward Nutt, Flight-Lieut. A. F. Scroggs and E. Finn. Pp. 8+16 plates. 9*d.* net. (London: H.M. Stationery Office.)

Indian Journal of Physics, Vol. 6, Part 3, and Proceedings of the Indian Association for the Advancement of Science, Vol. 15, Part 3. Conducted By Sir C. V. Raman. Pp. 165-262. (Calcutta.) 1.8 rupees; 2*s.*

Publications of the South African Institute for Medical Research. No. 26: Lymphoid Tissue in the Lung; its Distribution as illustrated by a case of "Status Lymphaticus", and its Importance in the Localization of Inhaled Particulate Matter. By F. W. Simson and Dr. A. Sutherland Strachan. Pp. 231-244. No. 27: Malaria Investigations in some parts of the Transvaal and Zululand. By Prof. N. H. Swellengrebel, S. Annecke and B. de Meillon. Pp. 245-274. (Johannesburg.)

Foreign.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. Escobedia, a Neotropical Genus of the Scrophulariaceae. By Francis W. Pennell. Pp. 411-426. (Philadelphia.)

Conseil Permanent International pour l'Exploration de la Mer. Faune ichthyologique de l'Atlantique nord. Publiée sous la direction de Prof. Joubin. No. 8. 24 planches. (Copenhague: Andr. Fred. Høst et fils.) 4.00 kr.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 113: The Egyptian Wild Irises By J. R. Shabetai Eff. Pp. 8+2 plates. (Cairo: Government Press.) 2 P.T.

Transactions of the San Diego Society of Natural History. Vol. 7, No 1: A new Species of Xantusia from Arizona, with a Synopsis of the Genus. By Laurence M. Klauber. Pp. 16+1 plate. Vol. 7, No. 2: Two New Ground Squirrels from Lower California, Mexico. By Laurence M. Huey. Pp. 17-20. Vol. 7, No. 3: Notes on the Races of *Saltator grandis* (Lichtenstein). By A. J. van Rossem. Pp. 21-24. (San Diego, Calif.)

U.S. Treasury Department: Coast Guard. Bulletin No. 19: The Marion Expedition to Davis Strait and Baffin Bay under direction of the United States Coast Guard, 1928. Scientific Results, Part 3: Arctic Ice, with Especial Reference to its Distribution to the North Atlantic Ocean. By Edward H. Smith. Pp. x+221. (Washington, D.C.: Government Printing Office.)

U.S. Department of Agriculture. Circular No. 168: Insects injurious to Agriculture in Japan. By C. P Clausen. Pp. 116. 20 cents. Farmers' Bulletin No. 1668: The Red Harvester Ant and how to subdue It. By V. L. Wildermuth and E. G. Davis. Pp. ii+22 5 cents. Technical Bulletin No. 242: Biology of the Indian-Meal Moth on Dried Fruits in California. By J. C. Hamlin, W. D. Reed and M. E. Phillips. Pp. 27. 5 cents. (Washington, D.C.: Government Printing Office.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Fourth Series (Biology), Vol. 6, No. 3. Pp. 347-571. (Tokyo and Sendai: Maruzen Co., Ltd.)

Norges Svalbard- og Ishavs-Undersøkelser: Skrifter om Svalbard og Ishavet. Nr. 35: Jura- und Kreidefaunen von Spitzbergen. Von D. Sokolov und W. Bodylevsky. Pp. 151+14 Tafeln. 15.00 kr Nr. 36: Acquisition of Sovereignty over Polar Areas. By Gustav Smedal. Pp. 143. 10.00 kr. Nr. 38: Lichens collected on the Norwegian Expedition to Franz Josef Land, 1930. By B. Lynge. Pp 31+2 plates. 3.00 kr. (Oslo: Jacob Dybwad)

Conseil Permanent International pour l'Exploration de la Mer. Bulletin hydrographique pour l'année 1930. Pp. 120 (Copenhague Andr. Fred. Høst et fils.) 6 25 kr.

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SATURDAY, DECEMBER 12, 1931.

CONTENTS.

PAGE
Science and Agriculture in New Zealand . . . 981
Sidelights on the British Association. By R. T. G. . 982
Physics of the Earth. By Dr. Harold Jeffreys, F.R.S. 984
A New History of Astronomy. By Dr. J. K. Fotheringham 986
Qualitative Analysis by 'Spot' Tests . . . 987
Short Reviews 988
The Evidence of Palæontology with Regard to Evolution. By Prof. A. E. Trueman 990
The Gene and the Theory of Living Structures. By H. S. 991
New Game Reserves in South Africa. By Prof. H. B. Fantham 992
News and Views 993
Letters to the Editor :
  The Internal Temperature of White Dwarf Stars.—Prof. E. A. Milne, M.B.E., F.R.S. . 999
  Molecular Weights of the Proteins in their Native State.—Prof. The Svedberg . . 999
  An Aspect of Co-ordination.—Prof. J. Kenner, F.R.S. 1000
  Cotton Growing in Egypt.—N. W. Barritt ; F. P. Slater 1001
  Outgrowths from Pieces of *Helix aspersa*, the Common Snail.—Prof. J. Bronte Gatenby . 1002
  The Specific Heat of Ferromagnetics and Ewing's Model of the Magnetic Atom.—Dr. J. R. Ashworth 1003
  Homo sapiens and African Prehistory.—Dr. E. J. Wayland 1003
  Organisation of Scientific Abstracting Services.—A. A. Eldridge 1004
  Gravity Anomalies.—Major E. A. Glennie . 1004
  Rotatory Magnetic Polarisation.—Prof. Edm. van Aubel 1004
  Superconductivity at High Frequencies.—Prof. J. C. McLennan, O.B.E., F.R.S., A. C. Burton, A. Pitt, and J. O. Wilhelm 1004
Research Items 1005
Astronomical Topics 1007
Scientific Management Problems 1008
The Lister Institute 1009
A New Illumination Device for Microscopy . . 1010
Mycorrhiza in Relation to Forestry . . . 1011
University and Educational Intelligence . . . 1011
Birthdays and Research Centres 1012
Societies and Academies 1012
Diary of Societies 1015
Official Publications Received 1016

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Science and Agriculture in New Zealand.

SINCE Lord Bledisloe's appointment as Governor-General of New Zealand, he has taken every opportunity of emphasising the need for scientific work as the basis of development of the country's resources. He has the unusual advantage of combining administrative ability with agricultural knowledge and a high appreciation of the possibilities presented by scientific research, and he has the courage to express his convictions clearly and without ambiguity. Before leaving Great Britain, he had, as chairman of the Lawes Agricultural Trust, the committee which manages the Rothamsted Experimental Station, the opportunity of familiarising himself with the detailed working of a great agricultural experiment station, and as chairman of the Long Ashton Research Station Committee he had had similar experience of a fruit research station. He was therefore well equipped for his work. He has, of course, been fortunate in his field of action. In no part of the Empire is there a higher standard of intelligence and ability among agriculturists, pastoralists, and fruit growers than in New Zealand. Right from the outset, universities were founded and agricultural education fostered. Nowhere is a worker in agricultural science better received than in New Zealand.

It is no accident that, in a world of agricultural depression, New Zealand, although largely dependent on agriculture, is probably suffering less than any other country at the present time. The agricultural development of New Zealand reads almost like a romance: it has all occurred so rapidly, yet with such certainty. From 1840, when organised settlement began, until 1880, sheep ranching was the main occupation and wool the chief export. There had been an export of wheat after 1870, the result of Vogel's development policy, until the invention of refrigeration paved the way for the great dairy and lamb industries, which are now among the most remarkable and efficient agricultural industries in the world. The invention came from Australia ; in 1873, James Harrison had been awarded a gold medal at the Melbourne Exhibition for his method of freezing meat. But the method was not developed until 1879, and then it was not successful. The first satisfactory cargo of frozen mutton and lamb arrived at London from New Zealand in 1882 in a sailing ship fitted with refrigeration appliances ; ten years later steamers were introduced, and continuous improvements have since been made.

On the agricultural side also the industry has developed remarkably, and from 1921 onwards it has been the subject of a good deal of legislative control, for the New Zealand farmer has learned to combine freedom of action in producing with united action in grading and marketing, and in consequence he has been able to send to Great Britain large and regular supplies of uniform high quality, and so to secure an enviable position in our markets. He does this at a profit, in spite of his great distance from our markets and of having to pay wages much higher per man (though not per job) than are paid here. The exports are rapidly rising. In 1929 that of butter was valued at £13·2 millions, of cheese £7 millions, frozen meat (mutton and lamb) £9·9 millions; in all, more than £30 millions by refrigeration transport, as against £15 millions of wool—a truly remarkable progress.

The development of the dairy industry, however, was not simply a matter of transport: it is a triumph for the bacteriologist, who has reduced to an exact science the art of producing clean milk, good butter, and cheese true to type.

No better illustration of the advantage of science to a community could be desired. But New Zealand does not rest satisfied with past achievements; it is perpetually improving its scientific equipment. The Cawthron Research Institute at Nelson in South Island, founded by Thomas Cawthron, a Camberwell man; the Canterbury Agricultural College, also in South Island; and the Massey Agricultural College in North Island, are all vigorous institutions, the first two well established and already held in high esteem among the agricultural institutes of the world, the last named new, well equipped, and with possibilities of a great career of usefulness. On the opening of this institution, Lord Bledisloe gave an address in which he summarised in a masterly way the economic and technical problems facing the New Zealand farmer, indicating also the lines on which they could be solved. " Even the most impoverished countries of the world ", he said, " have found public expenditure upon scientific research and the scientific guidance of their farming population to be a sound and remunerative investment."

This is an undeniable truth, and it holds generally; it is not confined to the agricultural population. Of all departments of public life, those concerned with the fostering of scientific work can least be spared. In the present national emergency, agricultural scientific workers, like their colleagues in other branches, are prepared to help shoulder the burden, but they ask that the work shall not be allowed to suffer, for it is even more needed in days of trouble than in days of prosperity. Great Britain has a good organisation for agricultural research and education, and an enthusiastic body of workers who have gained the confidence of farmers by the proved value of the help they have been able to render to the industry. It has taken years of patient work to build up the organisation and to train the workers: once destroyed, it would take even longer years to rebuild, because of the lack of confidence. Happily, the indications are that those charged with the invidious and thankless task of making national expenditure fit national means are fully alive to the imperative need of keeping intact the scientific organisation of Great Britain.

Sidelights on the British Association.

Advancing Science: being Personal Reminiscences of the British Association in the Nineteenth Century. By Sir Oliver Lodge. Pp. 191. (London: Ernest Benn, Ltd., 1931.) 6*s*. net.

MAXWELL'S "Treatise on Electricity and Magnetism " was published in 1873. H. J. S. Smith was president of Section A of the British Association which met at Bradford that year, and in his presidential address referred thus to the work: " For electricity now, like astronomy of old, has placed before the mathematician an entirely new set of questions, requiring the creation of entirely new methods for their solution ". Among his hearers was Oliver Lodge, then an enthusiast, twenty-two years of age, attending his first British Association meeting, greatly impressed by the distinguished men present, who were taking an active part in the proceedings. Soon afterwards he conceived the idea, as he tells us in the interesting note contributed to the Maxwell commemoration volume,* of making the production and demonstration of the electromagnetic waves predicted by Maxwell the work of his life.

For the next twenty-five years or more Lodge was a regular and welcome attendant at British Association meetings, and we have now his personal reminiscences up to the end of the century. And most interesting they are to all who care to learn something of the development of science during that period, specially perhaps to one who, like the reviewer, attended many of the meetings and is reminded by this record of the sayings and doings of friends now passed away.

The book had its origin in a suggestion by Dr. Ferguson, secretary of the Physical Society, that Sir Oliver should record his notion of what the

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* James Clerk Maxwell: a Commemoration Volume, 1831–1931. (Cambridge: At the University Press, 1931.) See NATURE, Oct. 10, p. 607.

British Association and the big men associated with it accomplished during the latter third of the nineteenth century; the headings of some of the sections are sufficient to illustrate its scope.

Commencing with a brief notice of Huxley, Tyndall, and Clerk Maxwell in the first chapter, we pass on to Crookes and radiant matter, and Fitzgerald on ether waves in the years 1879–83. Then comes an interesting account of the first Dominion meeting, at Montreal, under Lord Rayleigh's presidency, followed by Kelvin's vortex theory of the ether and the long discussions on the seat of the e.m.f. in a voltaic cell, 1885–87; the discovery of electric waves, Bath, 1888; the National Physical Laboratory with a section about the Red Lion Club; argon and the beginnings of wireless, 1892–1894, and finally the discovery of the electron, 1895–1900.

In his survey the author covers the whole range of subjects dealt with in Section A during thirty years, bringing back to the memory of many of his readers the salient points of discussions to which they listened and illustrating them by his own vivid recollections. Perhaps the most interesting pages are those in which he gives the history of electric waves and tells the story how he carried out the resolve made at Bradford in 1873.

Sir Oliver met Fitzgerald at Dublin in 1878 and was captivated at once by that most charming of men, a skilful physicist, a brilliant mathematician, and a daring thinker—witness his prediction in 1894 or '95 that the length of a yard stick might depend on its orientation; he had absorbed all that was involved in Maxwell's theory, and in 1880 laid before the British Association a paper on the possibility of originating wave disturbances in the ether by electromagnetic forces. At Southport in 1883 he calculated the energy lost per second by a circular ring carrying an alternating current and described a method of producing electromagnetic disturbances of comparatively short period; it was the method now used in wireless. But at the time the friends went no further. Four years later (1887) Lodge gave the Mann Lectures of the Society of Arts on protection from lightning, in which he directed attention to the importance of the self-induction of a lightning conductor leading to an alternating discharge. That same year, Hertz, at Carlsruhe, was investigating the " Outspreading of Electric Force ", as he called the waves coming from a circuit carrying a rapidly alternating current.

We heard of this in Cambridge early in 1888 and welcomed with enthusiasm this verification of the theory of our master. It is all in Maxwell, we said; no one had realised that by tuning the receiving circuit the tiny effects which we knew were there could be made visible. Fitzgerald was president of Section A that year (1888) at Bath and made a description of Hertz's work a main portion of his address. A paper by Lodge dealing with the propagation of waves along wires appeared in the *Phil. Mag.* for August 1888. In the years following, lectures were given and experiments shown to illustrate the Hertzian waves; reference may be made to one by Lodge at Oxford in 1894, in which he outlined the possibility of their extension to wireless telegraphy; in this work he was helped by Alexander Muirhead.

Two years later, at Liverpool, Sir William Preece, Chief Engineer to the Post Office, told Section A of Marconi's work, and wireless as we now know it, aided by Lodge's work on tuning, came into being. The discovery of the electron, announced at Dover by J. J. Thomson, in 1899, completes the story. Wireless had been held back by the need for a sufficiently sensitive receiver, and somewhat later (1904) Fleming showed that the stream of electrons from a hot cathode in an exhausted bulb constituted a much better detector than any coherer or crystal device.

Sir Oliver treats in a similar way, though not so fully, many of the other discussions and discoveries of those pregnant five-and-twenty years; for the story we must refer the reader to his reminiscences; and these are not all dry science. He tells of the spade work of a delegate who persuaded the Association to visit Southport—he does not mention his speech to the General Committee met to determine the next place of meeting. The Committee was getting a little bored by a delegate from Leicester, who spoke of the antiquity and history of his city, of its interests from the time of Simon de Montfort to the present day, ending with a lecture on the geology of the neighbourhood. The Southport delegate followed with the statement: Southport has no history; Southport has no antiquities; Southport has no geological formation, but it will give the Association a hearty North Country welcome; and he sat down. The Committee voted for Southport.

Again, at Dublin, our author found there the senior fellows spent much time telling comic tales. I once heard an elderly lady—this is not in Sir Oliver's book—ask one of the brilliant group mentioned: " Is that really true ? " to receive the reply, " Have you not yet learned, Mrs. M., that truth spoils stories ? "

The secretaries often had amusing experiences;

no doubt they still have; let me conclude with one of my own. It was in a cathedral city, and in discharge of my duty I had declined as politely as possible a paper on the ether scarcely suited for Section A. It was too theological. I went to the cathedral service on the Sunday of the meeting, when a venerable gentleman ascended the pulpit and from that secure position read to the assembled congregation the paper I had returned to him some few days earlier.

But it is not stories of this kind which give value to Sir Oliver's book. In a life of eighty years, he has made many of us his debtors; he has added to our debt by telling of advancing science during the last quarter of the nineteenth century in a manner which only he could achieve.

R. T. G.

Physics of the Earth.

Bulletin of the National Research Council. No. 77: *Physics of the Earth.* 1: *Volcanology.* By the Subsidiary Committee on Volcanology. Pp. viii+77. 75 cents. No. 78: *Physics of the Earth.* 2: *The Figure of the Earth.* A Collection of Short Papers, written by Leading Scientific Men in several branches of Geophysics, and treating of the Size and Shape of the Earth. Pp. v+286. 3.50 dollars. No. 79: *Physics of the Earth.* 3: *Meteorology.* Prepared under the auspices of the Subsidiary Committee on Meteorology. Pp. xi+289. 3.50 dollars. No. 80: *Physics of the Earth.* 4: *The Age of the Earth.* Pp. v+487. 4.50 dollars. (Washington, D.C.: National Academy of Sciences, 1931.)

THE books under review are the first four of a series of nine bulletins of the United States National Research Council, on various branches of geophysics, begun in 1926 under the stimulus of Prof. J. S. Ames. The preparation of each is in the hands of a very representative subcommittee.

The first, on volcanology, is in three sections, by Drs. K. Sapper, I. Friedlander, and T. A. Jaggar. It must be recognised, and the authors do recognise throughout, that physical volcanology has a considerable future, but no past and not much present. The first two chapters are mainly descriptive of the various forms of volcanic activity, with brief accounts of former attempts at explanation. The latter give the impression that most of them would have been better left buried. Jaggar's essay is what the subject needs; it is stimulating and full of ideas for future work. One may pick out for special mention his suggestion of the use of spectroscopic methods to determine the composition of the gases emitted, his explanation of the difference in level between the craters of Kilauea and Mauna Loa, and the following remark, in relation to volcanic rocks: "The real geological interest is quantity of commonest types. The laboratory interest is quality of uncommon types." Much use is made of the work of Day and Shepherd on the temperatures of lavas; but one wishes that Day himself had contributed more than a preface.

The second volume, nominally on "The Figure of the Earth", covers the figure of the earth, isostasy, tides, and the variation of latitude. There are sixteen chapters, by various authors; some deal with observational technique, some with methods of computation, while others are purely theoretical. Dr. A. T. Doodson contributes a comprehensive semi-popular account of tidal theory, explaining in general terms the amphidromic points—those places in open seas and oceans around which the tidal wave appears to circulate—and brings out the interesting point that the tide in the Atlantic as a whole is largely a matter of resonance. Dr. H. A. Marmer's account of mean sea-level makes the theorist marvel at the observational skill of the survey that has shown that the mean level of the sea is not perfectly flat, but shows variations of a few inches as between places hundreds of miles apart. Dr. W. D. Lambert's chapters on the bodily tides and on tidal friction constitute an excellent historical and critical summary of the present state of these subjects.

Dr. W. Bowie gives a historical account of the theory of isostasy, and gives proper credit to Airy as the real originator of the idea. But Prof. H. Fielding Reed, in the next chapter, seems to go completely astray in deciding for Pratt's theory against Airy's on geological evidence. He admits folding as the cause of mountain structure, while Pratt made no allowance whatever for folding. Granted the existence of several distinct layers in the crust, each lighter than the one below it, which is demanded both by geological evidence and by the modern study of near earthquakes, any crustal shortening such as gives rise to folding means an extra thickness of light matter on top. If then there is no corresponding excess of gravity, this can be due only to a deficiency of the heavier matter below; that is, to a depression of the base of the lighter layers. This is precisely Airy's theory. Prof. Reed gives evidence that in some cases the folding took place before the uplift, and argues that this fact is in favour of Pratt's theory and destructive of Airy's. This is not the case. Granted compression without uplift, the result would be a replacement of heavy matter by an equal *volume* of light matter, and therefore a deficiency of gravity. If then subsequent uplift took place by Pratt's mechanism—vertical expansion—the mass per unit area would remain as it was, and the deficiency of gravity would persist. This is in contradiction to the observed fact that gravity in mountainous regions is sensibly normal. Prof. Reed's theory errs in the opposite direction from the old idea of the mountains as excess loads.

Dr. Lambert contributes a further article, largely historical, on the theory and measurement of the figure of the earth. It is pleasant to see an account of Stokes's formula for the determination of the deviation of the geoid from the spheroid, given the variation of gravity over the surface; as Lambert says, eighty years after Stokes enunciated his theorem, observations of gravity are becoming sufficiently numerous to make its application possible.

Dr. Swick gives an account of methods of measuring gravity (including that of Meinesz). Other geodetic articles are contributed by D. C. Barton, D. L. Parkhurst, H. G. Avers, and C. V. Hodgson, and Dutton's classical paper is reprinted.

The final section deals with the variation of latitude, Lambert again being the principal author. He discusses incidentally Darwin's paper on the secular shifting of the pole, and shows that by a mathematical oversight Darwin was more favourable to this hypothesis than the circumstances warranted.

The third volume deals with meteorology, both from the observational and theoretical points of view. It is very full, both in description and in the accounts of the thermodynamics and dynamics of the atmosphere. But we notice with wonder that what we are used to call the eddy viscosity is called the Austausch coefficient, that this is said to be the usual English practice, and that Prof. G. I. Taylor is not mentioned in relation to it. Nevertheless, the amount of material is remarkable, considering the size of the volume.

The appearance and arrangement of the books are attractive, though there are rather too many misprints.

The first three volumes are in the nature of critical summaries of existing knowledge. The fourth, however, is a full and detailed account. The greatest part of it, nearly three-quarters, is by Prof. Arthur Holmes, and deals with the measures of geological time based on radioactive disintegration. A serious attempt has been made to discuss all the relevant analyses, a formidable mass of material. Holmes begins at the beginning with a general account of radioactivity; he adopts the view that the lead isotope of atomic weight 207 is the final product of the actinium series, derived ultimately from an isotope of uranium, probably of atomic weight 235. Rutherford's interesting estimate of a maximum age of the earth from the amounts of the elements in the actinium series is given fully. Pleochroic halos occupy a chapter. In the discussion of lead/uranium ratios the constants adopted are altered slightly from those previously recommended by Holmes and Lawson, and the whole of the data have been recomputed. It is to be hoped that there will be no further change in the practice in this matter; it can be assumed that the present values are accurate enough for any geophysical application, and we do not want further confusion owing to different workers using different values.

Full particulars of the known radioactive minerals are given, with an enormous number of analyses and age determinations from all parts of the world. The helium problems are also discussed. The helium/uranium ratio, though not very useful for finding the ages of minerals, seems to be coming into its own in application to complete rocks, from which the loss of helium by leakage is much less, and in the hands of Dubey and Günther this method is giving valuable results. A careful discussion of the needful precautions in interpreting lead and helium ratios is given. Future workers on geological time will certainly find Holmes's work indispensable.

The book begins with a short introduction by Prof. Adolph Knopf. Prof. Schuchert treats the older denudational and biological methods of estimating geological time, but also contributes one based on the maximum (instead of the mean) thickness of each formation and the rate of accumulation. This principle has already been applied by Reade and Goodchild, and gives results in general agreement with those derived from radioactivity. Schuchert goes rather further and draws a somewhat startling conclusion: that deposition in the Tertiary and Mesozoic was three or four times as fast as in the Palæozoic. We are used to the idea that post-glacial deposition has been abnormally rapid, but Schuchert thinks that the rate has increased steadily.

Prof. Knopf, in discussing the age of the ocean, mentions the possibility that the excess of sodium is removed from it by adsorption at the bottom. This would explain one great difficulty: how it is that the ocean, drawing its sodium and chlorine from independent sources, has managed to remain neutral throughout geological time. Prof. A. F. Kovarik gives a very elaborate account of the radioactivity data from the point of view of the experimental physicist; the values for the various constants that he finally decides upon as the best have been adopted in Holmes's section.

Most of the book deals really with the estimation of geological time rather than with the age of the earth. We are now in a position to compare directly the ages of formations in different parts of the earth by radioactivity, without reference to fossils, and therefore the new methods are available to make fundamental contributions to ordinary geology. If an igneous rock is found to have an age of 200 million years, we can say that its age is Permian even if there is no sedimentary rock near by between the Pre-Cambrian and the Tertiary.

Prof. E. W. Brown gives a brief account of astronomical clues to the age of the earth. Two of these, referring to the times needed for resonance phenomena to produce certain orbital features, are new. He suggests that my own estimate, based on the theory of the resisting medium, needs reinterpretation to allow for accretion on the planets; but as I suppose the medium to be hydrogen, the question of accretion does not arise. His general conclusion is that astronomical evidence is consistent with geophysics but less definite; and with this we may readily agree. HAROLD JEFFREYS.

A New History of Astronomy.

Die Geschichte der Sternkunde: von den ersten Anfängen bis zur Gegenwart. Von Prof. Dr. Ernst Zinner. Pp. xi + 673 + 13 Tafeln. (Berlin: Julius Springer, 1931.) 21·80 gold marks.

PROF. ERNST ZINNER is to be congratulated on having produced a captivating volume. What is most astonishing is the easy mastery with which he reviews the very different subjects that are contained in his work. There is here no heavy muster of facts, but enough to enable us to understand the lines of discovery and the development of ideas, the causes that contributed to progress, stagnation and decay, and the difficulties that had to be encountered. Astronomy is throughout brought into relation to the civilisation, the religion, the educational organisation, and the material environment of each age, and yet every important advance in observation, in theory, in apparatus is duly recorded. It seems strange to find combined in one book the beliefs of primitive peoples, the results of archæological research in Egypt and the Euphrates valley, the work of the Greek mathematicians, and of medieval schoolmen; the steady march of modern dynamical and observational astronomy, with a remarkable appreciation of the present position of research and of the conditions that govern research in all the numerous departments of present-day astronomy; and in each case the treatment is illuminating. It would be an achievement to have acquired such familiarity in a lifetime, but it may be noted that our author was only forty-four years of age when this volume appeared.

Not only the great astronomers of the past, but also most of the distinguished, and many of the less well-known, living astronomers are mentioned somewhere in this book. As the treatment is by subjects, not by persons, it is in some measure chance that determines whether a particular astronomer shall be mentioned by name or not. Unlike too many of his compatriots, the author shows no tendency to name the work of his fellow-countrymen in preference to foreigners. The catholicity of his interests may be illustrated by the fact that no fewer than four living alumni of the University of Oxford are mentioned. I have not attempted the task of enumerating the living alumni of Cambridge. The only trace of German national pride seems to lie in the use made of the word *Germanen.* The first fifteen parts of the book, comprising nearly the whole, profess to give the astronomy of different nations or races. The thirteenth of these, the astronomy of the *Germanen,* runs to 295 pages and includes the whole of modern astronomy, for, to our author, all nations that have received the German *Kultur* are entitled to be included under the generously comprehensive designation of *Germanen.*

What readers will miss most in this book is references. The author was probably right in omitting them. They would have added greatly to its bulk, and might easily have added many years to the labour of preparation. There is a general bibliography, six pages long, but, alas! it is arranged in alphabetical order by the authors' names and not by their subjects, and, what could probably not be helped, it includes only books, not papers. There is also a four-page bibliography of astronomical biographies, which ought to be valuable. Here and there bibliographical information is given in the text. But one would like to be able to trace the authority for some of the more speculative reconstructions of ancient science and ancient calendars, and to know, when results obtained by others are not accepted, whether the rejection is due to ignorance or considered judgment. For example, when Prof. Zinner devôtes nearly a page to the comets alleged to have accompanied the conception and accession of Mithridates, his rejection of my conclusions on that subject might be deliberate, but his failure to notice the passages cited by me from Si-ma Tsiän suggests that my discussion had escaped his notice. On the whole, it is probably more a merit than a defect that our author not only teaches his readers much, but also sets them hunting for his sources and for further information.

J. K. Fotheringham.

Qualitative Analysis by 'Spot' Tests.

Qualitative Analyse mit Hilfe von Tüpfelreaktionen: theoretische Grundlagen und praktische Ausführung. Von Dr. Fritz Feigl. Pp. xii + 387 + 2 Tafeln. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 28 gold marks.

Prof. Emich, the famous microchemist, has called "Tüpfelanalyse" "the qualitative analysis of the future", and looks forward to the time when there will be a specific test for every inorganic ion, with enormous saving of time and material in analysis. Dr. Feigl has written the first textbook on Tüpfelanalyse, or 'spot' tests, after ten years' research in the subject, and shows that the methods are not of the future alone, since already for almost every ion there are two or more 'spot' tests worked out in detail. There are several methods of complete qualitative analysis using 'spot' tests only, and one method, combining the tests with some of the older group separations, is already in use in the chemistry course of the University of Delft.

'Spot' tests all involve a colour change, and the apparatus is very simple, since the tests are all carried out either in test tubes, on a porcelain tile, or on filter paper previously impregnated with the reagent and dried. The reagents are mainly organic compounds. The author points out that one advantage of organic reagents is the higher molecular weight of the reaction products, which tend to be more visible than those formed with inorganic reagents.

The first part of the book is theoretical. Complex salt formation, which is involved in most of the tests, is discussed in detail. In an account of masked reactions, Dr. Feigl shows how an unspecific reagent may be made specific by the use of different solvents and by the addition of a reagent before the test which gives a complex salt with the interfering ions. An example of this is the thiocyanate test for cobalt in the presence of iron. The test is carried out in acetone solution and an alkali fluoride or syrupy phosphoric acid is added before the test to reduce the ionic iron concentration. In this way 1 γ of cobalt may be detected in a dilution of 1 : 50,000 in the presence of a thousand times the amount of iron. The possibilities of increasing the sensitiveness of a test by varying the conditions and by catalytic reactions are also dealt with.

There is an important chapter on induced reactions as they may be used to improve a test in qualitative analysis. The author gives a large number of examples, one of which is the barium test by sulphate precipitation. When the clear solution of lead sulphate in an acetic acid solution of an alkaline acetate is used as the precipitant for barium salts, not only is barium sulphate precipitated but also a considerable amount of lead sulphate, rendering the test eight times more sensitive, so that as little as 0·4 γ of barium in 1 : 125,000 dilution can be detected.

The chapter which has entailed the most detailed research is written on the organic groupings which react specifically with certain inorganic ions, the nickel specific $\begin{array}{ccc}-\mathrm{C} & - & \mathrm{C}- \\ \| & & \| \\ \mathrm{NOH} & & \mathrm{NOH}\end{array}$ group, the ferrous iron specific $\begin{array}{ccc}=\mathrm{C} & - & \mathrm{C}- \\ | & & \| \\ \mathrm{OH} & & \mathrm{NOH}\end{array}$ group, the $-\mathrm{CO}-\mathrm{CH}_2-\mathrm{CO}-$ group which is specific for thallium in the presence of carbon disulphide, the copper specific $\begin{array}{ccc}>\mathrm{C} & - & \mathrm{C}- \\ | & & \| \\ \mathrm{OH} & & \mathrm{NOH}\end{array}$ group, and the silver specific NH— group. A large number of compounds containing the different groups have been prepared, in order to discover the compounds most suitable to use for the tests.

There is a chapter on the effect of various organic groups on the solubility of the reaction product, and another on capillarity as it applies to spot tests, for the capillary properties of the filter papers are often of importance when two or three elements are to be detected simultaneously.

The practical section consists of a detailed description of the tests for all the inorganic ions. The tests are admirably described, being both complete and clear. The smallest amount of the element recognisable and the limit of dilution are given for each test; where other ions interfere, alternative procedure is given, and the largest amount of the interfering substance that may be present without disturbing the test. Where the reagents are rare, their preparation is described. There is a useful reference table at the end of the book summarising the tests and the reagents used. There are a few coloured illustrations, but as these are not clearly referred to the page and test illustrated, they are not very useful.

The book admirably achieves its object in combining both a book of reference and a practical handbook, and will therefore be valuable to all pure and applied chemists and everyone interested in the development of new methods of analysis.

Short Reviews.

La Grotte d'Isturitz. 1 : *Le Magdalénien de la Salle de Saint-Martin.* Par Dr. René de Saint-Périer. (*Archives de l'Institut de Paléontologie humaine,* Mémoire 7.) Pp. 124+13 planches. (Paris: Masson et Cie, 1930.) 120 francs.

As an archæological site the cave of Isturitz (Bayonne) was brought to the notice of Piette in 1895. Proposals for its exploration came to nothing. It was then being worked by a commercial company for its phosphates; and a series of objects of palæolithic age, which had been found in the course of the work, was given to the Société de Borda of Dax. Attempts were made to put a stop to the exploitation of the cave, but without success. A suit at law was instituted and the case dragged on until 1898, when a verdict was given against the company. Unfortunately, no injunction against further work had been granted while the matter was *sub judice*, and when operations ceased in 1898 the two galleries over which suit had been brought had been completely worked out. Valuable objects known to have been found, including examples of palæolithic carving and sculpture, have disappeared.

The opening of a second entrance to the cave on the death of the second owner, Dr. Langin, enabled systematic excavation to be begun in 1913. This was continued intermittently until 1921; but after that nothing further was undertaken until Dr. de Saint-Périer began operations in 1928. A second large series of related galleries was discovered in 1929. It is estimated that the complete exploration of the cave will take some years. In his desire to submit the evidence to his colleagues and to place the results on record at the earliest possible moment, Dr. de Saint-Périer has published this preliminary account of his excavation to date of the Magdalenian deposits of what he calls the "Salle de Saint Martin".

The conclusion to which the evidence points is that the inhabitants lived on the horse, of which they brought the joints and not the carcases to the cave. The horse is also the subject most frequently represented in their art. The cave was thickly populated, the climate dry and cold. The fauna and the culture alike point to early Magdalenian, the latter showing affinities with Tuc d'Audoubert, Les Trois Frères and Gantier, and corresponding with Lespugues *B*, the Magdalenian IV of the Abbé Breuil.

Archæologists will be grateful to the author for publishing his results with such commendable promptitude, even though his conclusions must be regarded as to a certain extent provisional, pending further excavation. Still more are they indebted to the Institut de Paléontologie humaine for the profusion of illustrations of high quality.

Elektrophorese, Elektroosmose, Elektrodialyse in Flüssigkeiten. Von Dr. P. H. Prausnitz und Dr. J. Reitstötter. (*Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe,* herausgegeben von Dr. Raphael Ed. Liesegang, Band 24.) Pp. xii + 307. (Dresden und Leipzig: Theodor Steinkopff, 1931.) 18·50 gold marks.

THIS is a very valuable book which will be of the greatest service to a wide variety of students and investigators, since it deals in a most comprehensive manner with a range of phenomena of equal interest to the physicist, chemist, and physiologist. To all those who are more particularly interested in colloid chemistry and physics the book will be indispensable.

The book is divided into five chapters: (1) General, (2) electrophoresis, (3) electro-osmosis, (4) electro-analysis, (5) technical applications. Throughout the book, and especially in the last chapter, special attention is paid to the extensive patent literature. This is a feature which will greatly enhance its value for the very large class of readers who are concerned with industrial processes and phenomena.

Although the authors refer the reader to the monograph on "Elektrochemie der Kolloide" (Pauli and Valko, 1929) for a fuller account of the theory of the subject, they give enough in the introduction and general part to enable the reader to understand the basic principles underlying the processes described. This portion of the book contains a description (with diagrams) of the various forms of apparatus employed in laboratory investigations —another very useful feature.

The documentation is extremely thorough and valuable. Thus the book concludes with 47 closely printed pages, embracing bibliography, patent register, author index, and subject index.

The work of Drs. Prausnitz and Reitstötter may be warmly recommended to all serious students of physical and colloid chemistry.

F. G. DONNAN.

The Paradox of the Ludicrous. By Prof. Samuel S. Seward. Pp. vii+145. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1930.) 12*s.* 6*d.* net.

THE real nature of laughter may be described as a standing scientific puzzle. Some of the greatest names in the history of philosophic thought, say from Hobbes to Bergson, are associated with attempts to solve the puzzle. Why do we laugh at the sight of a bishop running after his hat? Is it because we are at heart crowing over another's mishap? Or is it because a dignified person is being taken down several pegs? Or is it merely our reaction to an incongruous situation? Or did

Nature 'invent laughter' at minor misfortunes in order that man's vitality might not be sapped by an excess of sympathy? All these hypotheses, and others, have been tried, but none of them fits all the facts. For the facts are as disparate as laughing because one is metaphorically tickled by a joke, and laughing because one is literally tickled in the ribs.

Now comes Prof. Seward of Stanford University with his extremely interesting and well-written book, in which he says in effect that previous investigators have all been on the wrong tack, that they have all addressed themselves to the wrong question. Instead of seeking, as they have vainly sought, for a common quality in all causes of laughter, they ought to have been marking how the boisterous laughter of childhood leads on gradually to the quiet, mature chuckles at a joke in *Punch*. In other words, if we understand Prof. Seward aright, the evolution of laughter is an 'emergent' evolution. There we must leave the subject, but not without our reiterated appreciation of this excellent monograph. T. R.

Let's Help! a Collection of Good Causes. By Sir Charles Bright. Pp. xv + 198. (London: George Routledge and Sons, Ltd., 1931.) 4*s.* 6*d.* net.

In this volume Sir Charles Bright has brought together interesting information regarding numerous organisations which exist to further various kinds of good work. Among those described are a number of bodies engaged in extending the services of science in various directions, such as the British Science Guild and the National Institute of Industrial Psychology. The former was founded in 1905 by the late Sir Norman Lockyer to bring together all persons throughout the Empire interested in promoting the development and applications of science. The Guild has established numerous committees, such as those on the design and manufacture of microscopes, provision of glass and other laboratory ware, and the synchronisation of clocks. In 1921 it published a "Catalogue of British Scientific and Technical Books", containing 6627 titles, but in the 1930 edition the number of titles has grown to 13,915. Sir Samuel Hoare is president of the Guild and Sir Richard Gregory is chairman of the council of management.

The National Institute of Industrial Psychology, founded in 1921, has undertaken investigations under the direction of Dr. C. S. Myers for more than 180 firms representing nearly sixty different industries. Vocational tests have been devised and successfully applied to the selection of engineers, weavers, packers, chocolate makers, solderers, clerical workers, and many others. Research has also been carried out into problems of daily variations in efficiency, the nature of mechanical ability, and vocational problems of the blind. Numerous investigations have been made into the best methods of work in various occupations, but the error made by the pioneers of 'scientific management' in rigidly standardising movements has been avoided, since it is recognised that each worker, within limits, must develop his own style.

The Japanese Earthquake of 1923. By Dr. Charles Davison. Pp. xii + 127 + 6 plates. (London: Thomas Murby and Co., 1931.) 7*s.* 6*d.* net.

In this small volume Dr. C. Davison gives an intensely interesting account of the great Japanese earthquake of 1923 from two points of view: first, as it affected man and his works, and secondly, from the point of view of geophysics. The Japanese Home Office in 1926 issued a large report on the former aspect, and much of the first part of the book, including some interesting illustrations, is based upon that. The geophysical discussion summarises forty-one scientific memoirs, almost entirely by Japanese writers. Dr. Davison considers that though other earthquakes have been more violent, and some have taken a greater toll of human life, there has probably never been one that was so appalling in the total havoc wrought, largely because of the terrible fires that followed it. "In all probability there will never be another like it, for no city now exists with so many wooden houses as Tokyo contained in the days before the earthquake."

The story of the admirable behaviour of the populace in the midst of the disaster, and of the extraordinarily able and successful efforts of the Government in re-establishing the social organisation, is one of surpassing interest—perhaps the more so in view of the possible parallel man-wrought disasters of fire and explosion, if not of earthquake and tidal waves, that the future may have in store for other great capitals, if the nightmare threat of aerial warfare is not removed by international agreement.

Nuer Customs and Folk-Lore. By Ray Huffman. Published for the International Institute of African Languages and Cultures. Pp. xv + 108 + 8 plates. (London: Oxford University Press, 1931.) 8*s.* 6*d.* net.

Miss Huffman has lived for some years among the Nuer, members of the Nilotic group of tribes who are among the less accessible of the Sudanese peoples. Comparatively little is known about them, as they have a preference for their own ways, and, being slow to appreciate the advantages of European civilisation, have been able to preserve their state of reserve and seclusion. The author's thorough acquaintance with their language has enabled her to get closely into touch with them, and in this brief study she has set down much information which, if it does not give a complete account of their culture, is at any rate for the most part new. It is supplemented by an introduction by Dr. Westermann, giving a brief summary of the main features of their culture, which is dominated by their cattle tending and the periodic flooding of their country. The cult of what is apparently a rain deity holds a position of special significance in their beliefs. A number of folk-tales, in which the Nuer language is rich, is included.

The Evidence of Palæontology with Regard to Evolution.

A DISCUSSION on the extent and value of the contribution which the study of fossils can make to the study of organic evolution took place on Sept. 25 at a meeting of Section C (Geology) of the British Association. Even if it is agreed that palæontology is as incapable of providing a direct proof of evolution as is neontology, it must be admitted that palæontology reveals a whole series of facts which are correlated by that principle but are at present otherwise unexplained. It is generally agreed that the evidence of palæontology supplements that of neontology. Many palæontologists, however, would claim more than this for their subject; Prof. H. L. Hawkins emphasised that palæontologists see the problems of evolution in three dimensions, perhaps rather dimly, but claimed that a more satisfactory impression can be obtained in that way than from a sharper picture in one plane only, such as is ordinarily available for the student of living forms.

It is unfortunately true that in some respects the evidence which palæontology is able to contribute is scanty. Especially is this true in regard to the evolution of man, where fossil evidence does little more than supplement the evidence derived from the study of living Primates. Thus Sir Arthur Keith believes that from the fossil evidence alone we cannot construct man's genealogical history. The geological information is nevertheless important; "it permits us to verify and amplify the theory of man's evolution, which has been constructed from the evidence of anatomy, physiology, and embryology", but it is manifest that much more information is needed before our knowledge of man's origin rests upon a sound basis of ascertained facts. This incompleteness of the known fossil record of human evolution is emphasised by the different interpretations of the details of man's genealogy put forward by such authorities as Sir Arthur Keith and Prof. H. Fairfield Osborn.

In other groups of animals, however, and especially in those groups of mammals which have been investigated in such magnificent detail by Prof. Osborn, more complete series of fossils have been available, and the phylogenies of many families are reasonably clear. In such groups as the horses and the Titanotheres, the fossil record is at any rate sufficiently complete to warrant the assertion that the general lines of their evolution are moderately well known and can be demonstrated from fossil evidence.

In the case of the invertebrates also, the evidence of palæontology is of considerable weight, although the material available for study has certain obvious limitations, since the skeletons of the invertebrates are usually less closely related to the vital parts of the organism than is the skeleton of a vertebrate. Several of the speakers in this discussion claimed that, in spite of these disadvantages, invertebrate remains do afford valuable material for the study of evolutionary problems. The great numbers of specimens which are available for investigation make it possible to find series of specimens showing progressive changes in definite directions. The more abundant the specimens, the more completely may the seriation be demonstrated. In this way the palæontologist has been able to indicate certain series of invertebrate fossils which, in some cases, may accord closely to lineages or lines of evolution. The number of well-established lines among invertebrates (such as those of *Zaphrentis delanouei* and of the Chalk *Micrasters*) is admittedly small, for it is becoming increasingly clear that many so-called lineages are only approximations to lines of evolution, but there is abundant evidence of progressive changes by almost imperceptible gradations.

Many students of invertebrate fossils have paid great attention to the development of the skeleton during the life history of the individual. Certain invertebrates preserve in their skeletons a record of the changes in the skeleton during growth, for whereas the skeleton of a vertebrate is progressively modified during growth, the shells of many adult molluscs and the hard parts of many corals preserve unchanged the skeletons of the young individuals.

In the course of this discussion, several palæontologists (including Dr. F. A. Bather, Dr. W. D. Lang, Prof. H. H. Swinnerton, and the writer) emphasised the value of these ontogenetic characters in determining relationships—a value which has been recognised by palæontologists for many years. It was admitted that a more important criterion in establishing phylogenies is the recognition of transitional forms in a correct geological order, and that few palæontologists would propose to use ontogenetic evidence alone for constructing lineages. It was suggested, however, that, used with caution, ontogenetic evidence is of great value as a criterion of relationship. Dr. Lang maintained that some of the objections which have recently been urged against the recapitulation hypothesis are due to a failure to understand the views of palæontologists. He pointed out that not all the features seen in a developing organism (or preserved in the early part of its skeleton) are regarded by palæontologists as recapitulating adult characters; further, it is not an earlier adult *stage* which is normally represented in ontogeny, but rather certain individual *characters* possessed by an earlier adult.

Prof. Swinnerton emphasised the further importance of ontogenetic studies in relation to the behaviour of unit characters in development. He claimed that palæontology has important contributions to make to many of the problems which have been the concern of the geneticists. He pointed out that while palæontologists have studied more particularly those complex groups of characters which are represented in fossils by single structures (while the geneticist is concerned chiefly with unit characters), they have meanwhile accumulated much illuminating information relating to problems of inheritance. He suggested, moreover, that geneticists may too often have neglected the behaviour of those characters during development.

It may be remarked that Prof. D. M. S. Watson expressed grave doubts concerning the validity of the arguments used by some of the palæontologists who took part in the discussion. He especially deplored the use of ontogenetic evidence alone in the establishment of supposed phylogenies. He also criticised severely some current interpretations of the analyses of statistics relating to variability among invertebrate fossils, to which reference had been made.

In short, palæontologists are agreed as to the general extent and importance of the contributions of their subject to the solution of evolutionary problems; it is as regards the interpretation of the details of the evidence that there is much difference of opinion. A. E. Trueman.

The Gene and the Theory of Living Structures.

Dr. C. B. Bridges, whose name is associated with those of Morgan and Sturtevant in the now classical studies on the cytogenetics of *Drosophila*, and who recently went to Russia for a stay of some months, gave an address before the Genetical Society on Oct. 19, on the subject of "The Gene and the Theory of Living Structures".

Dr. Bridges led up to the question of the gene by a general discussion of scientific method. His general method of approach is an analysis from two aspects, that of structure and that of behaviour. This analysis is made at successively deeper levels, each simplification of the unit reducing complexity of structure; or, looking at it the other way, each change from a lower to a higher unit offering new possibilities of complexity not necessarily predictable at the lower level. Thus a crystal of sugar is successively analysable into sugar molecules, atoms arranged in a definite space-lattice, electrons, etc., composing the respective atoms. Reversing the process, the electrons must have preceded the atoms, the atoms the molecules, thus giving rise to evolution by progressive stages of aggregation, each stage presenting a fresh type of complexity. This might be called a form of the doctrine of emergent evolution; only the emergence is as true in the case of non-living as of living things. Of course, there is some disintegration as well as integration, but there is no reason to suppose that the process of integration is at an end, that the clock is running down; indeed, one might suppose that the time clock will only stop when it is wound up as tight as it will go.

At each stage of emergence, then, new characters arise which are not simply related to the properties of the components. Further, all these existences are affected by external conditions. The sciences describing matter and its properties may approach from the point of view of structure, like chemistry; or of behaviour, like physics: thus forming, as it were, a warp and weft of knowledge. Any simplification in the expression of structure calls for a corresponding complication in the expression of behaviour, and conversely.

The particular aspect of this evolutionary process which is presented to us depends on our local time and space. We have traditionally our three 'kingdoms'—animal, vegetable, and mineral; they might easily be two only, biontic and abiontic; and at some stage there must have been one only, the abiontic. Life exists only at certain levels of evolution and has no meaning outside these, just as temperature has no meaning below the molecular horizon, as it is a symbol of molecular activity.

What, then, is the essential property of living organisms? It lies in the manner of their reproduction, which is always continuous in time and space with an existing organism, and always autocatalytic in form. The process characteristic of living organisms is increase in spatial boundaries followed by splitting, either of the whole unicellular organism or, in higher plants and animals, of 'delegated' cells. It is clear that the machinery which brings about this type of multiplication must be as simple as a single cell. The significance of the nucleus in heredity is shown by the fact that the paternal influence equals the maternal in animals, where the sperm consists almost entirely of nuclear material, scarcely any cytoplasm being carried over into the new zygote. Taking the analysis a stage further, we find the nucleus formed from smaller bodies, the chromosomes, and the chromosomes in turn composed of still smaller particles, the genes. The genes correspond to the hypothetical units used by Mendel in his classical researches.

Now, when in the genetic investigation of *Drosophila* about twenty pairs of characters had been found, the fly having four pairs of chromosomes, it became clear that some of the chromosomes must carry more than one pair of factors. From this was developed the theory of the linear order of the factors and the conception of the gene as a particle having a definite place on the chromosome thread. The theory was confirmed by the discovery of non-disjunctions and of translocation: the genes in the translocated portion, said Dr. Bridges, have moved into a new street and have a new street number.

The actual size of a gene is probably of the order of 2.7×10^{-6} cm., smaller than any observed chromosomal structure. Probably each gene forms the central core to a body consisting of a skin and a core with chromonemal sap between. When the chromonema, which lies coiled in the chromosome like a spring in a tube, is uncoiled from its spiral it may be seen as a tangled skein bearing little knots; so if we cannot see the genes, we can see, as Dr. Bridges said, the tiny houses they live in. From Muller's X-ray work, which shows that a gene affected by irradiation is turned over at one stroke, the structure of the gene would seem to be simple and not compound.

What is the physical rank of the gene? It cannot be below a molecule, and must be built up from the molecules available in the nutrient sap surrounding it. It may possibly be a molecule of a new and unexpected type.

As regards the process which gives rise to two genes in place of one, two theories are mechanically possible. Either the daughter gene may be built up by the side of the old one, at a catalytic surface, with a point by point correspondence, or the original gene may become doubled and then split. The first would lend itself to a sort of 'zip-fastener' pattern with linear sub-units, as postulated by Serebrovsky. In Dr. Bridges' view, however, the phenomena described by Serebrovsky can be satisfactorily explained on lines of developmental mechanics without the postulate of linear sub-units of the gene. The gene might be a structure shaped like a pancake, having a single layer of molecules built into a definite pattern. A difficulty in the way of assuming that the daughter gene is formed at the surface of a vesicle as repetitions of unitary patches is the fact that genes mutate suddenly as if acting as simple units.

It is probable that the structure of all genes will be found to be of one type. This follows from increasing simplicity with descent in the scale of units. There is far less difference between chromosomes than between organisms, and hence probably far less difference between genes than between chromosomes. H. S.

New Game Reserves in South Africa.

By Prof. H. B. FANTHAM.

THE conservation of the natural fauna of a country is a matter of considerable importance. With the advance of agriculture and industrial development, the animals of South Africa, as in other parts of the world, have been in danger of extinction. In fact, within the last hundred years, six of its unique species, the bloubok, quagga, Namaqualand giraffe, Orange River buffalo, black-maned Cape lion, and the red hartebeest, have become extinct in the Cape Province, and many other species are in danger of extinction. The blesbok, bontebok, and white-tailed gnu only occur on private lands and have been preserved through the efforts of a few individuals.

The South African Government has not been unmindful of the interest and value of its fauna, and a number of large and important game reserves have been established, of which the Kruger National Park in the Transvaal of 5,000,000 acres (more than 7000 square miles) in extent, and the Umfolosi Reserve in Zululand—the home of the fast disappearing white rhinoceros—are perhaps the best known. Recently, on July 3, the Government of the Union of South Africa proclaimed three new game reserves, the constitution of which had been approved by Parliament on May 8.

The largest of these new reserves is termed the Kalahari Gemsbok National Park, in the Division of Gordonia, some distance north of Upington. This Kalahari reserve is about 1,800,000 acres (some 3000 square miles) in extent. It is an arid area, situated in the Kalahari thorn country between the Oup (Aub) and Nosop (Nossob) Rivers. The elevation is 2000-4000 ft. The vegetation consists mainly of thorn bush (species of *Acacia*), thorn-trees such as the cameeldoorn (*Acacia giraffæ*), which is the most characteristic tree of the region, and sparsely spaced tufts of desert grasses. The rivers are frequently dry sandy beds, which flow after rain, but water can always be obtained by sinking shallow wells. This reserve shelters a number of vertebrates, which feed on succulents and xerophytic vegetation, on which they thrive. These include the graceful and handsome gemsbok (*Oryx gazella gazella*), the red hartebeest, the blue wildebeest, and the springbok. The gemsbok was formerly widely distributed in southern Africa, but now has become relatively rare and even extinct in many parts of the country. They flourish in the Kalahari wastes, where they roam in herds and feed on succulent roots and underground stems dug out by their hoofs. Under protection in the new reserve they should increase in numbers. In addition to the antelopes mentioned, the kudu occurs in the reserve, klipspringer are said to be present, and wild ostrich are known.

The second reserve is the Addo Elephants National Park in the Divisions of Alexandria and Uitenhage, Eastern Cape Province. It comprises an area of more than 11,000 acres, well covered with dense scrub and bush. Portions of the Union Forest Reserve and of a number of farms have been combined to form this game reserve, where the now small herd of the southern geographical race or subspecies of the African elephant can live and propagate. Abundance of *Acacia*, succulent *Portulacaria*, aloes, and other succulents provide ample food. A few years ago the Government was obliged to reduce the herd greatly, as they invaded neighbouring farms and did considerable damage. The presence of good watering places in the new reserve, it is hoped, will prevent further damage to cultivated lands by these interesting small elephants. Cape buffalo, which were almost exterminated by rinderpest, still survive in the Addo reserve, and kudu and bushbuck occur in herds. A similar race of elephants occurs in the Knysna reserve, comprising the finest indigenous forests in the Union, and in both the Knysna and the Addo wild pig are abundant, accompanying the elephants and feeding on their droppings, thus aiding in the dispersal of the seeds of trees.

The third reserve is styled the Bontebok National Park. It is situated in the Division of Bredasdorp in the south-western Cape Province. It is a small reserve, some 1700 acres in extent, and will be a sanctuary for the rarest of the South African antelopes, the bontebok (*Damaliscus pygargus*). For many years this small but most beautiful and richly coloured antelope has been confined to a few farms in this area and has been preserved through the efforts of a few individuals. Formerly it was widely distributed along the coastal strip, and without the active interests of the animal lovers already mentioned it would, without doubt, have become extinct. It is highly important that the bontebok, the only indigenous large mammal of the south-west Cape, should be given a permanent refuge.

From my friend, Dr. E. Warren, Director of the Natal Museum, I learn that the mountain zebra at Cradock are still not adequately protected. These animals are more beautiful than Burchell's zebra, and have adapted themselves to mountain life and bleak stony wastes. It has been suggested by Sir Lionel Phillips that they should be established in a reserve at Bain's Kloof, and, for the sake of posterity, it is to be hoped that a mountain zebra reserve will be proclaimed in the near future.

News and Views.

AMONG the many members of the Society of Jesus who have added to scientific knowledge, few were better known than the seventeenth century natural philosopher Franceso Terzi de Lana, the tercentenary of whose birth falls on Dec. 13. Like his friend and contemporary, Father Kircher, Lana published various works among which was his now very rare book, "Prodromo, overo Saggio di alcune Inventioni . . ." of 1670. In this, he described a series of useful discoveries and it has been called the first book of the science of aeronautics. To raise oneself in the air he suggested the use of four thin metal spheres exhausted of air and attached to a car. The experiment was never made, but Lana's ideas foreshadowed the balloon and airship. His other work of note was his "Magisterium Naturæ et Artis . . .", in which he intended to cover the entire field of the natural sciences; only three of the intended nine volumes were issued, but these have been referred to as "a veritable cyclopædia of all sciences connected with natural philosophy". Born at Brescia, Lana entered the Society of Jesus in 1647, studied at the Roman College and afterwards taught at Terni, Ferrara, and elsewhere. When his health began to decline, he returned to his native city and died there on Feb. 22, 1687.

ON Wednesday, Dec. 2, in the University Museum, Oxford, Prof. E. Freundlich, director of the Astrophysical Observatory at Potsdam, delivered a lecture on the results of the Potsdam Solar Eclipse Expedition to Sumatra in May 1929, to determine the deflexion of light in the sun's gravitational field and to examine its variation with distance from the sun. Dr. Freundlich dealt solely with the results obtained from the series of plates exposed in one of the two telescopes which were employed at Sumatra. Four of these plates were exposed on the star field immediately surrounding the sun and the remaining three on a star field at a distance of 25° from the sun. Exposures on the same star fields were also made at the same place some months later and at night. In order to obtain the highest possible accuracy it was not advisable to measure the distance apart of two star images on the eclipse plate and compare it directly with the corresponding distance on the night plate. Plates exposed so as to obtain laterally inverted images of the star fields were adopted as intermediate standards of comparison.

PROF. FREUNDLICH showed that after corrections for aberration and refraction had been made, the star image displacements could be expressed as the sum of two terms, one, the scale effect term due to small variations in focal length of the observing telescope, and the other due to the actual light deflexion. The change in focal length is primarily a temperature effect. It manifests itself in the same way as the light deflexion, that is, it gives rise to a dilatation, which, however, increases with increasing distance from the sun, whereas the light deflexion effect decreases. Unfortunately, the weight of the coefficient of the scale effect term is approximately two hundred times greater than that of the light deflexion term, but by superimposing on each plate the image of a specially prepared ' reseau ' placed at the focus of a collimating lens, Prof. Freundlich and his collaborators were able to differentiate between the two terms and obtained the value $2{\cdot}24'' \pm 0{\cdot}20''$, instead of the value $1{\cdot}75''$ as predicted by theory for the deflexion of a beam of light in the sun's gravitational field. A recalculation of the results of the Lick expedition paying particular attention to the influence of the scale effect term yielded a value of $2{\cdot}2''$. A revision of the field equations of the theory of relativity would appear to be of the highest importance.

DURING the last few weeks, much interest has been aroused by the discovery of fossilised remains of the mammoth (*Elephas primigenius*) near Nottingham. Similar remains have been found, from time to time since the middle of last century, at other places in the vicinity of the city. Unfortunately, nearly all of these have been lost or destroyed. Even so recently as three years ago, a complete skull was found and promptly destroyed by the workmen, and only a small fragment of one of the tusks was rescued. It is hoped that the publicity given by the newspapers to the present find will result in a more enlightened treatment of such remains in future. The Trent Gravel Company's workings are in a patch of the older river gravels, situated half a mile away from the river Trent at Attenborough. These gravels were deposited after the last erosional phase of the river and now underlie its present flood plain. The remains which were recently found consist of one tusk five feet long, a third upper and a corresponding lower molar. They were found twenty feet below the surface, in the bottom layers of gravel. One molar was much worn by rolling, and must therefore have been derived from older deposits. The condition of preservation of the other, and the fact that it had not been rolled, show that it was contemporary with the gravel in which it was embedded. It thus furnishes additional testimony in favour of the view that the mammoth survived into post-glacial times in Great Britain.

A remarkable group of meteorite craters near Henbury in Central Australia was explored in May 1931 by Mr. A. R. Alderman, of the University of Adelaide, and his account of them was given before the Mineralogical Society on Nov. 3 (see Nature of Dec. 5, p. 977). Later, in June of this year, a second expedition to the locality was undertaken by Mr. R. Bedford, of the Kyancutta Museum at Kyancutta, South Australia, who travelled about 3000 miles by motor truck. Numerous masses of meteoric iron, weighing from a fraction of an ounce up to 170½ lb., have been found scattered around the thirteen craters, and 1350 pieces were collected by the two parties. A selection of the 542 complete masses of the iron, together with his sketches and photographs of the craters, recently sent by Mr. Bedford to the British Museum, are now on view in the meteorite pavilion of the Natural History Museum at South Kensington, as a temporary loan exhibit from the Kyancutta Museum. In the report in Nature of Mr. Alderman's paper, the last sentence should read: These craters, which are very similar to the famous Meteor Crater in Arizona, though much smaller, were evidently formed by the impact of a shower of meteorites at some remote period.

At the meeting of the International Seismological Association in Stockholm in 1930 a committee under the chairmanship of Commander Heck of the United States Coast and Geodetic Survey was appointed to consider what modifications are desirable in the code used for seismological telegrams or broadcast messages. It is now announced that a provisional code has been adopted and will be brought into use as from Jan. 1, 1932. The code will be submitted to the Association for approval or modification at the meeting which is to be held at Lisbon in 1933. The principal departure from the code in use hitherto is that provision is made for reporting phases other than P and S. Originally the letters P and S signified merely the first and second conspicuous disturbance in an earthquake record, but more precise meanings are given nowadays. For example, if a station is about 110° from the epicentre, the first phase on the record may be PR_1, a longitudinal wave reflected at the surface, whilst the next clearly defined phase may be S_cP_cS, a wave which is initially and finally transversal, but longitudinal in the central liquid core of the earth. With the new code the times of these or other pairs of phases can be reported. The other new feature of the code is the inclusion of check groups. The check figures are obtained by adding figures of the significant groups according to specified rules. When the figures tally, the recipient may be certain that he has a correct message, and experience with similar check groups in meteorological broadcasts shows that when figures do not tally the recipient has a reasonable chance of discovering what error has been made. Copies of the code may be obtained by application to M. E. Rothé, director of the International Seismological Bureau, 38 Boulevard d'Anvers, Strasbourg.

On Nov. 30 an interesting experiment in electric traction was carried out on the Great Southern Railways Company's line from Dublin to Bray, when a special train driven by current supplied from Drumm storage batteries was successfully tried. The train was 135 ft. long and weighed 75 tons, and an average speed of thirty miles an hour was maintained. The battery, which is the invention of Dr. J. J. Drumm, of Dublin, is of a new design, its special feature being that it is capable of supplying a heavy discharge during periods of acceleration, and of being rapidly charged to its full capacity. Though full particulars of the battery have not yet been published, information regarding it was issued by a department of the Irish Free State Government during preliminary tests made about a year ago. The positive plates of the cells are of nickel and graphite, but the negative plates appear to be of nickel gauze. The containers are of monel metal and the electrolyte is stated to be mainly a solution of caustic potash in distilled water. A party of experts, with Mr. P. J. McGilligan, Irish Free State Minister for Industry and Commerce, travelled in the train on Nov. 30, and all expressed their satisfaction with the results of the trial. It is hoped that by the use of the Drumm battery it will be possible to electrify the Irish Free State railways at a comparatively small cost. An account of the preliminary tests was published in *Engineering* for Sept. 5, 1930.

A new departure has been made at the Science Museum, which is visited by many thousands of children annually, by providing a gallery specially planned to be attractive and interesting to them. The descriptive labels of objects in the main galleries are for the most part scarcely within their grasp, and consequently their interest in the objects is not aroused. In the new Children's Gallery, which will be opened to the public on Dec. 12, illuminated perspective scenes are freely used, and these are supplemented by working models. One series of exhibits illustrates the development from man-transport through various types to the mechanical transport of to-day; another shows how primitive forms of lighting have been successively replaced by more efficient methods. Three of the earliest of human crafts, the flint tool-maker, the potter, and the smith, are represented, and films of each at his work will be shown. With each exhibit is a reference to the Museum Gallery in which similar objects are to be seen. Time measurement, the making of a pot, and a model aeroplane in a wind channel are also included in the exhibits; illuminated transparencies show astronomers at work; alchemists and modern chemists' shops are compared; and the development of the aeroplane is sketched.

The United States Patent Office has issued the specification of the first plant patent to be granted under the new provisions which were added to the patent law last year. The revised statute states that a patent may be granted to " any person who has invented or discovered and asexually reproduced any distinct and new variety of plant other than a tuber-propagated plant ", and that the patent shall grant to the inventor " the exclusive right to asexually reproduce the plant ". The law applies, therefore, only to the production of new varieties by grafting, budding, etc., and not by seeds. The patentability in any particular case will be determined according to the ordinary principles of patent law, but it is clear that a new plant must have characteristics which clearly distinguish it from known varieties, whether those characteristics relate to colour, immunity from disease, flavour, perfume, resistance to cold or heat, storage qualities, and so on. The specification of Plant Patent No. 1 granted on Aug. 18, 1931, is for the climbing rose 'New Dawn', which is stated to be distinguished from the 'Dr. Van Fleet' by its ever-blooming habit, and when grown in the latitude of New Brunswick, N.J., to provide "a succession of blossoms on a single plant from about the end of May to the middle of November or until stopped by frost".

IN connexion with the project, fostered by the Canadian Government, for establishing a regular steamship service during the summer navigation season between Churchill, the new port on the western coast of Hudson Bay, and Europe, which was described in an article in NATURE for July 11, p. 53, it is of interest to record that test shipments of grain, amounting to 545,000 bushels, were loaded and cleared from the port on Sept. 18 and 22. No further transport movement has been attempted this year, but it is hoped to bring the port into regular operation in 1932. The point of crucial importance is the duration of the navigable season in the Strait and Bay. In the report of Capt. N. B. McLean, quoted in the article above referred to, the period of free navigational movement was given as about four months, between the dates of July 19 and Nov. 16. This tentative conclusion was based on observations made on the formation and prevalence of ice during the seasons of 1927 and 1928. A report is now to hand on the "Navigable Conditions in Hudson Bay and Strait during the 1930 Navigation Season", from which it appears that the Strait had become fairly clear of ice by the last week in July, though there was "heavy, close-packed ice" at Burwell on July 25-26. At Nottingham Island Direction Finding Station, no ice of consequence was observed after July 24. Churchill harbour was free from ice so early as June 11, and ice was apparently not again formed until Oct. 19. The first ice which might affect navigation on the Hudson Bay route was reported on Oct. 16 by the Nottingham Island Station, and on Nov. 4 at the same station there was "heavy, close-packed ice as far as could be seen". As regards fog, between Aug. 2 and Oct. 31 there were about seventy hours' dense fog and from 20 to 50 hours' light fog, according to locality.

FURTHER news is to hand of the investigation of the Oldoway bone beds by the East African Archæological Expedition which, under the leadership of Dr. L. S. B. Leakey, has accompanied Dr. Hans Reck to the site on which the latter discovered the Oldoway skeleton in 1913. According to a dispatch from Nairobi in the *Times* of Dec. 3, stone tools have now been discovered in all five of the bone beds. It will be remembered that when Dr. Leakey and Dr. Reck addressed to NATURE the joint letter which appeared in the issue of Oct. 24, p. 724, Bed No. 2, to which it had been determined that the skeleton belonged, had yielded only two flakes showing bulbs of percussion, while the overlying beds 3 and 4 had yielded unrolled coups-de-poing typical of late Kenya Chellean and Acheulean. It would now appear that in Bed No. 2 early Chellean implements have been found in the lower layers and advanced Chellean at the top, while Beds 1 to 4 provide a complete sequence from pre-Chellean to advanced Acheulean. It is also stated that part of an articulated skeleton of a deinotherium, usually regarded as of miocene age, was discovered in a bed associated with pre-Chellean implements in conditions which preclude the possibility that it is derivative. Confirmation and fuller details must be awaited; but it does not necessarily follow that an extremely high antiquity must be attributed to the artefacts. Although Prof. J. W. Gregory has assigned certain beds which he correlated with Kumasian deposits to the Miocene, this classification is not accepted in Dr. Leakey's recent book. The members of the Expedition are inclined to regard the Oldoway beds as of lower and middle pleistocene age. In any event, a much higher antiquity is attributed to *Homo sapiens* than has previously been accepted. Dr. E. J. Wayland's letter on p. 1003 of this issue should also be read in this connexion.

IN the American journal *Engineering and Contracting* for September 1931 is a reprint of an interesting article by Col. T. T. P. Luguer, of the Corps of Engineers Reserve, on Mason and Dixon's Line, which was first published in the *Military Engineer*. Charles Mason, who was born in 1730 and died in 1787 and was assistant to Bradley and to Maskelyne, was engaged with Jeremiah Dixon in 1763 to settle the boundary controversy between Pennsylvania and Maryland, which had raged with exceeding bitterness for a century. Col. Luguer gives a sketch of the history of the boundary dispute, which involved among other things a lawsuit in the Court of Chancery lasting fifteen years, and describes the methods used by Mason and Dixon, and the fixing of the boundary marks. There were many difficulties and dangers to be overcome, and on Oct. 9, 1767, having proceeded a little more than 230 miles from the northeast corner of Maryland, the Indians refused to permit the line to be run farther. The accuracy of the work was good, considering the apparatus used, and at the last survey, about twenty-five years ago, the maximum deviation from the true parallel was found to be about 1000 ft., and that for the greater part of the distance the errors were very small. A special report on the resurvey of the Maryland-Pennsylvania Boundary was published by the State of Pennsylvania in 1909.

AT the Crystal Palace Show in the third week of November the most interesting section was that of the fur-bearing mammals, of which were exhibited not only the usual variety of rabbits, but also choice colour varieties (silver and 'cross') of the common fox, the form of the Arctic fox which remains coloured in winter, musk-rats, coypus, polecat-coloured ferrets—dignified by the title of 'fitch'—and in particular, specimens of the mink, an animal not at all common in zoological collections, and of particular interest as being intermediate in form and habits between the otters and the terrestrial weasels. The show of poultry was not so interesting as that of the Poultry Congress at the Crystal Palace last summer, because there was the usual limitation of species—no guinea-fowls, whereof the Congress exhibited several species and hybrids, and only one specimen of the swan-goose (*Cygnopsis cygnoides*), commonly known in England as the Chinese goose. It is, however, the domestic goose of eastern Asia generally, being found in its least specialised form in India, and in China showing several breeds as distinct as those of the western greylag ; at the Congress most of these could be compared. The wild race of the swan-goose appears never to have been imported, and is little known.

IN the North Mammal House at the London Zoological Gardens can now be seen no less than three species of tree-kangaroos (*Dendrolagus*) from New Guinea, specimens of *D. matschiei*, which was only described for the first time in 1907, having recently been received. This is the brightest coloured of all kangaroos, having a body of rich bay, while the extremities are buff. A young one, about six months old and mostly independent of the pouch, is as bright as its mother. This species is rather small as kangaroos go, and so is the black tree-kangaroo, *D. ursinus*, which is strikingly quadrupedal in its movements and looks rather like a huge clumsy marten. The third species, the grizzled grey tree-kangaroo (*D. inustus*), is, however, a hopping biped like the ground-kangaroos and looks far more like them, though with small ears and a decidedly sheepish-looking head ; this is small in proportion to the body, which is of good ordinary kangaroo size. This species shows very plainly that the tree-kangaroos really display no approach to the phalangers, that approach being made by the little rat-like musk-kangaroo (*Hypsiprymnodon*) which has not yet been exhibited in England.

AT a meeting of the Section of the History of Medicine of the Royal Society of Medicine on Dec. 2, Dr. J. D. Rolleston disposed of a legend current in the medical profession and elsewhere concerning Sir Benjamin Ward Richardson, F.R.S., who died in 1896, when a sympathetic obituary notice appeared in NATURE for Nov. 26, 1896, p. 80. Although Richardson's work and even name are unknown to a large proportion of the present generation, his memory, according to Dr. Rolleston, is still kept alive by those interested in the alcohol problem, in the scientific investigation of which he was a pioneer, as shown by his paper read before the British Association in 1866; the establishment of model abattoirs, for the provision of which he founded a society ; and the biographies of medical men and natural philosophers which he published in the *Asclepiad*. The legend in question was that Richardson, with the fanatical zeal of a teetotaller, poured down the sink the contents of a priceless wine cellar, which had been left him by Sir Walter Trevelyan in 1879 "to be applied for scientific purposes". Richardson was much embarrassed by the gift, although he had numerous suggestions as to its disposal. Finally nothing was done, and the bottles and their contents, one of which was exhibited by Dr. Rolleston, remained in possession of Richardson's family. Last July, a large consignment was sent to the late Prof. W. E. Dixon at the Pharmacological Laboratory at Cambridge, where it still remains, Dixon's death having taken place before he was able to examine it.

THREE years ago a series of tests on street lighting was organised at Sheffield by the Department of Scientific and Industrial Research. The tests were carried out by a group of independent observers, and ten different street-lighting installations were examined. The analysis of the results indicates that there was a tendency to assess the degree of 'glare' by the amount of discomfort experienced rather than by the reduction of visual sensitivity. A further series of tests was carried out a year ago at Leicester. The results have just been published by the Department in Illumination Research, Paper No. 13 (London: H.M. Stationery Office). In this test a series of eight street-lighting installations was arranged in Leicester, and the observers had to assess, without using any apparatus, the relative advantages and disadvantages of the various systems of lighting. Particular attention was paid to general visibility, attractiveness, and glare. The results show that the order in which the eight installations were placed by various observers was identical so far as regards estimates of the visibility of objects on the roadway, the reduction of ocular sensitivity, and discomfort from glare are concerned. The agreement arrived at, however, was not in accordance with the results obtained by computing the ocular sensitivity by laboratory experiments. Apparently, in estimating glare in street lighting, observers are influenced mainly by the sensation of discomfort experienced. Most of the observers thought that the most attractive installation consisted simply of large diffusing bowls. It has to be kept in mind that the observations were made by pedestrians. It is possible that the driver of a fast-moving motor-car might come to other conclusions, as he is liable to be affected by considerations which do not apply to pedestrians.

THE annual general meeting of the Association for the Promotion of Co-operation between Scientific and Technical Societies and Institutions within the British Empire was held at Burlington House, London, on Dec. 1. The report, which was adopted, referred to the appeal for a central building in London issued in February of this year to the members of the constituent societies and institutions, in which it was stated that options had been secured for a limited period on a site near Westminster Abbey, and that an estimated sum of £350,000 would be required to defray the cost of the complete building, including the purchase of leases, etc. It was further mentioned that to complete the purchase of the leases it would be necessary to secure £100,000 in cash by June 24, 1931, when the options on the site would expire. A considerable response to the appeal was received, but the sum available by June 24, however, fell considerably short of the amount required in cash, and the Council of Management decided to allow the options on the leases to lapse. The acute financial and industrial conditions prevailing during this year, culminating in the recent crisis, have rendered it necessary for the Council to postpone a public appeal until national conditions have improved. Though regretting the consequent delay in proceeding with the central building scheme, the Council will not relax its efforts to bring the scheme to fruition at the earliest possible moment.

The British Engineering Standards Association has now been reorganised to permit of it dealing with standardisation questions in the chemical, engineering, building, and textile industries, these groups or divisions of industry being controlled by representative divisional councils of equal standing. A supplemental Royal Charter has been granted to the Association authorising this reorganisation and changing the title to the "British Standards Institution". The Institution is governed by a Grand Council on which the above divisions of industry have equal representation. This latest development in the standardising movement, which has grown enormously since the first committee was set up by the Institution of Civil Engineers in 1901 as the "Engineering Standards Committee", is a clear indication that industry as a whole has increasingly recognised the economic value of the work, and for the first time the chemical and allied industries are now possessors of the proper machinery for setting up national standards for chemical materials, plant, and apparatus, and for methods of analysis and testing. The British Standards Institution is an entirely independent body, in the closest touch with industrial requirements and modern technical knowledge, and with full government support but free from government control. It exists to assist industry by preparing British standard specifications based on what is best in present practice, and do not attempt to attain an ideal which might be too costly to adopt.

We have received a short communication from Mr. Alfred Rosewood, of San Francisco, on "Disasters at the Moon's Third Quarter". He refers, among recent earthquakes, to those of Tuscany on Sept. 4, Solomon Island on Oct. 4, and Japan on Nov. 2, all occurring within about a day of the moon's third quarter; and, among other disasters, to the fall of the Quebec Bridge on Aug. 29, 1907, and the failure of the St. Francis dam during the night of March 12-13, 1928, both within the same interval of third quarter. The coincidences, at first sight, are striking, but if we extend the survey over a longer period the relation vanishes. For example, of fifty-eight of the most destructive earthquakes of the present century, three (April 14, 1906, on Formosa, Nov. 10, 1922, at Copiapo, and Sept. 2, 1923, in Japan) occurred on the day before the third quarter, and two (March 17, 1906, in Formosa, and April 14, 1928, in Bulgaria) the day after. If we take two days before and after, the number is increased by three. Thus, destructive earthquakes are not more frequent about the time of the moon's third quarter than at other parts of its period.

The Registrar-General's Statistical Review, 1930; Tables, Part ii, Civil, has been issued (H.M. Stationery Office. Price 2*s*.). The chief subjects of its statistics are population, births, marriages and divorces, registers of electors, and populations of British Dominions. The marriages in England and Wales during 1930 numbered 315,109, a few less than the previous year, equal to a rate of 15·8 persons married per 1000 population. This rate is the highest recorded since 1921, notwithstanding the present economic depression, and it is of interest that 22 males and 699 females married at the age of sixteen years, the lowest legal age at which marriages may be solemnised. The births registered numbered 648,811, an increase over the previous year of 5138, though the rate remained the same (16·3 per 1000 population). This increase is probably accounted for by the high marriage rates of the last two years. The proportion of the sexes in the births registered was 1044 males to 1000 females.

The small-scale maps of the Ordnance Survey was the subject of a paper to the Royal Geographical Society by Brigadier H. S. L. Winterbotham on Nov. 9, in which he referred to various innovations and improvements in recent editions. The new relief edition of the 'one-inch' is well under way, and the Plymouth sheet has already been published. A new 'half-inch' map is also in progress which will have hill shading and contours. The 'ten-inch' map, which, among other claims to value, is an excellent map for the main roads, is shortly to be put on sale in one sheet, mounted on both sides so as to facilitate easy reference by the motorist. Other innovations which the Ordnance Survey is introducing include diagrams of large towns bound up with the relevant quarter-inch sheets, and attempts to label the main roads so that the passage from one sheet to another shall be simplified and entail no searching.

A scheme whereby the activities of immigrant insects may be more closely recorded has recently been formulated by the Hastings and St. Leonards Natural History Society. It is hoped to obtain detailed information concerning the influence of weather conditions on the route of flight, periodicity of migrations, the sex condition of the migrants, etc. A standard card for recording information has been prepared, and, at the beginning, only the commoner and more conspicuous migrants will be recorded. A number of the printed cards will be sent to anyone who wishes to co-operate in the work on application being made to Dr. Norman Ticehurst, 24 Pevensey Road, St. Leonards, Sussex. Specimens for dissection should be sent to Dr. C. B. Williams, The University, 10 George Square, Edinburgh.

The Christmas Lectures at the Royal Institution will be delivered by Sir William Bragg on "The Universe of Light", beginning on Dec. 29.

AT the conclusion of his leave of absence from England, Dr. B. A. Keen has resumed his duties as assistant director of the Rothamsted Experimental Station. For the past twelve months he has been director of the Imperial Institute of Agricultural Research, Pusa, India. His scheme of reorganisation of agricultural research has been accepted, and certain portions of it are being put into effect at once. As we have already directed attention to the drastic curtailing of research grants in India, it is satisfactory to record that agricultural research has not only escaped, but has even secured funds for an appreciable expansion of its activities.

THE following appointments in the Colonial agricultural service have recently been made by the Secretary of State for the Colonies: Mr. W. N. C. Belgrave, plant physiologist, Federated Malay States, to be chief research officer, Federated Malay States; Mr. N. Greenwood, agricultural chemist, Nigeria, to be chemist, Agricultural Department, Gold Coast; Mr. E. S. Garner, to be agricultural officer, Sierra Leone; and Mr. J. G. M. King, to be agricultural officer, Tanganyika Territory.

THE annual meeting of the American Ornithologists' Union was held in Detroit, Mich., on Oct. 19–23. The officers were re-elected for 1932 as follows: *President*, Joseph Grinnell, Berkeley, Calif.; *Vice-Presidents*, A. C. Bent, Taunton, Mass., J. H. Fleming, Toronto, Ontario; *Secretary*, T. S. Palmer, Washington, D.C.; *Treasurer*, W. L. McAtee, Washington, D.C.; *Additional Members of the Council*, James P. Chapin, Ruthven Deane, H. C. Oberholser, J. L. Peters, C. W. Richmond, T. S. Roberts, P. A. Taverner. The election of new members included three corresponding fellows: Albert Collin, of Helsinki, Finland; M. B. Kinnear, of London; and Ernst Mayr, of Berlin. The Brewster Medal, given biennially for the most meritorious work on American birds, was awarded this year to Mrs. Florence Merriam Bailey for her "Birds of New Mexico".

ACCORDING to a report issued by Science Service, of Washington, D.C., two workers at the State University of Iowa, H. S. Olcott and D. C. McCann, have found that carotene, the yellow colouring matter of the carrot, is transformed into vitamin A by the action of an enzyme contained in the liver. Experiments showed that carotene is destroyed and vitamin A appears when carotene is incubated with fresh liver tissue derived from rats lacking vitamin A. Further research showed that the change is due to an enzyme for which the name of 'carotenase' is proposed.

A GENERAL discussion on the "Adsorption of Gases" has been arranged by the Faraday Society, to be held at Oxford on Jan. 12–13. The general introduction to the discussion will be given by Prof. Hugh S. Taylor (Princeton). The discussion will be divided into three sections. Section I., on experimental methods, will be opened by Prof. E. K. Rideal; Section II., on kinetics and energetics, by Prof. H. Freundlich (Berlin); and Section III., on theories of adsorption, by Prof. M. Polanyi (Berlin). Among the foreign visitors are Dr. Chariton (Leningrad), Dr. H. Dohse (Ludwigshafen), Prof. H. Mark (Ludwigshafen), Prof. O. Volmer (Berlin), Prof. B. K. Bonhoeffer (Frankfurt), Dr. W. Frankenburger (Ludwigshafen), Prof. E. Hückel (Stuttgart), and Prof. A. Magnus (Frankfurt).

WE have received the August–October issue (vol. 17, Nos. 4 and 5) of the *National Medical Journal of China*. It is a parasitological number and contains a collection of twenty-two papers dealing with various aspects of the subject, clinical and scientific. Some of them are of considerable interest and importance, for China still offers a wealth of material for investigations on parasitic diseases. There is, however, no contribution on the subject of malaria, which still remains a formidable menace to public health in South China.

A WORK on the "Medicinal and Poisonous Plants of Southern Africa", by Prof. J. M. Watt, professor of pharmacology in the University of the Witwatersrand, and Dr. Maria G. Breyer-Brandwijk, is announced by the publishers, Messrs. E. and S. Livingstone, 16 and 17 Teviot Place, Edinburgh. The plants are being grouped under their natural orders, and their poisonous or medicinal effects are fully discussed. The book will be well illustrated and should be very useful to the medical man and pharmacist. Publication is promised in 1932 provided that a certain proportion of the production costs are guaranteed before going to press. The book is therefore offered at a special pre-publication price of twenty shillings post free. Subscriptions should be sent to the publishers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An administrative assistant in the University College of Hull—The Registrar, University College, Hull (Dec. 16). A fellow in the Department of Coal Gas and Fuel Industries of Leeds University, for the prosecution of post-graduate research in gas chemistry—The Clerk to the Senate, University, Leeds (Dec. 17). A junior lecturer in chemistry at University College, Southampton—The Registrar, University College, Southampton (Dec. 17). A George Henry Lewes student in physiology in Cambridge University—Prof. Barcroft, Physiology School, Cambridge (Dec. 31). A professor of pathology in the Medical College, Calcutta, and bacteriologist to the Government of Bengal—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Dec. 31). A senior lecturer in anatomy in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, 73 Strand, W.C.2 (Jan. 15). A scientific research fellow at Girton College, Cambridge, for research in mathematical, physical, and natural sciences, including engineering, medicine, and agriculture—The Secretary, Girton College, Cambridge (Feb. 1). A graduate assistant for physics and mathematics at Darlington Technical College—The Chief Education Officer, Education Offices, Darlington.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Internal Temperature of White Dwarf Stars.

IT has recently been discovered by S. Chandrasekhar,[1] B. Swirles,[2] and R. C. Majumdar,[3] independently, that the opacity of a degenerate gas is very small compared with what would be computed for a classical gas at the same density and temperature, the ratio being an inverse power of Sommerfeld's degeneracy-criterion parameter. This discovery seriously affects estimates of the internal temperatures in white dwarf stars. It has previously been held that interiors of the white dwarf stars are amongst the hottest of stellar interiors; for example, Russell and Atkinson [4] remark that their internal temperatures must be of the order of 50 times those of a main sequence star built on the 'diffuse' model. Again, Jeans [5] says "it appears that the central temperatures of the white dwarfs must be enormously high, while those of giant stars of large radius must be comparatively low". This has given rise to the paradox that the coolest stellar interiors appeared to be the best generators of stellar energy, the hottest the worst. To quote Jeans [6] again, "... many of the hottest and densest stars are entirely put to shame in the matter of radiation by very cool stars of low density, such as Antares and Betelgeuse".

If, however, the opacity in the interior of a white dwarf is very low, the temperature gradient in the interior must be very small. In the limit of zero opacity (assuming also small conductivity) the temperature-distribution is isothermal. The degenerate core is therefore a mass at an approximately uniform temperature, and the value of this temperature is determined purely by the observed mass M and luminosity L and the intrinsic opacity κ_1 of the gaseous envelope which surrounds the core. On the 'generalised standard model', in which the energy-sources are uniformly distributed and the opacity takes a constant value κ_1 in the gaseous envelope, the temperature T' of the approximately isothermal degenerate core is, in the standard notation:

$$T' = \frac{(R/\mu)^{\frac{5}{3}}}{(\frac{1}{3}a)^{\frac{2}{3}}K}\left(\frac{\kappa_1 L}{4\pi cGM - \kappa_1 L}\right)^{\frac{2}{3}}. \quad . \quad . \quad (1)$$

For the observed mass and luminosity of the Companion of Sirius, T' is $0 \cdot 34 \times 10^6 \kappa_1^{\frac{2}{3}}$ degrees, or, even if we adopt the high value $\kappa_1 = 300$ for the gaseous envelope, the value of T' is only 15 million degrees. For smaller values of the envelope-opacity it will be still smaller. For an almost completely degenerate star the internal temperature is determined by the *photospheric* opacity in the thin gaseous envelope.

According to my conclusion that all stars contain a degenerate zone surrounded by a gaseous envelope, formula (1) applies to all stars. Stars with a high value of L/M have small, incompletely degenerate cores, in which the temperature gradients though small are larger than in completely degenerate cores. Formula (1) still gives the interfacial temperature between core and envelope, and is thus a lower limit to the central temperature. It follows that stars with large internal generation of energy, that is, large values of L/M, have very hot central cores. Such stars will not be built on the standard model, but the effect of concentrating the energy sources to the centre, keeping other parameters constant, is only to increase the central temperature. Jeans's paradox, therefore, completely disappears; the best generators of energy have the hottest cores, and this applies to stars of all types, from white dwarfs to giants.

This result is quite obvious physically. The gaseous envelope acts simply as a blanket the rôle of which is to keep the core warm. A high energy-generator surrounds itself with a thick blanket, which keeps it very warm; a low energy-generator with a thin blanket. The actual value of the temperature attained in the core depends naturally on the intrinsic opacity of the blanketing envelope.

The above considerations illustrate, by a particular example, my contention that we cannot discuss the internal state of a star without discussing the opacity of its outer layers. In the case of a completely degenerate white dwarf, to ignore the effect of the photospheric opacity would be to obtain an utterly false estimate of the internal temperature.

The above results were communicated to Section A of the British Association on Sept. 29, 1931, at the discussion on the evolution of the universe, but did not appear in the printed accounts. I may add that the full theory of the 'generalised standard model', now fairly completely worked out, affords possible explanations of many of the observed characteristics of the stars in general, including some of those summed up in the 'Russell diagram', the approximate 'mass-luminosity' law for non-dense stars, the occurrence of pulsating stars and Novæ, and the possible existence of several types of configurations for large M and L (O-type, giant M-type, N-type, etc.) stars.

E. A. MILNE.

Wadham College, Oxford,
Nov. 17.

[1] S. Chandrasekhar, *Proc. Roy. Soc.*, **133**, A, p. 241, Sept. 1931.

[2] B. Swirles, *Monthly Notices, R.A.S.*, June 1931, p. 861.

[3] R. C. Majumdar, *Astr. Nach.*, Nr. 5809, Aug. 1931.

[4] H. N. Russell and R. d'E. Atkinson, NATURE, May 2, 1931, p. 661.

[5] J. H. Jeans, "Astronomy and Cosmogony", p. 139.

[6] J. H. Jeans, "Astronomy and Cosmogony", p. 125.

Molecular Weights of the Proteins in their Native State.

MOST of the determinations of molecular weights of the proteins carried out in this laboratory by means of the ultracentrifugal method were made on material which had been subject to purification using ammonium sulphate as a precipitating or crystallising agent.[1] When trying to isolate the lactalbumin from cows' milk, we observed that no product homogeneous with regard to molecular weight could be prepared —the figures ranging from 12,000 to 25,000—and that the molecular weight increased during the process of purification.[2] A closer study of this phenomenon showed that the condensation is due especially to the action of the ammonium sulphate used for the 'purification'. The bulk of the native material in cows' milk from which the lactalbumin is formed has a low molecular weight, probably not exceeding 1000. This startling discovery made it an urgent task to re-examine as many of the proteins previously studied as possible without any chemical treatment at all or at least under conditions closely resembling those of their native occurrence. A short summary of the results so far obtained is given below.

Ovalbumin.—An extensive ultracentrifugal investigation of the white of hen's egg was undertaken by Mr. B. Sjogren. He found that the sedimentation constant of the egg-white diluted with 1 per cent sodium chloride is always lower than the sedimentation constant of the purified ovalbumin,[3] which is $3 \cdot 5 \times 10^{-13}$. Sometimes a sedimentation constant so low as $1 \cdot 5 \times 10^{-13}$ was observed, and sometimes values approaching that of purified ovalbumin was found. The cause of these irregularities has not yet been traced. The sedimentation constant for the egg-white from eggs which had been preserved in water-glass solution for one and a half years was the same as for purified ovalbumin. A solution of egg-white of low sedimentation constant gave the normal ovalbumin value after treating it with ammonium sulphate.

The study of egg-white will be taken up again, but it is already clear that the ovalbumin does not always exist in the egg in the same form as that of the 'purified' ovalbumin. On the other hand, it seems that ovalbumin of the normal sedimentation constant is sometimes present in the egg and is very easily formed from egg-white under the influence of such salts as ammonium sulphate. The molecular weight 34,500 is the upper limit of the condensation process,[4] which corresponds to a sedimentation constant of $3{\cdot}5 \times 10^{-13}$.

Hæmoglobin.—For the determination of the molecular weight of hæmoglobin, Fåhræus and I[5] prepared solutions by simple water hæmolysis of the blood corpuscles. Measurements were made both on electrolyte-free (dialysed or electrodialysed) solutions and on solutions to which had been added sodium or potassium chloride in concentrations of 0·1 to 1 per cent. In all cases the same molecular weight, namely, about 68,000, was found. Nichols and I[6] later determined the molecular weight of hæmoglobin which had been crystallised by means of ammonium sulphate and found the same value. It therefore seems that hæmoglobin is not affected by the ammonium sulphate treatment and really does exist in the blood corpuscles.

Serum Albumin and Serum Globulin.—The question of the real state of the serum proteins in the blood has been the subject of much discussion. At the present time the ultracentrifugal technique offers the best means of attacking this problem. Preliminary determinations by Mr. K. O. Pedersen, Mr. P. v. Mutzenbecher, and Miss Inga-Britta Eriksson have shown that serum diluted with 1 per cent sodium chloride solution gives a sedimentation constant which is of the same order of magnitude as that of purified serum albumin and purified serum globulin. When using the refractive index method for recording the sedimentation, indications of a double maximum corresponding to the sedimentation constants of the two serum proteins were found. The question of the individual existence of serum albumin and serum globulin in the native serum can probably be settled by means of the new high-speed ultracentrifuge which has recently been installed in this laboratory.

Amandin (determinations by Miss Inga-Britta Eriksson).—This substance was chosen as a representative of the oil-seed proteins. A 10 per cent sodium chloride solution extract of almonds showed a high molecular protein with a sedimentation constant of the same order of magnitude as that of purified amandin. The extract also contained a substance of much lower molecular weight, the presence of which prevented an accurate determination of the sedimentation constant of the former substance.

Phycocyan (determinations by Miss Inga-Britta Eriksson).—An aqueous extract of the alga *Aphanizomenon* diluted with 1 per cent sodium chloride solution showed a sedimentation constant of $11{\cdot}5 \times 10^{-13}$, identical within the limits of error with the value $11{\cdot}2 \times 10^{-13}$ previously obtained for purified *c*-phycocyan.[7]

Phycoerythrin (determinations by Miss Inga-Britta Eriksson).—An aqueous extract of the alga *Ceramium* diluted with 1 per cent sodium chloride solution gave within the limits of error the same sedimentation constant, namely, $11{\cdot}4 \times 10^{-13}$, as that of the purified *r*-phycoerythrin, namely, $11{\cdot}5 \times 10^{-13}$.

The proteins phycocyan and phycoerythrin therefore exist in the aqueous extracts of the algæ and probably also in the living cells with the same molecular weight, namely, 208,000, as in the purified laboratory products.

Hæmocyanin (determinations by Mr. B. Sjogren and Miss Inga-Britta Eriksson).—Blood from the vineyard snail, *Helix pomatia*, was studied both undiluted (protein concentration 3 per cent) and diluted with 1 per cent sodium chloride (protein concentration 0·1 per cent). The values for the sedimentation constant were in perfect agreement with those obtained previously for the purified hæmocyanin.[8] In dilute solution the value 98×10^{-13} was found for the blood as well as for the purified protein. It is obvious, therefore, that the hæmocyanin is present in the blood of *Helix* with the same enormous molecular weight, namely, 5,000,000, as in the purified hæmocyanin.

From the above determinations it seems justifiable to draw the conclusion that most of the proteins do possess the same molecular weight in their native state as in the purified laboratory products. On the other hand, there are cases where the protein exists in the form of a low-molecular pro-protein in the living organism and is brought into the shape of a real protein by the 'purification' process, especially by the action of such salts as ammonium sulphate.

THE SVEDBERG.

Laboratory of Physical Chemistry,
University of Uppsala,
Uppsala, Sweden, Nov. 6.

[1] NATURE, 123, 871; June 8, 1929.

[2] Svedberg and Sjogren, *Jour. Amer. Chem. Soc.*, 52, 3650; 1930.

[3] Svedberg and Sjogren, *Jour. Amer. Chem. Soc.*, 52, 5187; 1930.

[4] Svedberg and Nichols, *Jour. Amer. Chem. Soc.*, 48, 3081; 1926.

[5] *Jour. Amer. Chem. Soc*, 48, 430; 1926.

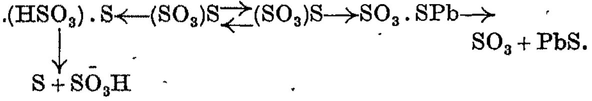
[6] *Jour. Amer. Chem. Soc.*, 49, 2920; 1927.

[7] Svedberg and Katsurai, *Jour. Amer. Chem. Soc.*, 51, 3573; 1929.

[8] Svedberg and Chirnoaga, *Jour. Amer. Chem. Soc.*, 50, 1399; 1928; Svedberg and Heyroth, *ibid.*, 51, 550; 1929.

An Aspect of Co-ordination.

A CO-ORDINATE union between a bivalent atom, for example, of oxygen, and an atom or group *X* may be regarded as having resulted from the attachment of a neutral atom of the bivalent element to *X*, and its mode of formation frequently corresponds to this, although the transference of an already co-ordinated bivalent atom from another atom to *X* is a frequent variant of it. In any compound, therefore, the combination may be expected to behave as a composite atom or group, so that electronic effects, which in the original group would assert themselves at *X*, will assert themselves similarly in a qualitative, though possibly not quantitative, manner at the bivalent atom in the combination. For example, the composite thiosulphate ion, which is formed from the sulphite ion and sulphur, is stable only so long as it preserves its double negative charge, and breaks down into its components on partial or complete neutralisation. This, however, can occur in two ways, because there are two alternatively possible effective seats of the negative charge to which a cation may attach itself—the original ionic group or the attached sulphur atom:



$$\begin{array}{l}
(\mathrm{H\bar{S}O_3}).\mathrm{S} \longleftarrow (\mathrm{\bar{S}\bar{O}_3})\mathrm{S} \rightleftarrows (\mathrm{SO_3})\mathrm{\bar{S}} \longrightarrow \mathrm{SO_3.SPb} \longrightarrow \\
\quad\downarrow \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \mathrm{SO_3 + PbS.} \\
\mathrm{S + S\bar{O}_3H}
\end{array}$$

It might be expected that a cation of suitable intermediate character could be found which can attach itself in either manner, and this possibility appears recently to have been realised.[1]

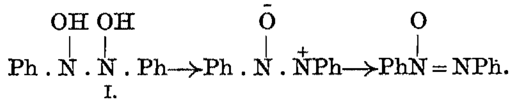
The salt formation of tertiary amines involves the lone pair of electrons on the nitrogen atom, and even when these are used in co-ordinating an oxygen atom, the capacity for salt formation is nevertheless retained in the resulting amine oxide. The oxides are recoverable from their salts, as are the amines :

$$R_3N + H\bar{A} \rightleftarrows [R_3NH]\bar{A}$$

$$R_3NO + H\bar{A} \rightleftarrows [R_3NOH]\bar{A}.$$

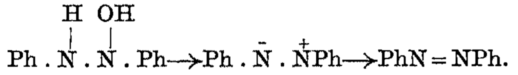
Although this is a particular case of the application of the principle of transmission of electronic effects by electrostatic induction, the implications attached to the relationships thus exemplified seem not to have been fully appreciated hitherto.

Thus, it will doubtless be agreed that the interaction of nitrosobenzene with β-phenylhydroxylamine will yield (I.) in the first place :



$$Ph\,.\,\overset{OH}{N}\,.\,\overset{OH}{N}\,.\,Ph \longrightarrow Ph\,.\,\overset{\bar{O}}{N}\,.\,\overset{+}{N}Ph \longrightarrow Ph\overset{O}{N}{=}NPh.$$

I.

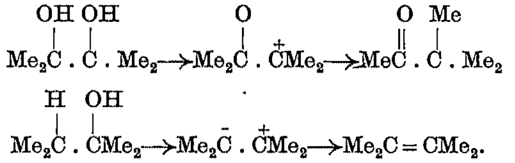


$$Ph\,.\,\overset{H}{N}\,.\,\overset{OH}{N}\,.\,Ph \longrightarrow Ph\,.\,\bar{N}\,.\,\overset{+}{N}Ph \longrightarrow PhN{=}NPh.$$

II.

Since, however, the lack of basic properties in azobenzene indicates that (II.) would at once break down into azobenzene and water, so (I.) at once furnishes azoxybenzene, and it will be noted that the modern, rather than the obsolete cyclic formula is thus deduced for the product.

The pinacone-pinacoline change has been the subject of extended discussion during recent years,[2] but does not seem to have been connected with the formation of azoxybenzene. Yet the grouping $>C\,.\,O$ may be regarded in the manner just discussed, and in fact the formation of *o*-nitrosobenzyl alcohol from *o*-nitrotoluene in presence of alkali must be regarded as proceeding by transference of a co-ordinated oxygen atom to a negatively charged carbon atom. The mode of formation of tertiary alcohols from their hydrocarbons also is probably of this kind.[3] The behaviour of pinacone towards acid therefore corresponds to that of methyl *iso*propyl carbinol, as indeed was suggested by Tiffeneau :



$$Me_2\overset{OH}{C}\,.\,\overset{OH}{C}\,.\,Me_2 \longrightarrow Me_2\overset{\bar{O}}{C}\,.\,\overset{+}{C}Me_2 \longrightarrow Me\overset{O}{\overset{\|}{C}}\,.\,\overset{Me}{C}\,.\,Me_2$$

$$Me_2\overset{H}{C}\,.\,\overset{OH}{C}Me_2 \longrightarrow Me_2\bar{C}\,.\,\overset{+}{C}Me_2 \longrightarrow Me_2C{=}CMe_2.$$

This view is also the basis of the electronic mechanism adopted by Robinson in regard to the reaction, but the present angle of approach seems worthy of record, since it may help to correct a not uncommon tendency to regard the pinacone change as something apart, rather than as essentially a particular case of the Hofmann decomposition of amines (as the dehydration of alcohols also may be considered to be).

Whereas, in the cases of the nitrogen compounds and of methyl *iso*propyl carbinol, neutrality of the product can be achieved by the sharing of a lone pair of electrons, originally present or resulting from the reaction, no such pair is available in the case of pinacone, and the necessary electrons can only be provided by transference at the same time of the group attached to them. This, it is suggested, is the real significance of Meerwein's demonstration that the Wagner and similar rearrangements are dependent on a cationic condition of the complex involved.

The above comparison between nitrogen and carbon compounds also lends point to the view that, in an entirely different field, the ortho-para directive properties of alkyl groups do not differ fundamentally in their origin from those of the amino-group, but correspond with the relative positions of carbon and nitrogen in the periodic system.

J. KENNER.

College of Technology,
Manchester,
Oct. 23.

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[1] Compare Priyadaranjan Rây, NATURE, vol. 127, p 856, June 6, 1931.

[2] A review is provided in the Annual Reports of the Chemical Society, 1930, p. 114.

[3] Compare Jones and Kenner, *Jour. Chem. Soc.*, p. 1846, 1931.

Cotton Growing in Egypt.

IN his review (NATURE, Oct. 31, p. 766) of recent publications on the working of the Seed Control Law in Egypt, Mr. Slater directs attention to the complementary nature of this law to the work of pure seed propagation carried out by the scientific staff.

As an agricultural research worker I very much doubt if it is correct to say that the cotton plant is the best studied agricultural crop. But with regard to legislation, it is probably true to say that no crop is subject to such an amount of careful legislative control as is the cotton crop in Egypt. Apparently the cultivator does not always know what is good for him, since attempts to evade the law appear to have been numerous. Perhaps it is unfortunate that the operation of the law has synchronised with a period of progressive market depression, so that it is not possible to make any estimate of the effect of the law from the economic point of view. Mr. Slater, who is in a position to know, does not comment on the effect of the law from the consumer's point of view.

These publications, unfortunately, do not give any information of a scientific nature on the principles underlying the working of the law, but it is said that the administration is indebted to the prevalence of a certain type of cotton plant known as Hindi which serves as an index of impurity. This Hindi cotton is recognised in the field by its white flower and general resemblance to American cotton. Its seed is quite naked, and except for its sharp point at the micropylar end is almost identical with the seed of Sea Island cotton. It thus possesses the characters of both its parents, Sea Island and American. The Seed Control Law operates only by excluding seeds of this naked Sea Island type. No account is taken of the lint characters, nor has anyone proved that the lint of naked seeded cottons is inferior to the lint of fuzzy seed cottons. I have seen evidence to the contrary, and also that cotton from fully fuzz seed is frequently inferior in spinning properties. From the genetic point of view, the Seed Control Law operates to exclude types resembling that of the best long staple parent, and propagates seed of full fuzz regardless of its lint quality.

Egypt certainly presents us with an interesting experiment in legislative control of an important crop. If the result is ultimately beneficial to the cultivator he will doubtless support it, but should it turn out to be nothing more than pseudo-scientific interference it will require more than scientific ingenuity to circumvent the evaders.

N. W. BARRITT.

Rothamsted Experimental Station,
Harpenden, Nov. 8.

In replying to Mr. Barritt, I am conscious of a feeling of uncertainty of what he wishes me to say to some of his veiled criticisms, largely levelled at the administrative policy of the Egyptian Ministry of Agriculture.

I may be wrong, but I fear Mr. Barritt has not quite grasped the meaning of the words 'quality' and 'uniformity' and their relative significance in a commercial commodity such as raw cotton. It appears to me that he is taking a very limited view of quality by ignoring uniformity, owing to his acceptance of spinning properties as the ultimate criterion of textile quality. I may point out that cotton is not only grown to be spun, but also to provide clothes which are acceptable to the wearer, who is becoming more critical year by year. Cotton which spun into the strongest yarn ever yet made would not find a market in one-hundredth part of the trade if it were so uneven that it would not dye to a level colour, or provide the many other desirable properties of a finished fabric.

The Egyptian Seed Control Law seeks to maintain uniformity in raw cotton by penalising those who attempt to mix seed-types. The consumer in Great Britain would not cavil at raw cotton which contains a low but constant proportion of Hindi cotton, but if there is no law to control that proportion, and the farmer is allowed to mix his seed according to his taste or fancy, it is difficult to see how the consumer is to benefit. If Mr. Barritt means that propagation of Hindi cotton or similar types would provide the consumer with better and more uniform fabrics at the same price, not stronger yarn, I am in agreement with him. At the same time, I must point out that Mr. Barritt puts forward no evidence other than a reference to spinning, which is only the beginning of the textile industry in Great Britain, to justify a complete reversal of the botanical policy of the Egyptian Ministry of Agriculture.

If I have answered Mr. Barritt's criticisms only from the consumer's point of view, it is because I believe the grower's and consumer's interests have much in common. I leave it to the Egyptian botanical experts to reply to his suggestions from the botanical side, but from my own experience I can say that mere mention of the Sea Island parentage of Hindi cotton is valueless as an indication of quality. Cotton grown from pure Sea Island seed in localities other than its native habitat is often inferior to cottons of lower pedigree. Moreover, the amount of genuine Sea Island (West Indian) cotton grown is ridiculously small, and yet there is more available than the textile industry is able to consume.

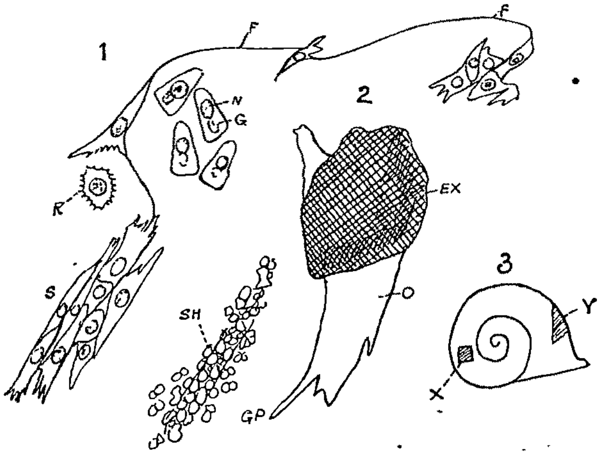
F. P. Slater.

Rock Bank,
Bollington, near Macclesfield,
Nov. 13.

Outgrowths from Pieces of *Helix aspersa*, the Common Snail.

In connexion with a cytological problem now being investigated, an attempt has been made to culture snail tissue. It is well known that snails are able to repair extensive injuries under what must be extremely septic conditions. The epithelium beneath the shell and elsewhere is not keratinised or otherwise protected, except perhaps for its faculty to produce mucus. It follows that such material might provide easy material for tissue culture, very careful aseptic precautions not being necessary.

Blood is procured from a snail by carefully cracking a hole in the shell, as shown in Fig. 3, *X*. A glass needle is stuck into the tissue and the blood wells up into the space between the shell and the snail, from which it is removed with a pipette. The front of the shell is peeled, *Y*, and pieces of mantle cavity epithelium with underlying tissue removed. These are cut up with a very sharp knife into ½ mm. pieces, in blood or Ringer solution, which need not be sterile. Indeed, except for flaming the coverslips and pipette, no aseptic precautions have been taken. A small drop of blood is put on the middle of a square coverslip and a piece of tissue (with as little Ringer solution in it as possible) added. The whole is sealed over a hollow slide, vaseline being used. Such preparations will grow out at room temperature (15° C. in my laboratory), but the best results are obtained at 25° C. in an incubator. I have also tried 30° C. Various forms of growth can be noted. Amœbocytes first come out (*F* in Fig. 1) and form a network of cells around the piece. After a day they form groups (*S*) apparently dividing and growing at the ends. Small round cells (*R*) also occur. By twenty-four hours the epithelial cells (*NG*) tend to come away from their layer, and flatten on the slide. Crystals (*SH*) now appear singly, and eventually join up to form long lines just beside the explant. These are at present regarded as shell material secreted by the epithelial cells. Now, besides this outward migration, in many cultures complete sheets of sub-epithelial connective tissue grow out, as in Fig. 2, *EX* being the explant, *O* the outgrowth, and *GP* one of the growing points, and also remarkable bulbous growths appear.



It seems important to wash the explant pieces in blood or Ringer solution before placing them in the blood on the coverslip. Apparently those bacteria, normally troublesome in vertebrate tissue cultures, do not interfere with growth in snail cultures, so that a person unused to the niceties of strict aseptic conditions should have no trouble in observing forms of growth in such snail cultures. Pieces of muscle keep alive and move spasmodically for as long as a week in such cultures. What seem to be very active outgrowth and division of both shell epithelial and vascular epithelial cells, has more recently been got as follows. The ordinary hanging drop preparation of mantle wall is made, and a piece of narrow coverslip added underneath, so that the explant lies between. All mantle cavity wall explants seem initially infected, but the bacteria keep in bounds for about three days, after which, unless the explant is well washed in blood, they multiply exceedingly. This account of some of the experiments can only be regarded as preliminary, as very little is known yet about the best conditions for this type of work on the snail.

In the epithelial cells *NG*, the Golgi apparatus (*G*) is very clearly to be seen *intravitam*, thus supporting the previous findings of R. Ludford [1] on the presence of this cell element in tissue cultured cells.

I am grateful to Miss Honor B. Fell for her courteous answers to inquiries about literature.

J. Brontë Gatenby.

Zoology Dept., Trinity College,
Dublin, Oct. 19.

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[1] *Proc. Roy Soc*, B, vol. 101, 1927.

The Specific Heat of Ferromagnetics and Ewing's Model of the Magnetic Atom.

Prof. W. Gerlach has recently investigated the connexion between the spontaneous magnetism and the specific heat of a ferromagnetic, and he confirms the close relationship between them, pointed out by Prof. P. Weiss, which seems to imply the existence of an immense intrinsic magnetic field within a magnet. The magnitude of this field, however, is so large that there is a difficulty in accounting for its origin from observed magnetic values.

In a paper I submitted to the *Philosophical Magazine* of March 1922, an experiment was described which showed that an applied alternating magnetic field brings about a loss of ferromagnetism at a lower temperature than the normal critical temperature, leaving unaltered the temperature at which the specific heat suffers a sudden diminution, a temperature which is the same as the normal critical temperature for magnetism.

This almost certainly rules out the hypothesis that the large intrinsic field required to account for the specific heat changes emanates from the rotating magnetic element in a ferromagnetic substance. Hence the suggestion was made in the paper referred to that there must be two fields in a magnet interacting in some way on each other, one concerned with magnetic quantities as commonly observed and the other with specific heat changes.

Now Ewing's new model of the atom offers a possible solution of some of the difficulties mentioned above and supplies the double field required. In Ewing's words, " Each atom forms a magnetic system comprising a Weber element capable of turning, but controlled by magnetic forces exerted on it by other parts of the atom which are taken as fixed ". Mechanically, the model consists of a central pivoted magnetic needle controlled by bar magnets of equal strength, arranged radially in pairs at equal distances around the central needle with poles of one name all facing outwards. The poles pointing inwards produce an almost neutral control on the moving needle as required by the facts of magnetic induction, although the control magnets themselves may be very strong. To make this model fit the facts of ferromagnetism and abnormal specific heat we have only to suppose that it is as likely that the outwardly pointing poles of any atom will be north as south, and so one half the atoms may be supposed to have one polarity externally and the other half the opposite polarity. Between two atoms of opposite polarity there will be a strong attraction and a strong field, and they will tend to join together, forming molecules and groups of molecules. Such molecules or their component atoms, when subjected to thermal agitation, will acquire translatory movements, and these will inevitably set up atomic or molecular oscillations in virtue of the strong magnetic ties between one and another. The Weber element will be constrained to partake of these vibratory movements, and the substance as a whole will appear to lose magnetism and to gain in specific heat as the atoms or molecules successively take up vibrations with rise of temperature.

The model affords an explanation of the experiment mentioned above in which an alternating field applied to a ferromagnetic lowers its critical temperature, but leaves the temperature of the discontinuity of the specific heat unchanged. Such an alternating field would facilitate the vibrations of the Weber element, but would have no influence on the system of 'fixed' atomic magnets. Rupturing of atomic ties with accompanying loss of potential energy due to violent thermal agitation would account for the discontinuity of the specific heat.

That this model of the ferromagnetic atom should offer a plausible view of how an immense intrinsic magnetic field may exist in a magnet and yet not be influenced by external magnetic forces, and how the magnetism and specific heat of a ferromagnetic may be linked together, is the more noteworthy when it is remembered that the model was devised for an entirely different purpose, namely, the removal of a difficulty occurring in the early stages of magnetic induction with which the older and simpler model was confronted and was incompetent to meet.

J. R. Ashworth.

Rochdale, Nov. 3.

Homo sapiens and African Prehistory.

The confirmation by Dr. Leakey and Mr. Hopwood of the antiquity of Hans Reck's Oldaway man, and Mr. Reid Moir's letter in Nature of Nov. 7, encourage me to publish, for the first time, a disconcerting discovery made in Uganda about a year ago.

At Nsongegi, in Ankole, the Kagera river is flanked by some remarkably fine terraces of which there are three. The upper and oldest is represented by mere remnants and carries in its upper parts an industry which, though not yet fully studied, is clearly seen to display marked Clactonian affinities, and is dated as Pluvial I. (Leakey's Kamasian). The second, or the hundred foot terrace, like the first, marks a time when in consequence of high precipitation the lakes rose and flooded back into their feeder valleys, and is dated as Pluvial II. (Leakey's Gamblian). Pluvial II. had, it would appear, two rainfall peaks, and during the relatively short period between them lake levels subsided to some extent, and thereby alluvial deposits in the valleys were exposed and became fertile plains, the hunting ground of prehistoric man. This interregnum was sufficiently long to permit of a moderate amount of denudation, and for the freshly exposed land surface to become more or less lateritised before it was again covered by gravels and silts. The temporary land surface yields stone tools, cores, and flakes in amazing abundance, representative of what in Europe would be regarded as two cultures: one of very late Acheulean and the other of early Mousterian facies, and it may be noted in passing that cleavers and some peculiar cores are of common occurrence. It would seem that a somewhat similar culture (the Nanyukian) of unproved but supposedly Interpluvial I. date (that is, between the Kamasian and the Gamblian) has been discovered in Kenya.

A number of pits were put down under my direction through the second terrace just referred to, and in one of them there was discovered *in situ*, 16 feet below the old occupation site that yields so many artefacts, a 'digging-stone', the usual large, round, flattish stone with a hole pierced through the middle. It was made from a comparatively soft rock (phyllite). Others have, I understand, been found resting on bed rock some 6 feet from the surface on the neighbouring hillsides. The specimen in question was found in well-bedded and quite undisturbed deposits belonging (unless our interpretation is radically wrong) to the earlier part of Pluvial II. times which, according to the Glacio-pluvial correlation, would belong to Riss days. The discovery was so disturbing that, beyond recording the facts in private letters, I forbore to give it wider publication pending further research. This will be carried out next year.

The discovery is not quite unique, however, for in 1926, Mr. T. Hirst, of the Geological Survey of Uganda, discovered a broken digging-stone stone at a depth of 3 feet from the surface in undisturbed deposits of a gravel apron connecting the 50-foot terrace of the Kafu river in Bunyoro with the river-flat deposits, both of which are interpreted as of Pluvial II. date, the latter being brought in by secular disturbances in Pluvial II. times. This inconvenient discovery appears to have been set aside and overlooked, and was only brought to light again when the corroborative evidence of the digging-stone of Nsongegi was produced.

Digging-stones have been regarded as of late appearance, but I have some which almost certainly date back to the dry period following Pluvial II. and preceding the Makalian Pluvial (presumably of Bühl date) of Kenya. They have not hitherto been found apart from the work of neanthropic man, and the two discoveries cited above strongly suggest that neanthropic man was in existence in the early part of Pluvial II. days, a possibility which, as I have said, I have hesitated to indicate. There is, however, less objection to it now that Reck's claim has been re-examined and upheld. E. J. WAYLAND.

15 Westcliff Terrace Mansions,
Ramsgate, Nov. 13.

Organisation of Scientific Abstracting Services.

As chairman of a small committee entrusted with the task of surveying the methods employed in scientific and technical abstract services, I invite the co-operation of editors and intelligence officers in collecting a body of information from which suggestions leading to increased efficiency may be derived. A conference recently held at the invitation of Mr. H. T. Tizard, president of the Association of Special Libraries and Information Bureaux, was attended by representatives of a large number of such services. Consideration was given, *inter alia*, to methods of dealing with foreign publications; this is one of the subjects in which information is sought, but the opportunity is being taken to gather confidential statements of fact and opinion which will form the basis of a comprehensive report on this most essential contribution to scientific progress. Responsible officers of organisations of the character indicated are invited to complete a questionnaire which has already been dispatched, or will be forwarded on receipt of a post-card, by Mr. S. S. Bullock, general secretary of the Association of Special Libraries and Information Bureaux, 16 Russell Square, London, W.C.1.

A. A. ELDRIDGE.

Imperial College of Science and Technology,
London, S.W.7,
Dec. 4.

Gravity Anomalies.

IN India, Hayford gravity anomalies are unsatisfactory. The large negative and positive anomalies that are found cannot be ascribed to purely local density anomalies in the superficial crustal layer.

As a result of a somewhat lengthy investigation of these gravity anomalies, I have come to the conclusion that the Hayford hypothesis of isostatic compensation is incorrect, and that gravity anomalies can be adequately explained by a warping up and down of the crustal layers. According to this hypothesis, the main gravity anomalies, after removing topographical effects without compensation, are due to departures of the granite - tachylyte and tachylyte - dunite interfaces from their normal levels. The Airy system of compensation applies to folded sedimentary ranges under which there has been a deep down warp of the crustal layers, but horst ranges and other positive elements of the crust are entirely uncompensated.

Although these conclusions have been mainly derived from observations made in India, there appears to be good evidence that gravity anomalies, outside India in both continental and oceanic areas, can be successfully explained by crustal warpings without compensation. In particular, this hypothesis appears necessary to account for the remarkable anomalies found by Dr. Vening Meinesz in the East Indian Archipelago.

A paper describing these investigations will be published shortly as one of the Professional Papers of the Survey of India. E. A. GLENNIE.

Geodetic Branch, Survey of India,
Dehra Dun.

Rotatory Magnetic Polarisation.

H. BECQUEREL[1] a énoncé le résultat suivant :

Pour les corps d'une même famille chimique le quotient de la rotation magnétique du plan de polarisation de la lumière Λ par le produit $n^2(n^2-1)$, n désignant l'indice de réfraction, est un nombre qui varie peu.

J'ai montré[2] que ce quotient $\frac{\Lambda}{n^2(n^2-1)}$ variait avec la température pour l'eau de 0° à 100° et pour le sulfure de carbone de 0° à 40°.

Il m'a semblé intéressant de faire la même étude pour le β méthylnaphtalène, dont Constantin Salceanu[3] a mesuré récemment la constante de Verdet et l'indice de réfraction à l'état fondu à six températures comprises entre 34° et 174°. Le tableau suivant montre que l'expression calculée augmente considérablement avec la température.

Températures.	n.	$\Lambda \times 10^5$.	$\frac{\Lambda}{n^2(n^2-1)} \times 10^5$.
34°	1·6056	4512	1109
78·5°	1·5864	4359	1142
111·7°	1·5695	4187	1162
142·5°	1·551	4039	1194
174°	1·5286	3879	1242

EDM. VAN AUBEL.

Gand, le 10 octobre, 1931.

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[1] *Annales de chimie et de physique*, 5e série, tome 12, p. 5 ; 1877.

[2] *Journal de physique*, Paris, novembre, 1896.

[3] *Comptes rendus de l'Académie des Sciences*, Paris, 20 juillet 1931, p. 161.

Superconductivity at High Frequencies.

WE have recently repeated with unsilvered vacuum flasks our experiments reported in NATURE of Aug. 29, p. 373, and in the *Phil. Mag.* of September last, and find lead and tin become superconducting with currents having frequencies of the order of 10^7 per second. We also find that the transition temperatures are progressively lowered as the frequency is increased.

J. C. McLENNAN.
A. C. BURTON.
A. PITT.
J. O. WILHELM.

Toronto.

Research Items.

Indian Archæology in Eastern Canada.—At the time of settlement of Eastern Canada by the French in the sixteenth and seventeenth centuries, the country was inhabited by tribes who spoke entirely different languages—Algonkian and Iroquoian. Algonkian sites are located on the banks of streams and lakes, usually on the north and west, and avoid clay. The Iroquoian sites of the semi-permanent villages in many cases are on the tops of flat-topped peninsula-like sand hills, the surrounding land being suitable for corn and other vegetable foods. The characteristics of the Algonkian and Iroquoian cultures are differentiated by Mr. W. J. Wintemberg in *Bulletin* 67 of the National Museum of Canada. The stone artefacts from both Algonkian and Iroquoian sites consist of chipped, ground, and polished implements, but the Algonkians were pre-eminent as stone-workers, and their artefacts of this material excel those of the Iroquois in number, variety, and uses. Stone pipes, indisputably of Algonkian origin, are not known on their sites, with the exception of the so-called 'Micmac' pipes, which are late. Iroquoian stone pipes are of many different types. Objects of native copper are found in many different localities, but in most cases not on sites yielding Algonkian pottery, those found here probably belonging to the mound-builders. Very few are found on Iroquoian sites, and then as a rule from those of the earlier periods. Earthenware from both classes of sites consists of fragments, a few whole pots and a few pipes. The bone work of pre-European Algonkians is poor; but the Iroquois were highly skilled bone-workers, and no artefacts are more abundant on their sites than those made of bone.

The Impaling Instinct of Shrikes.—In his systematic revision of the American shrikes (*Lanius*) Alden H. Miller includes many notes upon habits and behaviour, but we refer particularly to his observations upon the characteristic habit of impaling food (*Univ. California Pub. Zool.*, vol. 38, No. 2, p. 11, 1931). Young shrikes reared in cages, without the opportunity of learning methods of impaling, showed an initial inherited reaction fairly complete on its first appearance. It consisted, at its simplest, of the dragging of food along a perch until it met some resisting object (in this case nails inserted in the perch), when a series of tugs often lodged the food firmly on the projection. The object is to afford suitable fixation for rather large food objects so that they may be more readily torn to pieces. Small objects were eaten without any attempt at impaling. There was no indication that objects were impaled with the object of forming a store of food for future use, although there was evidence that even caged birds killed more than they could eat and kept on impaling surplus animals which they never touched again. Such actions are interpreted as automatic reactions to moving prey, an incomplete series of the ordinary feeding reactions; but it would be wrong to attribute them to a 'lust for slaughter' or to deliberate cruelty, since they appear to be purely instinctive. Indeed, contrary to popular opinion, shrikes usually kill their food thoroughly before impaling it.

Development of the Egg.—The attention of teachers and students of zoology is directed to a symposium on the development of the egg given at the Carnegie Institution, Washington, in November 1930 and published in three parts in the *Scientific Monthly* for June, July, and August 1931. In the first part, Dr. G. L. Streeter gives an account of the development of the egg as seen by the embryologist, based chiefly on the study of mammalian eggs. He traces briefly the development of the egg, for example, of the rabbit, gives a rapid summary of human development from the blastocyst stage, and adds some remarks on the importance of the quality of the egg: "Good eggs produce hardy, long-lived individuals and poor eggs succumb during intra-uterine life, infancy, or early years of maturity". Dr. Carl G. Hartman discusses the development of the egg as seen by the physiologist, follows the fortunes of the egg as it reacts with the ovaries and the anterior lobe of the pituitary, and considers the conditions produced by it during its sojourn in the mother's body, including the interplay of some of the endocrines. In the third article, Dr. C. W. Metz takes the geneticist's view of the developing egg and refers principally to the chromosomes and their influence in heredity and development. All three articles are well illustrated, and the first is particularly noteworthy for the photomicrographs of living mammalian eggs which form two of the full-page illustrations. One of these full pages contains eleven photomicrographs reproduced from Dr. P. W. Gregory's memoir on the early stages of the rabbit's egg; the other shows photographs, by Prof. Warren H. Lewis and others, of the eggs of the mouse, guinea-pig, monkey, etc. Three eggs of the mouse are shown in the two-cell stage (with polar body), and in the next figure ten eggs of the mouse are seen in the later cleavage, about the eight-cell stage.

Size-inheritance in Poultry.—An extensive study of the weight of fowls in crosses between Leghorns and Brahmas has been made by Mr. Wilson T. Waters (*Rhode Island Agr. Expt. Station Bull.* 228). Nearly 3000 birds were studied in experiments extending over ten years. Records of growth in weight were made, including the $F_1 - F_4$ generations, as well as back crosses and controls. Both breeds reach their full size in ten months. The reciprocal F_1 hybrids were intermediate in weight at the end of ten months. After the third week, Brahma chicks grow more rapidly than Leghorns, and thus attain a larger size. The F_1 and F_2 hybrids follow the growth curve of the Brahmas up to the seventh month, and the growth rate then becomes intermediate. Hybrid vigour is thus shown only in the earlier months of development of the hybrids. Segregation for size was shown in the F_2 and later generations. It is concluded that the difference in weight between the two breeds depends chiefly on two independent genes, each of which affects the weight equally, and they are cumulative in their effects.

Cellular Permeability.—Marcel V. L. Homes (*Bull. de l'Acad. Roy. de Belgique, Classe des Sciences*, 17, 3, 409–419; 1931) states that the absorption of solutes by living cells may be represented by an equation of the form $Q_t^e = Ae^{-at} + B$, where Q_t^e is the total quantity of the dissolved solute outside the cells at time t, and A, B, and a are constants. A and B may be evaluated in terms of the initial and equilibrium values of Q. It is shown that the constant a has dimensions $\frac{1}{[T]}$ and it is called by the author, who regards it as an important index of cellular permeability, the 'rate factor'. The rate factor may be experimentally determined in terms of the concentration of the external solution at equilibrium, at any time t, and at zero time, and in one case quoted is shown to be approximately constant. The actual rate of absorption at any time t, namely, dQ/dt, is simply derived from the value of the constant a and the initial and equilibrium values of Q. The permeability of a cell for a given solute is regarded as defined by two quantities: (1) the accumulation factor at equilibrium (as used by Hoagland and Davis), (2) the rate factor (*a*), which is expressed in the units reciprocal hours.

Adobe Brick Analysis for Plant Contents.—Exact knowledge regarding the early introduction of crop and weed plants into America is somewhat meagre, and the method of adobe brick analysis adopted by G. W. Hendry is yielding much valuable information, some account of which is given in *Agricultural History*, vol. 5, 1931. Adobe or sun-dried bricks readily disintegrate in water and yield their plant contents in a good state of preservation. The material so far collected has been small, but examination of the walls of various historic buildings has already thrown much light on the question of plant introduction. As regards crop plants, the wheats afford a good example of the importance of the discoveries made by this method. Propo wheat has been found in twelve out of fourteen buildings examined, the date of foundation of the earliest of which is given as 1701, and appears to have been the most extensively grown variety during the Spanish and Mexican periods. The introduction of this variety into California had, however, previously been thought to have been so late as 1870. Similarly, Little Club Wheat, usually considered as introduced from Chile about 1860, is shown to have been abundant in California, Arizona, and Sonora about a century earlier, thus assigning its introduction to the agency of Spanish missionaries from Mexico. New evidence is also provided regarding the introduction into California of alien weeds. Three species only, *Rumex crispus*, *Erodium circutarium*, *Sonchus asper*, all of which have a wide distribution, appear to belong to the pre-missionary period, namely, before 1769, and the writer regards them as probably present at the time of occupancy by Europeans. Other species are found particularly associated with the missionary period (1769–1824), while a further group would seem to be of definitely later introduction. Further studies of material collected from areas extending southward into Mexico would greatly extend the discoveries already obtained.

The Macdonnell Ranges.—The Macdonnell Ranges in Central Australia are relatively little known and are poorly mapped. Mr. C. T. Madigan describes the results of three expeditions to these ranges in the *Geographical Journal* for November. The whole area appears to be a series of eroded folds with east and west axes. The ranges are limbs of folds near anticlinal axes and the plains are filled synclinal troughs. The main range is described as an ancient geosyncline which has been above the sea since early Palæozoic times. The country to the south was invaded by Permo-Carboniferous and Cretaceous seas carrying icebergs, but the old ranges remained dry land. In later Palæozoic times isostatic adjustments to the results of erosion took place and the formations to the south were buckled. This buckling possibly continued into Tertiary times. To the north of the range the strata appear to have been practically undisturbed since Cambrian times. Mr. Madigan notes that the rivers with their southernly flow cut at right angles across the ridges and are excellent examples of antecedent rivers. The paper is illustrated by some striking photographs.

Pre-Cambrian Rocks of Quebec.—*Memoir* 166 of the Geological Survey of Canada (pp. 314 and geological map, 1931), by H. C. Cooke, W. F. James, and J. B. Mawdsley is devoted to a district in Quebec lying just east of the Ontario boundary. The main topics discussed are the Keewatin and Timiskaming series; pre-Huronian technics and intrusives; the Cobalt series; and the economic geology (sulphide deposits and gold and molybdenum deposits). The Keewatin series was here formerly called the Abitibi volcanics, but doubt as to the proper correlation has now been removed by continuous mapping from Ontario into Quebec. The internal structures of the Keewatin are described in precise and significant detail, and the observations are applied in interpreting the folding structures. Convincing evidence is given that the Timiskaming series of sediments is later than the Keewatin. Generally the discordance is slight, but in places the contacts suggest that highly-folded Keewatin lavas have been overthrust by sheets of Timiskaming formations. The intrusives include diorite-porphyry and amphibolite (earlier than the post-Timiskaming folding) and a gabbro-diorite-granodiorite-granite series (later than the folding). There are also many altered peridotites of which the age relationships are imperfectly known.

The Radioactive Constants.—The September number of the *Journal de Physique* contains the report, which also appears in the *Philosophical Magazine* and elsewhere, of an international committee which was appointed to decide upon the best values of the radioactive constants. Whilst largely devoted to tables of numerical data, it also contains some interesting comments on these. The value chosen for the number of α-particles emitted per second by a gram of radium is $3\cdot7\times10^{10}$. This is rather higher than the mean of older values, but is departed from to only a small extent by several apparently reliable recent determinations. For the uranium-radium ratio in old minerals the value $2\cdot94\times10^{6}$ has been adopted. In the matter of standard ranges of particles, certain discrepancies are noted, which perhaps throw doubt upon the accuracy of the useful relation which states that the range of an α-particle is proportional to the cube of its speed, and the report again emphasises that the use of a coefficient of absorption for β-particles, in the sense of the modulus of an exponential expression, is, although convenient, somewhat indefinite.

The Diffraction of Proton Waves.—An electrical investigation establishing the wave nature of protons of medium speed is described by Y. Sugiura in a *Scientific Paper* (No. 310) from the Tokyo Institute of Physical and Chemical Research. The method used was closely similar to one which has been used for electrons. A beam of protons was rendered homogeneous by sorting in a magnetic field, and was made to impinge upon a film of metal deposited on glass; diffraction took place at the metal crystals, and the pencils passing off were detected by an electrometer device. An electrically heated palladium tube, exposed externally to hydrogen gas, was used both as the source of hydrogen for the inside of the apparatus, and as the anode for the discharge system for accelerating the protons to the desired speeds. This proved very satisfactory, giving many more charged atoms of hydrogen than charged molecules. The wave-lengths concerned were of the order of a few hundredths of an angstrom unit, and the diffraction patterns obtained, although not very well resolved, were those which would be expected from the crystal structure as found by X-rays for the metals used.

Gallnuts as a Chemical Reagent.—In a paper in *Isis* for November, Dr. M. Nierenstein discusses the history of the use of gallnuts as a reagent. Pliny states that the black colour produced on paper soaked in extract of galls will serve to detect iron in verdigris. Although many ancient authors wrote on ‘atramentum’, no attention seems to have been paid to the phenomenon until Albertus Magnus referred to it in his botanical writings. Paracelsus describes the use of galls in detecting iron in water. Tachenius was mainly interested in the astringent principle present in the gall, and may be regarded as the founder of the chemistry of the tannins. Since alkalis react with vitriol, Tachenius regarded tannin as an alkali. A lengthy extract from this author is given, and also one from Boyle, on the use of galls in water analysis. The further references to the use of the reagent in testing for iron are more briefly discussed.

Isolation of the Radical Ethyl.—Two years ago Prof. Paneth and Herr Hofeditz of Königsberg succeeded in demonstrating the somewhat transitory existence of the radical methyl in the free state (Nature, **124**, 161, July 27, 1929). In the November issue of the *Berichte der deutschen chemischen Gesellschaft*, Prof. Paneth and Herr Lautsch describe further experiments which have resulted in the isolation of the radical ethyl by a method which differs only slightly in detail from that used in preparing methyl. Thus the lead tetra-ethyl was vaporised at - 25° C. instead of at - 70° C., and since it dissociates at a lower temperature than lead tetramethyl it was possible to substitute hard glass for quartz. The gaseous product obtained in these experiments resembled methyl somewhat closely, so that its identity had to be established. This was done by bringing it into contact with zinc, with which it reacted to form a compound which had the same melting and boiling points as zinc ethyl. Further proof was obtained when the zinc ethyl was oxidised to zinc oxide and ethyl alcohol, the existence of the latter being established by means of the iodoform reaction. The ethyl also combined with antimony to give antimony triethyl. Attempts to isolate the *n*-propyl and isobutyl radicals have not yet been successful, since these more complex products show a tendency to break down. In discussing the mechanism of the reaction involved in the disappearance of the free radicals, the authors come to the conclusion that the latter process takes place on the walls of the containing vessel and is unimolecular. They have also shown that the main product in this case is *n*-butane, which was also identified, but they did not succeed in obtaining ethane from methyl.

Portable X-Ray Medical Unit.—We have received *Bulletin* A2 from Messrs. Watson and Sons (Electro-Medical), Ltd., describing the Watson-Sankey Portable X-ray Unit, which has been designed in collaboration with Dr. R. H. Sankey. The component parts consist of a trolley base on which the apparatus is mounted, a switch board, a high-tension transformer, and a tube stand. These components are small and light, making for easy transport, and fit comfortably into dust-proof canvas cases. They can be assembled within a few minutes. It would appear to be an advantage that the apparatus can be operated on the ordinary power supply or, if necessary, on the lighting circuit. The price of the outfit is about £160, including one Metalix Radiator X-ray tube.

Astronomical Topics.

The Leonid Meteors.—The observations made in Iowa in the early hours of Nov. 16 have already been noticed (Nature, Dec. 5, p. 972). A Science Service Bulletin of Nov. 19 reports that a richer shower was seen on the morning of Nov. 17. Dr. Olivier observed from the Catskill Mountains, where the weather was perfect. Fully 900 meteors were seen here, including some fine fireballs; two of these left trains that lasted for 12 minutes each. He states that he saw more meteors this year than in 1901, which was the best display at the last visit of the rich part of the swarm. The richest half-hour was from 3.30 to 4 a.m. (add 5 hours to reduce to U.T.). Mr. A. M. Skellett observed the effect of the meteors on the transmission of wireless waves: he says, "A cloud of electrified particles accompanies every meteor in its descent. When the meteor enters the Kennelly-Heaviside conducting layer this disturbs the condition of balance, so that the effective height of the layer is temporarily lowered. A fogging of radio-signals results." This is a point that should be examined if the expected rich shower occurs next November.

Mohd. A. R. Khan, principal of the Osmania University College, Hyderabad, Deccan, writes that he observed twelve Leonids on Nov. 15, between 22^h 10^m and 23^h (Greenwich Time). Of these, the eighth was conspicuously bright. The sky was cloudy during the nights of Nov. 13 and 14, while Leo was above the horizon.

Sir William Herschel's Mirrors.—Capt. M. A. Ainslie has recently acquired two mirrors made by Sir W. Herschel; it is highly probable that one of them is the actual mirror that was in use when the planet Uranus was discovered. They are of seven-inch aperture and seven-foot focus. The two mirrors are exactly alike in these respects, and Capt. Ainslie notes that they were probably used in an attempt that was made to use them together in a binocular telescope; by placing the flats at different distances from the mirrors, it is possible to form the images at a distance apart equal to the distance between the eyes. Capt. Ainslie has had the mirrors mounted, and tested them carefully on double stars and other test objects. He gave an account of his observations at the meeting of the British Astronomical Association on Nov. 25. The reflecting power of the mirrors is not very good; it has doubtless deteriorated; but the quality of the images is astonishingly good, and some very close double stars could be separated. He observed the planet Uranus, and noted that a power of 200 showed clearly that it had a disc.

The Velocities of Distant Nebulæ.—A re-examination of the increase of radial velocity with distance for the extra-galactic nebulæ has been made by Hubble and Humason in the *Astrophysical Journal*, vol. 74, p. 43. The main difficulty lies in determining the distances of these nebulæ, for which purpose various indirect methods have to be applied. For those nebulæ in which individual stars can be recognised, the presence of cepheids, novæ, and other suitable objects forms a valuable and fairly accurate guide; the cepheids being the most trustworthy data of all. Such nebulæ then form a sample collection from which the average total luminosity of a nebula may be determined. Individual luminosities are found to be closely grouped round this mean value, which may thus be used for estimating the distances of the more remote nebulæ. This is, in fact, the only method available for such bodies, some of which are estimated to be 32,000,000 parsecs distant. The velocity-distance relation has been re-determined with the aid of new material (including Shapley's revision of the luminosity-period relation for cepheids), and the authors express it in the form: velocity = distance/1790, with an uncertainty of about ten per cent.

A paper by Humason in the same journal, p. 35, gives the results of radial velocity measurements for forty-six extra-galactic nebulæ as observed at the Mount Wilson Observatory. The largest observed velocity was 19,700 km./sec., and the observations (with one exception) confirm the velocity-distance correlation.

Scientific Management Problems.

A SIGNIFICANT feature of the centenary meeting of the British Association was the inclusion for the first time of a department devoted to industrial co-operation in Section E (Economics). Whether or not, as Major L. Urwick suggested in opening a discussion on the aims, methods, and progress of research into management problems, the contrast between the control over natural resources with which science has endowed us and our lack of control over economic and social forces exemplified in the grave economic crisis has provided the stimulus, the application of scientific methods in this field is pregnant with possibilities. While the assertion that business is science or even a profession might be challenged by many who are well aware of the debt that industry owes to science, and who might even admit that the only hope of the survival of business is in its submission to the logic of scientific method, comparatively few would dispute the statement that the only hope of any control of economic forces lies in the application at every point in the business structure of the world as the final criteria governing its actions, of the logic and methods of inductive science by which those forces have been created.

The discussion opened by Major Urwick indicates that, by inviting industrial representatives to discuss industry from the scientific point of view, the British Association has recognised the integration of industry and science. Management research aims at bringing the whole volume of existing scientific knowledge and technique to assist in the solution of problems of planning, supervision, control, and legislation involved in economic operations. As pursued by the International Management Institute, such research is free from the grotesque and unintelligent forms which so-called research of this type can assume in the service department of American universities, a tendency from which, as Flexner has shown, even the Harvard School of Business Administration is not exempt. Major Urwick rightly pointed out that the research worker in management has little concern with popular differentiations between organisations on the ground either of objective or of ownership. The service to be rendered by science in this field must be disinterested and represent in the main attempts to enlarge the boundaries of an existing department of science or to apply scientific methods to discover general principles of management.

The rapid extension of this field of inquiry, especially in America, has led to two main difficulties which retard development. The first difficulty lies in the mass of published work, much of which has unfortunately been uncritical and even unscientific. This difficulty becomes less serious with the increasing number of managers who have received formal training and with the emergence of authoritative textbooks, but the serious difficulty presented by the absence of industrial co-operation is only slowly giving way before the formation of management research groups or the use of management ratios. Even yet we know practically nothing of the principles which should govern the large-scale combinations characteristic of modern business, and beyond this, traditional thinking and vested interests of all kinds oppose scientific reorganisation of the world economy. The increased power production conferred by science has been used by all kinds of groups—social, professional, national, or venal—to secure differential advantages; and revolutionary change or social chaos can only be avoided if we can achieve methods of organisation which will give us control of the forces released by a rapidly mechanised economy. The integration of science and business on lines initiated by the British Association may secure a new approach to the whole situation.

In describing the American position, Dr. H. S. Person, managing director of the Taylor Society, New York, remarked that very little management research was comparable with the scientific research carried out in laboratories, although in its best manifestations management research sought to substitute the control of knowledge for whim and casualism, and the possibility of developing the principles and technique for the control of our economic destiny had already been demonstrated. The present industrial difficulties in the United States may be connected with individualistic and imperfectly applied industrial research which creates problems of management. Discussing the research into methods of management which in the aggregate has transformed American management, Dr. Person emphasised its practical and pragmatic basis, the methods adopted and the extent of the inquiry being determined by the specific problem under investigation. Management research was also characterised by specific findings which made it vital and constructive, and despite its rapid expansion was still incomplete and was now tackling problems of collective government. The readiness of American industry to exchange information is due to the conviction that general improvement in management and general prosperity create an environment favourable to greater individual prosperity.

Sir Horace Wilson, discussing the British position, pointed out that management research differed from technical research in that progress was almost impossible in its main subjects except by co-operative methods. Training for industry was one aspect of management research which had attracted much attention in Great Britain, and the limitation of the training given in the Department of Business Administration at the London School of Economics to students of good general education who had had two years' practical experience in business indicated a method of avoiding some of the pitfalls of such training in America. Other problems with which management research was concerned were the recruitment of personnel both for administration and for shop management, and in addition there was little experience yet available to guide us in the management of large industrial units or to indicate the limits of effective control of such units. Management research should materially assist in discovering the principles to be observed in organising such units and in providing the men capable of managing them. Many institutions, such as the British Engineering Standards Association (now the British Standards Institution), the Industrial Welfare Society, and the National Institute of Industrial Psychology, had made important contributions to special management problems. The mutual exchange of experience in the solution of particular problems could never take the place of the proper selection of personnel for key positions, but over a wide field could improve and assist the practice of management.

Dr. Hellmuth Boller, describing the Austrian position, referred to the effect of foreign competition and the foreign market required for nearly sixty per cent of Austria's industrial output as well as the persistence of a steady fifteen to twenty per cent of unemployment in the working population in forcing on management research and efficiency. Under a

National Board, groups had been organised for the exchange of experience, covering the metal, textile, and foodstuffs industries. The importance of securing the full co-operation of employees had clearly been demonstrated, and the close and intensive co-operation secured between the groups of chiefs and of subordinates was an essential method of organising exchange of experience. Confidence and mutual interest were the only sound basis for management research, and particularly in the Austrian method of critical visits to selected departments combined with advance or preliminary reports which were afterwards elaborated. No objections had been raised to the publication of the findings of sub-groups of experts based on these reports, and particular attention had been paid to budgetary control.

The Lister Institute.

THE Report of the governing body of the Lister Institute for 1931 refers to the various changes which have occurred in the membership of the governing body, council, and members and staff of the Institute during the past year, and describes in brief the numerous researches in which the staff and their co-workers have been engaged. A bibliography is appended to the Report, to which those interested in particular subjects may be referred for the fuller information to be obtained from original papers. Among the changes in staff may be mentioned the retirement of Sir Charles Martin and Prof. A. Harden. Prof. J. C. G. Ledingham took up the directorship of the Institute and Dr. R. Robison succeeded Prof. Harden as head of the Biochemical Department on Jan. 1.

The researches described may be roughly classified into investigations in experimental pathology and bacteriology and studies on nutritional subjects. The National Collection of Type Cultures is housed at the Institute, although the salaries of the necessary staff are furnished by the Medical Research Council: during the year, more than 5000 strains of bacteria and fungi have been distributed to workers in various parts of the world, and 200 types, including many new species, have been added to the collection. A third and enlarged edition of the catalogue of the collection is in course of preparation.

Prof. Ledingham has found in his studies on fowl-pox that the Bollinger bodies seen in the epithelial cells of the lesion consist of agglomerations of Borrel bodies ($0{\cdot}25\mu$ diameter) in a lipoprotein matrix. The Borrel bodies pass through Berkefeld V filters and a single one can infect, so that it is possible that these minute bodies are the actual etiological agents. Dr. G. H. Eagles and Dr. D. McClean have been able to cultivate vaccinia virus in a cell-free kidney extract and carry through a series of subcultures. The virus survives for considerable periods under anaerobic conditions in the cold, but filtration of the centrifuged kidney extract removes some property essential to prolonged survival. The virus can be filtered through the Berkefeld V: as with fowlpox virus, it is probable that the elementary bodies found in the lesions are the actual infecting agents.

Dr. E. W. Hurst has confirmed the observation that the virus of poliomyelitis (infantile paralysis) is transmitted along the axis-cylinders of the nerves. Monkeys can be infected with regularity by combining intrasciatic inoculation of the virus with mild trauma to the nerve. Virus and lesions first appeared in the lumbar cord, the latter first on the side of the inoculated nerve: the leg area of the opposite motor cortex was the next site to harbour virus, other areas only being involved much later. The lumbar cord is connected chiefly with the opposite motor cortex: there are only few connexions with other parts of the central nervous system. With Dr. R. W. Fairbrother, Dr. Hurst has also shown that infection with vaccinia virus does not modify a simultaneous infection with poliomyelitis. Dr. Morgan has been able to immunise two out of four horses to poliomyelitis and obtain a potent anti-serum. The potency is precipitated with the euglobulin fraction of the serum protein by adding up to 34 per cent by volume of saturated ammonium sulphate solution: the precipitate can be dialysed and redissolved in normal saline, giving a concentrated preparation which should be of great advantage in the treatment of the disease by the intraspinal route. Contacts with cases of infantile paralysis have been found to possess antibodies in their serum, although they have not developed the disease.

Work has also been carried out on the preparation of gas gangrene antitoxin, on the preparation of a dysentery toxin (Shiga) for use as a test toxin, and on the preparation of toxic extracts of the meningococcus for the purpose of titrating anti-meningococcal sera. A concentrated anti-staphylococcus serum has also been produced by the immunisation of a horse with staphylococcal filtrates.

Some preliminary work has been carried out under the auspices of the Accessory Food Factors Committee on vitamin standards. Miss Hume and Miss H. Smith have been investigating the suitability of pure re-crystallised carotene as a standard for vitamin A; Dr. H. Chick and Miss H. M. Jackson, a concentrate adsorbed on kaolin from an extract of rice polishings, provided by Dr. Jansen, as a standard for vitamin B; and Dr. Zilva, decitrated lemon juice as a standard for vitamin C. Miss Hume, Miss Pickersgill, and Miss M. Gaffikin have been examining the standard solution of irradiated ergosterol issued by the Medical Research Council for use in the estimation of vitamin D. They find that it is stable when kept at 0° C. Data have also been collected on the accuracy of the biological test for vitamin D. Consistent results were obtained with ten animals on each dose, good results with six, but inconsistent results with only three or four on each dose. An attempt is being made to construct a curve relating dosage and degree of calcification.

Dr. H. Schütze and Dr. S. S. Zilva have established the existence of a very definitely lowered resistance to infection with *S. Suipestifer* among rats deprived of vitamin A, as compared with animals on a complete diet.

Dr. H. Chick and Miss Copping have found that vitamin B_2 is destroyed by strengths of alcohol above 50 per cent: its solubility and precipitation limits are uncertain and appear to depend on the compounds with which it may be associated in solution. Egg white is a convenient source of this vitamin since it contains no vitamin B_1. Active concentrates have been prepared by aqueous acid extraction, which cure the dermatitis developing in rats on a vitamin B_2-free diet, but do not stimulate growth for more than a few weeks. Autoclaved yeast extracts are, however, satisfactory. It thus appears that a third factor is required by the rat for growth in addition to vitamins B_1 and B_2. This factor is also present in green-leaf vegetables, egg-yolk, and ox-liver, but absent from wheat embryo, meat, and white vegetables. Its thermostability distinguishes it from the other B vitamins hitherto described. Miss Roscoe has found no relationship between fat in the diet and the need for vitamin B_2: fat lessens the need for vitamin B_1.

Dr. W. R. Aykroyd has found that the endosperms of wheat, rice, and maize contain little vitamin B_1 as compared with the embyro or whole grain. Parboiled rice, however, even after milling, contains definite amounts, due apparently to diffusion inwards from the germ and pericarp during the boiling. Maize has been found a good source of vitamin B_2, as good as wheat, and better than rice. Pellagra, however, occurs among maize-eating peoples and is rarely observed where rice is the staple food. This result is against the theory that pellagra is due to a simple deficiency of vitamin B_2.

Miss E. M. Hume and Miss H. H. Smith have compared the effect on bone calcification in rats of diets low and rich in ergosterol, the animals being given a complete synthetic diet without vitamin D but irradiated daily. The bone ash was slightly lower in the animals on the low ergosterol diet which were not irradiated than in any of the other groups. The diet used contained no fat: many of the rats developed scaliness of the tails, which has been attributed to absence of fat from the diet. Hume and Smith observed the condition, however, in other rats on a diet containing fat, so that it must be due to some other defect in the diet.

Dr. N. S. Lucas has reinvestigated the permeability of human epidermis to radiations between 4370 A. and 2400 A. The transparency has been much underestimated, since considerable scattering of the incident light occurs, so that it fails to reach the slit of the spectrograph, although it may ultimately be transmitted by the skin at a distance from its point of entry. When allowance is made for this, by producing scattering of the light before it reaches the skin, it is found that 55 per cent is transmitted at 3130 A. and 26 per cent at 2940 A. The absorption curve agrees closely with those of casein, serum albumin, tryptophane, and tyrosine.

Dr. Smedley-MacLean and Miss Pearce have shown that when a large excess of peroxide acts on oleic acid at 95° C., less than 20 per cent of the carbon appears as formic, carbonic, and acetic acids, acids with 15 and 12 carbon atoms being obtained, that is, oxidation occurs first at the double bond followed by oxidation of the 18 carbon chain in the γ position. In the presence of a cupric salt, the oxidation proceeds much further, 70 per cent appearing as the lower acids. At 60° C. the chief products are 4-keto 7-hydroxy caprylic and succinic acids with 20 per cent of the lower acids. The evidence lends no support to the view that fatty acids are broken down by β-oxidation in the body. The presence of succinic acid is of interest since an oxidising enzyme for this acid is widely distributed throughout the tissues.

Among other researches with which the Report deals may be mentioned those of Dr. Robison on calcification *in vitro* and on the chemistry of the hexosephosphates and the work of Dr. V. Korenchevsky on the amount of fat in castrated and cryptorchid animals: degeneration or removal of the seminiferous tissue leads to an increase in fat deposition.

A New Illumination Device for Microscopy.

THE microscopic examination of opaque materials and the surface structure of natural objects have recently attracted much attention. The root idea of the Lieberkühn has been embodied in various types of ring illuminator in which the light may reach an annular reflector from below, or may be dealt with in a manner more analogous to the vertical illuminator.

Messrs. Ernst Leitz have recently brought out improved apparatus of the latter kind in which the light reaches the object from an annular illuminator around the objective, but avoiding the restriction in the size of the object which has been necessary in some arrangements. A small 8-volt lamp and condenser project a roughly parallel beam which is reflected downwards by an annular mirror held at 45° to the beam and to the axis of the microscope tube. The reflector is pierced with a central aperture which transmits the upward image-forming rays from the objective. The annular beam thus produced from the reflector enters an annular lens (or reflector system for the higher powers) and is focused on the object without traversing the objective itself. Thus the disadvantages of back reflections and stray light are avoided. The general arrangement of the parts is shown in the accompanying illustration (Fig. 1).

A special series of fifteen new objectives, comprising 'dry', 'water immersion', and 'oil immersion' lenses has been produced, in which the low-power lenses are designed to work without a cover glass over the object. Each of the low-power lenses has its own ring condenser, and rapid transition from one object to another is facilitated by the use of a convenient objective changer which clamps firmly and definitely into position. The lamp and condenser system need not be changed.

One advantage of apparatus of this kind is that the illumination can be controlled with much greater precision than with any more or less haphazard reflector arrangement, and that a systematic study of objects can therefore be commenced with less uncertainty. The interpretation of the images in some cases, especially with the higher powers, is not an easy matter, and will require careful study; diffraction effects can easily be mistaken for surface colour; nevertheless, it is clear that new investigations are possible. The well-illustrated catalogue of this 'Ultropaque Illuminator' gives photographs of various objects, amongst which are vegetable tissues, skin, chromatophores, leather, wood-sections, fabrics, and so on. This method may also have important possibilities in metallography. L. C. M.

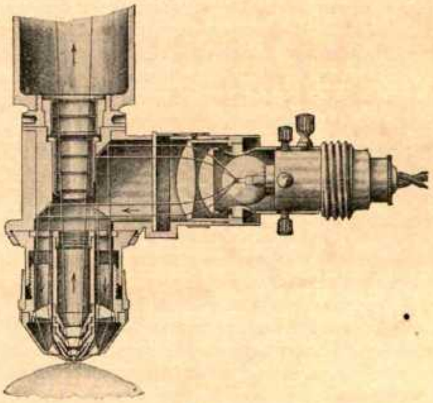

FIG. 1.

Mycorrhiza in Relation to Forestry.

IN Section K (Botany) at the recent meeting of the British Association, a report was read by Dr. M. C. Rayner on "Mycorrhiza in Relation to Forestry". The paper was drawn up by Dr. Rayner, and comprised the Report of the Committee (Mr. F. T. Brooks, Dr. Rayner, and Mr. W. H. Guillebaud), to which a grant of £40 had been made by the British Association to be spent in investigation work in this branch of research.

The purpose and scope of the investigations are explained in a preliminary statement printed in last year's British Association Report. In this statement the main objects of research are summarised as follows: (1) To ascertain whether the formation of normal mycorrhiza may fairly be regarded as a causative factor in the healthy growth of young trees, it being already assumed that it is an invariable concomitant of such growth. (2) To determine whether the absence of mycorrhiza associated with unsatisfactory growth is related to:

(*a*) Absence of the mycorrhiza-forming fungi appropriate to the trees; or

(*b*) the existence of soil conditions inimical to the formation of functional mycorrhiza of a beneficial type. (3) To ascertain whether it is practicable to supply deficiencies or ameliorate existing soil conditions by experimental treatment of nursery stock or in other ways.

The experiments carried out under (1) were made with Scots, maritime, and Corsican pines. Evidence for the first only is as yet available, but it appears to support the view that the formation of normal mycorrhiza is a causative factor of great importance to the growth of young trees. Under the second head, the presence or absence of the appropriate fungi, some interesting investigations have been carried out which in many cases require further work for substantiation upon a practical basis. The Wareham and Ringwood plantations formed the site of this research work, and under (3) it is stated that certain definite conclusions have been reached respecting the inimical causes operating in the Wareham plantations, and that experiments on the lines inaugurated will show that practical field methods at a reasonable cost can be undertaken to ameliorate the existing poor conditions.

The Report should be consulted for the details of this valuable piece of research, and it is to be hoped that funds will be available to continue it to a practical conclusion.

University and Educational Intelligence.

BIRMINGHAM.—The new ore-dressing laboratory of the Mining Department is to be opened on Dec. 16 by the Right Hon. Sir Robert Horne. At the degree congregation to be held on the same day, honorary degrees will be conferred on Sir Robert Horne and on Mr. Evan Williams, president of the Mining Association of Great Britain.

The Council is recommending to the Court of Governors that the title of emeritus professor be conferred on the former vice-president and professor of mechanical engineering, Prof. F. W. Burstall, and on the former professor of brewing and biochemistry, Prof. A. R. Ling.

The number of registered students for the current session shows a considerable increase, new entries being nearly nine per cent above those for 1930.

CAMBRIDGE.—Dr. H. C. Darby has been appointed University lecturer in geography.

The John Humphrey Plummer professorship of mathematical physics has been established. The stipend of the professor is £1200 a year or, if he holds a fellowship with dividend, £1000 a year. Candidates are requested to communicate with the vice-chancellor on or before Jan. 6. No testimonials or references need be sent. If a candidate desires to submit any, they should not exceed four in all, and in the case of testimonials, ten copies of each should be sent to the vice-chancellor not later than Jan. 6.

It has been recommended that the following sub-departments in the University shall be recognised: In the Department of Botany, the sub-departments of (1) Plant Physiology, (2) Mycology; in the Department of Zoology, the sub-departments of (1) Experimental Zoology, (2) Entomology. The directors of these sub-departments shall be the University readers in the subjects.

LONDON.—The following degrees have recently been conferred:—D.Sc. degree in chemistry on Thomas J. Drakeley (University College) for a thesis entitled "The Reactivity of Coke" (*Jour. Soc. Chem. Ind.*, Aug. 1931). D.Sc. degree in geology on Leo Picard (Imperial College—Royal College of Science) for a thesis entitled "Geological Researches in the Judean Desert" (obtainable from Max Weg, Leipzig). D.Sc. degree in physical chemistry on Frederick K. V. Koch (Imperial College—Royal College of Science) for a thesis entitled "On Ionic-Molecular Interaction" (*Jour. Chem. Soc.*, 1927–28, 1930–31; *Phil. Mag.* 1930–31). D.Sc. degree in zoology on Marjorie J. Triffitt (Bedford College) for a thesis entitled "Studies on *Heterodera Schachtii*" (*Jour. of Helminthology*, 1928–31; Imp. Bureau of Agric. Parasitology Bulletin). D.Sc. degree in chemistry on Terence T. H. Verschoyle (Imperial College—Royal College of Science) for a thesis entitled "The Ternary System Carbon Monoxide-Nitrogen-Hydrogen and the Component Binary Systems between Temperatures of − 185° and − 215° C., and between Pressures of 0 and 225 Atmospheres"; with two subsidiary contributions.

AN election to Beit fellowships for scientific research, founded and endowed by the late Sir Otto Beit, and tenable at the Imperial College of Science and Technology, South Kensington, will take place on or about July 12, 1932. The annual value of a fellowship is £250, and it is tenable for two years. Candidates must not hold any other scholarship or fellowship. Not more than three fellowships will be awarded in 1932. Applications must reach the Rector, Imperial College, South Kensington, London, S.W.7, from whom further information and forms of application may be obtained, not later than April 12, 1932.

THE thirty-second annual meeting of the Science Masters' Association will be held on Dec. 29–Jan. 1, at the Chemistry Department, Imperial College of Science, South Kensington, S.W.7. The president, Dr. Cyril Norwood, will deliver his presidential address on Dec. 29. Lectures will be given by Prof. Jocelyn Thorpe, on schools and research, Dr. G. C. Simpson, on modern weather forecasting, and Prof. E. W. MacBride, on the inheritance of acquired characteristics. Several discussions have been arranged, amongst which is a consideration of the size of classes for practical work in science. Amongst the lecture-demonstrations which will be given are those on experiments in colour, by Mr. E. G. Savage, and on television suitable for school laboratory work, by the Television Society. In connexion with the meeting, several visits of interest, and members', trade, and publishers' exhibitions have been arranged.

Birthdays and Research Centres.

Dec. 13, 1874.—Prof. R. S. Troup, C.I.E., F.R.S., professor of forestry in the University of Oxford and Director of the Imperial Forestry Institute, Oxford.

Among the many important problems affecting the British Empire at the present time there are few which afford more scope for useful investigation than the question of co-ordinated surveys dealing with vegetation and soil in relation to climate on one hand and biotic factors on the other, with a view to the recognition of the climax types which may occur and a survey of their distribution. Such surveys would place the economic use of the land on a more scientific basis than is the case at present, since they would indicate the trend of natural processes on distinct soils and sites, and would tend to prevent the policy and practice of agriculture and forestry from running counter to natural laws. The effect of clearing forest in causing the rapid deterioration of the soil opens up a large subject of investigation in different parts of the Empire.

Dec. 16, 1859.—Prof. D. H. Campbell, professor of botany in Stanford University, California.

There is great need for a classification of the archegoniates and spermatophytes more in accord with our present knowledge than is the very antiquated system employed by many taxonomists both in Great Britain and the United States. Too often taxonomists are more interested in the discovery of new species and in questions of nomenclature than in a comprehensive study of the relationships of the major plant groups.

The importance of the genetic problems, which have attracted so large a number of botanists at the present time, is unquestionable, and our knowledge of the mechanics of heredity has been greatly advanced. However, this absorption in the *methods* of evolution has directed attention from important problems dealing with the history of the plant kingdom, and we must still depend mainly upon comparative morphology, ontogeny, and the fossil record for an understanding of the course of evolution in the higher plants.

Dec. 16, 1884.—Prof. J. W. Bews, professor of botany in the Natal University College, Pietermaritzburg.

The study of South African plant ecology and plant geography continues to yield interesting results, which have an important bearing on the larger question of the evolutionary history and differentiation of the flowering plants as a whole. I am still directing my attention to these problems, from both the morphological and physiological sides. Detailed studies of other families (besides the grasses already dealt with) are being undertaken, while comparative physiological work on the water-relationships and carbohydrate metabolism of more and of less highly evolved types of plant is also being carried out with the help of students. As a further development, I am becoming interested in the study of ' human ecology '.

Dec. 17, 1861.—Mr. Edward Heron-Allen, F.R.S., hon. mem. R. Accad. S. Caecilia, Rome, past president of the Royal Microscopical Society.

My seventieth birthday finds me with my collaborator, Mr. Arthur Earland, in the middle of Part 2 of our monograph of the " Foraminifera of the *Discovery* Expedition ". When the whole of this work is finished we hope to deal with those of the Great Barrier Reef Expedition. My monograph of the " Recent Foraminifera of Great Britain ", which is kept up to date, must wait for publication (which is provided for) until after my death. Our collections and library will shortly be concentrated in a room placed at our disposal at the Natural History Museum, and their rearrangement and the keeping of them up to date, catalogued and indexed, will occupy all my ' idle ' hours for the rest of my life.

Dec. 17, 1882.—Mr. F. T. Brooks, F.R.S., reader in mycology in the University of Cambridge.

I am especially concerned at present with the problems of disease resistance in plants, particularly with those relating to parasitic invasion. These problems are of great botanical interest, and they are also of considerable economic importance. The interplay of host, parasite, and environment is an intriguing study.

Dec. 18, 1856.—Sir J. J. Thomson, O.M., F.R.S., Master of Trinity College, Cambridge, and formerly Cavendish professor of experimental physics in the University of Cambridge.

Experimental researches on problems relating to the discharge of electricity through gases, and the preparation, in collaboration with my son, Prof. G. P. Thomson, of the second volume of " Conduction of Electricity through Gases ". Theoretical investigations on the use of lines of electric force to give a physical representation of the processes going on in the electromagnetic field, including the phenomena associated with electronic waves.

Societies and Academies.

LONDON.

Geological Society, Nov. 27.—A. C. Seward: (1) Fossil plants from the Bokkeveld and Witteberg beds of South Africa. With a few exceptions the specimens are referred to a single genus, for which a new generic name is proposed. The fossils are portions of stems of a plant allied to some of the psilophytalean genera characteristic of Middle Devonian rocks in Europe. They bear a close resemblance to stems of *Cyclostigma*, but there are grounds for regarding the South African plant as rather more primitive than any of the arborescent Lycopodiales, and probably more closely related to the Psilophytales.—(2) Carboniferous plants from Sinai. In 1868 Salter briefly described a specimen from the Sinai Peninsula as *Lepidodendron mosaicum*: this name is adopted for the best specimens in this collection, and others are named *Lepidodendron sp.* and *Halonia tortuosa*. *Lepidodendron mosaicum* Salter is compared with *L. obovatum* Sternberg and with other species. The age of the Sinai beds as indicated by the plants would seem to be either near the upper limit of the Lower Carboniferous, or possibly early Westphalian. A brief reference is made to phytogeographical problems raised by the occurrence of Carboniferous plants to the south of the Tethys Sea.—T. N. George: The British Carboniferous reticulate Spiriferidæ. The short-hinged spirifers which are customarily referred to the genus *Reticularia* fall into two main groups. One group, constituting *Reticularia* proper (genotype *Terebratula imbricata* Sowerby), is characterised by relatively large forms which possess a coarse shell-structure and an apparent absence of biramous spines. The second group, referred to a new genus, contains relatively small forms with a fine shell-structure which do not advance beyond an incipiently uniplicate stage in the development of shell-sculpture.

Dublin.

Royal Irish Academy, Nov. 9.—**R. K. Boylan**: The mobilities of atmospheric large ions. Observations made by the McClelland method and also by the Zeleny divided-electrode method disclose the existence in atmospheric air not only of the Langevin ions of mobility 0·0003 cm./sec./volt./cm., but also of groups of large ions of higher and lower mobilities.—**R. Southern** and **A. C. Gardiner**: Reports from the Limnological Laboratory (2). The diurnal migrations of the Crustacea of the plankton in Lough Derg. Continuous observations on the vertical distribution of seven species of Crustacea of the plankton were made during the day and night for a period of six days from a boat anchored in the middle of Lough Derg. The daily migrations of the plankton are shown in a series of twenty histograms. Considerable variation in distribution was shown from day to day, and the causes of this variation are investigated. Certain species are composed of classes differing in their behaviour. The migrations of adult *Daphnia longispina* are precisely reversed in the case of immature forms of the same species. The males of *Cyclops strenuus* remain in deep water throughout the day and night, whilst the females and immature individuals migrate to the surface at night.

Paris.

Academy of Sciences, Nov. 3.—The president announced the death of Gabriel Kœnigs, member of the section of mechanics.—**C. Gutton** and **G. Beauvais**: Oscillators with very short waves. An experimental study of the effects of gas pressure in a valve producing short waves. For very low pressures, some hundred thousandths of a millimetre, the oscillation frequencies depend on the real frequency of the oscillating circuit. With higher pressures in the valve (0·008 mm.) a higher frequency is obtained, which is determined by the dimensions and potentials of the valve electrodes.—**Alessandro Terracini**: The reducibility of certain algebraical correspondences.—**F. Leja**: The convergence factor of series of polynomials.—**D. Belorizky**: The solution of the problem of three bodies given by Sundmann.—**Mlle. Suzanne Veil**: The diffusion and cataphoresis of methylene blue in gelatin. An application of the microphotometer to the problem. The curve of diffusion is regular and gives no evidence of the discontinuity noted by Mokruschin. The phenomenon of cataphoresis of methylene blue in gelatin is much more complex than that of diffusion.—**J. Hérenguel** and **G. Chaudron**: The preparation of pure magnesium by sublimation. The apparatus used is described and figured. After two sublimations in a high vacuum (mercury vapour pump) the magnesium contained less than 0·001 per cent of chlorine and was free from silicon and iron. The metal was fused to an ingot in the same apparatus in argon under a pressure of some centimetres.—**D. Ivanoff**: The mechanism of the reaction between ethyl carbonate and the Grignard reagent.—**L. Hackspill**, **A. Stieber**, and **R. Hocart**: Crystallised boron. It is shown that the substance sold as crystallised boron consists mainly of compounds of this element. The authors have prepared a boron of 99 per cent purity by the action of a high frequency discharge in a mixture of hydrogen and boron trichloride. Pure boron can also be obtained by the action of an incandescent tungsten filament on the vapour of boron tribromide. Both these give the same X-ray spectrum.—**Bogdan Varitchak**: The movements of the protoplasm in an Ascomycete, *Sordaria fimicola*.—**Raymond Hovasse**: Silicoflagellate or Radiolaria? A new protist, *Bosporella tricœnoides*.—**Jean Saidman**: The comparative biological properties of high frequency and very high frequency currents. Four out of the five properties discovered by d'Arsonval for high frequency currents are shown to persist with very high frequency currents. Details of four cases treated are given.—**Mme. Z. Gruzewska** and **G. Roussel**: The α-lipase of horse serum. Its activity in multiple bleedings.—**Cl. Fromageot** and **A. Porcherel**: The action of pancreatin upon different types of wool. Different kinds of wool show differences in the reaction with pancreatin, the coarser wools proving the more resistant. The loss of weight of the wool may reach 82 per cent.—**A. Ch. Hollande** and **Mme. G. Hollande**: The cytological structure of the human type of tubercle bacillus. The evolutive cycle of *Mycobacterium tuberculosis*.

Prague.

Czech (Bohemian) Academy of Arts and Sciences (Second class, Natural Sciences and Medicine), April 17.—**K. Domin**: Races and forms of *Carex sempervirens*.—**F. Némejc**: A study of the systematic position of cones of the type *Sporangiostrobus* Bode.—**F. Novotny** and **F. Toul**: An experimental study on the estimation of traces of elementary oxygen. The Binder-Weinland method is unsuitable for detecting traces of oxygen, as the red coloration, which should indicate oxygen, is very sensitive to impurities.—**F. Bílek**: Nomographic anamorphosis in a hyperbola.

June 5.—**V. Hlavaty**: An introduction to the theory of Lie groups.—**F. Herles**: The influence of digitalis drugs as shown on electrocardiograms.—**J. Vítek**: The relation of the alkaline reserve of the cerebro-spinal liquid to the alkaline blood reserve and its bearing on the diseases of the nervous system.—**J. Babička**: Polarographic analysis with the dropping mercury cathode of extracts from plant tissues. The discovery of Prof. B. Němec that the nuclei of meristematic plant cells dissolve in hot water, whereas the nuclei of non-meristematic cells are coagulated, has been confirmed by polarographic micro-analysis. The proteins which by the action of hot water split off from chromosomes were found most abundantly in the root tips of *Vicia faba* and *Alium cepa*, whilst the other parts of the root showed a gradual diminution.—**P. Sillinger**: The species *Festucetum carpaticæ* in the Low Tatra mountains compared with an analogous association in other parts of the western Carpathians.—**B. Brauner** and **E. Švagr**: A physico-chemical study of the sulphates of the rare earths. The degree of hydrolysis has been determined in sulphates of Sc, Y, La, Ce, Pr, Nd, Sm, Gd, Tb, Er, Yb, Th by conductivity measurements of the normal and acid sulphates, by the inversion of saccharose and catalysis of methyl acetate.—**V. Hovorka**: A study of the oxidation of hydrazine and semicarbazide by potassium iodate. Free iodine, liberated in this oxidation, is bound by the addition of mercuric chlorate. The reaction is promoted by acidifying with hydrochloric acid, which dissolves precipitates formed in the reaction mixture. Excess of acid is, however, undesirable. At the end of the oxidation, potassium iodide is added and the excess of iodate determined by the iodine thus liberated.—**K. Michal**: (1) The relation between the population density and the optimum for life, and of this to the sex ratio, in some invertebrates. The animals congregate to maintain a higher temperature and humidity. The optimal conditions yield more females, whilst unfavourable conditions lead to excess of males. The deciding factor is nourishment.—(2) Oscillation in oxygen consumption during the day and during the whole life of invertebrates (meal-worm, house-fly). Maximum of oxygen consumption is reached in early morning hours, when feeding is most intense; minimum at noon. Greatest consumption of oxygen occurs when the organism is half grown, and does not correspond to the rate of growth of the body.

Rome.

Royal National Academy of the Lincei, May 3.—**G. Armellini**: The horizontal diameter of the sun in 1929 and 1930. At the Campidoglio Observatory measurements are made at noon on every clear day of the sun's horizontal diameter by four independent observers. In order that the results obtained over a series of years may be strictly comparable, the method of measurement has been kept unchanged since it was introduced by Respighi in 1876. The mean values (in seconds) thus obtained for the sun's radius during the past seven years are: 1924, 961·03; 1925, 960·63; 1926, 961·02; 1927, 961·54; 1928, 961·58; 1929, 961·63; 1930, 961·68. The causes of these more or less periodic fluctuations in the solar radius are being sought in the fact that the energy produced by the sun is not always exactly equal to the energy irradiated.—**G. Abetti**: Height of the chromosphere in 1930. Observations at Arcetri show a diminution in the mean height of the solar chromosphere from 10·38″ in 1929 to 10·28″ in 1930. The observations made at Madrid and Catania indicate decreases of 0·32″ and 0·3″ respectively. The total area of the prominences, which fell by 156 units in 1928–29, has again fallen by 291 units for 1929–30. According to the international observations collected and reduced at Zurich, the relative numbers of spots underwent reduction from 65·0 in 1929 to 35·7 in 1930, and it appears that the minimum solar activity of the present cycle starting in 1923 is not far distant.—**Q. Majorana**: New photoelectric effect in alkali metal cells.—**P. Vinassa**: Valency and symmetry. The forces acting in chemical reactions modify substances, often considerably, but either do not alter the symmetry of the components or change it into other symmetrical groupings. In the depths of the earth, rocks are fused to a magma which is greatly dissociated and ionised, but the symmetry remains unaltered.—**M. Betti and P. Pratesi**: Optical resolution of racemic aldehydes (2). By means of its reaction with β-naphthylphenylaminomethane, racemic *p*-methylhydratropic aldehyde may be resolved into its optically active components.—**F. Zambonini and S. Restaino**: Praseodymium and thallous sulphates. These sulphates form the following crystalline double sulphates: $Pr_2(SO_4)_3, 5Tl_2SO_4$; $Pr_2(SO_4)_3, 4{\cdot}5\ Tl_2SO_4$: $Pr_2(SO_4)_3, 3Tl_2SO_4, H_2O$, and $Pr_2(SO_4)_3, Tl_2SO_4, 4H_2O$.—**Giuseppe Corbellini**: The associability of *m* congruences of curves in space of *n* dimensions.—**G. Mammana**: The product of series capable of summation by Cesaro's method.—**A. de Mira Fernandes**: Centres of gravity of plane sections of a homogeneous body.—**Pia Nalli**: Rigid transports of vectors in Riemannian spaces.—**B. Segre**: Poincaré's problem of pseudo-conformal representation.—**G. Colonnetti**: Theory of arches with one or two hinges.—**G. Lampariello**: The impossibility of wave propagation in viscous fluids.—**R. Zoja**: The distribution of the tensions in a solid with rectilinear axis and with rectangular section of varying height (2).—**Paolo Straneo**: The unitary theory of gravitation and electricity (2). Presentation and preliminary discussion of the equations of the field. By development of the unitary theory previously considered, equations of the field are now deduced which are the simplest to express, at the limit, the gravitational equations of Einstein on one hand and Maxwell's electromagnetic equations on the other.—**A. Corbellini**: Stereoisomerism of derivatives of 1 : 1′-dinaphthyl. 1 : 1′-Dinaphthyl-8 : 8′-dicarboxylic acid, obtainable in good yield by reducing the diazo-compound of 8-amino-1-naphthoic acid, may be separated into its two optical antipodes by fractional crystallisation or precipitation of its brucine, cinchonine or strychnine salts. Unlike those of other analogous acids, the optical isomerides here described readily undergo racemisation in alkaline solution, even at the ordinary temperature.—**F. Rodolico**: Diopside and tremolite from Monte Spinosa in the Campigliese. The composition of the sample of tremolite analysed is in agreement in some respects with the older formula, $CaMg_3(SiO_3)_4$; if, however, the substitutions assumed by Warren (1929) are accepted, the analytical results exhibit moderately good agreement with the formula $H_2Ca_2Mg_5(SiO_3)_8$. When allowance is made for the traces of limonite present and for a certain amount of alteration which the mineral has evidently undergone, the composition of the diopside examined is in accord with the accepted formula.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 17, No. 8, Aug. 15).—**A. L. Shalowitz**: The physical basis of modern hydrographic surveying. Acoustic depth sounding, in addition to increasing enormously the rate at which surveys can be carried out, has led to the development of a rapid method of position-finding at sea. A small charge of T.N.T. is exploded near the ship, the sound waves are picked up by hydrophones near the shore, and automatically radio signals are sent out from a shore station. The time interval between the explosion and receipt of the radio signal gives the distance from ship to hydrophone, provided the horizontal velocity of sound in water is known. Extensive data on the latter show close agreement between measured and theoretical velocity based on bottom temperature of the sea, suggesting that the sound wave travels mainly along the bottom layers of water.—**Andrew C. Berry**: A metric for the space of measurable functions.—**Lincoln La Paz**: The Euler equations of problems of the calculus of variations with prescribed transversality conditions.—**G. A. Miller**: Theorems relating to the history of mathematics.—**Y. H. Woo**: On the intensity of total scattering of X-rays by gases (1 and 2). A general theory for a polyatomic gas is developed, assuming that only the coherent scattered radiation from the different atoms will interfere while the incoherent radiation will be simply added up. The theory gives results in fair accord with Barrett's work on hydrogen, oxygen, and nitrogen.—**E. O. Wollan**: Note on scattering by diatomic gases. Woo's results (above) accord with the author's recent experimental work, suggesting that Woo's equation is valid wherever one can assume spherical symmetry for the atoms of the gas molecule.—**Wilder D. Bancroft and John W. Ackerman**: The solid solution theory of dyeing.—**Wilder D. Bancroft and John E. Rutzler, Jr.**: Reversible coagulation in living tissue. The sensitivity of *Mimosa pudica* can be decreased by sodium thiocyanate and salicylate (peptising agents) and also by sodium citrate and amytal (coagulating agents). Experimental results suggest that anæsthetisation of plants as of animals is due to reversible coagulation of proteins which, being partly coagulated in the normal plant of *M. pudica*, account for its sensitivity.—**Barbara McClintock**: The order of the genes *C*, *Sh*, and *Wx* in *Zea mays* with reference to a cytological known point in the chromosome.—**Harriet B. Creighton and Barbara McClintock**: A correlation of cytological and genetical crossing-over in *Zea mays*. Evidence has been obtained that pairing chromosomes, heteromorphic in two regions, exchange parts when they exchange genes assigned to these regions.—Clyde E. Keeler: A reverse mutation from 'dilute' to 'intense' pigmentation in the house mouse.—Howard B. Frost: Trisomic inheritance of doubleness, complicated by lethals, in *Matthiola incana.*

Diary of Societies.

FRIDAY, December 11.

Andersonian Chemical Society (at Royal Technical College, Glasgow), at 3.15.

Biochemical Society (at London School of Hygiene and Tropical Medicine), at 3.30.

Royal Astronomical Society, at 5.—Prof. Freundlich: On the Gravitational Deflection of Light (Total Solar Eclipse, 1929, May 9).

Royal Geographical Society, at 5.—The British Expedition to Greenland (Films).

Royal Society of Medicine (Ophthalmology Section) (at Royal Eye Hospital, St. George's Circus), at 5.

Royal Society of Medicine (Clinical Section), at 5.30.

Malacological Society of London (at Linnean Society), at 6.

Institution of Chemical Engineers (at Chemical Society), at 6.

Institution of Mechanical Engineers, at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.

Institution of Structural Engineers (Informal Meeting) (at Chamber of Commerce, Birmingham), at 6.30.

Society of Dyers and Colourists (jointly with Manchester Literary and Philosophical Society—Chemistry Section) (at 36 George Street, Manchester), at 7.

Institution of Electrical Engineers (London Students' Section), at 7.

Geologists' Association (North-East Lancashire Group) (at Blackburn Technical College), at 7.

Oil and Colour Chemists' Association (Manchester Section) (at College of Technology, Manchester), at 7.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow), at 7.15.

Society of Chemical Industry (South Wales Section) (jointly with Institute of Chemistry) (at Thomas' Café, Swansea), at 7.30.

Junior Institution of Engineers, at 7.30.

Textile Institute (Lancashire Section) (at Manchester), at 7.30.

Keighley Association of Engineers (at Queen's Hotel, Keighley), at 7.30.

Royal Institution of Great Britain, at 9.—Prof. H. J. Fleure: City Morphology in Europe.

SATURDAY, December 12.

Geologists' Association (Demonstration at Natural History Museum), at 2.30.

North of England Institute of Mining and Mechanical Engineers (at Newcastle-upon-Tyne), at 2.30.

Royal Institution of Great Britain, at 3.—Roger Fry: Great French Painters (2).

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.

MONDAY, December 14.

Royal Society of Medicine (United Services Section), at 5.

Institution of Mechanical Engineers (Graduates' Section, London), at 6.15.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.

Society of Chemical Industry (Yorkshire Section) (jointly with Refractories Association of Great Britain) (at Royal Victoria Hotel, Sheffield), at 7.

Institute of Metals (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.

Royal Institute of British Architects, at 8.

Royal Geographical Society, at 8.30.

Institution of Electrical Engineers (Western Centre) (at Bristol).

TUESDAY, December 15.

Royal Institution of Great Britain, at 5.15.—Dr. F. J. W. Whipple: Air Waves and how they are used to explore the Upper Atmosphere (2).

Royal Society of Medicine, at 5.30.—General Meeting.

Institution of Civil Engineers, at 6.

Institute of Industrial Administration (Annual General Meeting) (at Institute of Hygiene), at 6.30.

London Natural History Society (Entomology Section) (at London School of Hygiene and Tropical Medicine), at 6.30.

Society of Chemical Industry (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 6.45.

Institution of Electrical Engineers (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.

Quekett Microscopical Club (at 11 Chandos Street, W.1), at 7.

Society of Chemical Industry (Edinburgh and East of Scotland Section) (jointly with Institute of Chemistry—Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.

Royal Anthropological Institute, at 8.30.

WEDNESDAY, December 16.

Society of Glass Technology (at Leeds), at 2.

Glasgow University Alchemists' Club (at Glasgow University), at 3.30.

Royal Society of Medicine (Comparative Medicine), at 5.

Royal Meteorological Society, at 5.

Geological Society of London, at 5.30.

Newcomen Society for the Study of the History of Engineering and Technology (at 17 Fleet Street), at 5.30.

Royal Microscopical Society (at B.M.A. House, Tavistock Square), at 5.30.

Institution of Automobile Engineers (Leeds Centre) (at Metropole Hotel, Leeds), at 7.15.

Folk-Lore Society (at University College), at 8.

Royal Philosophical Society of Glasgow (at 207 Bath Street, Glasgow), at 8.

Royal Geographical Society, at 8.30.—The British Expedition to Greenland (Films).

Institute of Brewing (North of England Section) (at Midland Hotel, Manchester).

THURSDAY, December 17.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Institution of Electrical Engineers, at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Mining Institute, Newcastle-upon-Tyne), at 6.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.

Royal Photographic Society of Great Britain, at 7.

Institution of Electrical Engineers (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.

Chemical Society, at 8.—Discussion on The Critical Increment of Homogeneous Reactions.

Institute of Brewing (Scottish Section) (at Caledonian Hotel, Edinburgh).

FRIDAY, December 18.

Society for Experimental Biology (in Department of Zoology, University College), at 10.30 A.M., at 2.15, at 4, and at 5.30.

Institution of Electrical Engineers (London Students' Section), at 6.15.

Royal Photographic Society of Great Britain, at 7.

Society of Dyers and Colourists (Glasgow Section) (at George Hotel, Glasgow), at 7.15.

Society of Chemical Industry (Glasgow Section) (at Royal Technical College, Glasgow), at 7.30.

Society of Chemical Industry (South Wales Section) (at Technical College, Cardiff), at 7.30.—Christmas Lecture.

Leicester Literary and Philosophical Society (Chemistry Section) (jointly with Leicester Association of Engineers) (at College of Technology, Leicester), at 7.30.

South London Botanical Institute (at 323 Norwood Road, S.E.24), at 8.

Institute of Chemistry, at 8.—Sir Frank E. Smith: The Chemist and the Community (S. M. Gluckstein Memorial Lecture).

Royal Institution of Great Britain, at 9.—Rev. Dr. C. Alington: The Education of the Average Man.

SATURDAY, December 19.

Society for Experimental Biology (in Department of Physiology, University College), at 10.30 a.m., and at 2.15.

Royal Institution of Great Britain, at 3.—Roger Fry: Great French Painters (3).

North-East Coast Institution of Engineers and Shipbuilders (Tees-Side Branch—Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

Public Lectures.

SATURDAY, December 12.

Horniman Museum (Forest Hill), at 3.30.—Dr. W. G. Ivens: Negroid Peoples of the Pacific Islands.

TUESDAY, December 15.

Imperial Institute, at 2.15.—Capt. A. E. Watts: Hong Kong.

WEDNESDAY, December 16.

Imperial Institute, at 2.15.—Capt. H. Luxmoore: New Zealand.

Royal Institute of Public Health, at 4.—Sir Pendrill Varrier-Jones: The Welfare of the Tuberculous Citizen.

THURSDAY, December 17.

Imperial Institute, at 2.15.—Major G. D. Heslop: Tanganyika.

Science Museum (South Kensington) (in connexion with Exhibition of Modern Glasses), at 4.45.—J. Hogan: Stained and Painted Glass.

Official Publications Received.

British.

Southern Rhodesia Geological Survey. Bulletin No. 18: The Geology of the Country around Shamva, Mazoe District. By R. Tyndale-Biscoe. Pp. 87+11 plates. 8*s.* 9*d.* Short Report No. 27: Notes on Mixing in the Felixburg Goldfield. By J. C. Ferguson. Pp. 16. (Salisbury.)

Annual Report for the Year ended March 31st, 1931, of the Executive Council of the National Institute for the Blind. Pp. 84. (London.)

Union of South Africa: Department of Mines and Industries: Geological Survey. The Geology of the North-Eastern Pretoria District and adjoining Country. An Explanation of Sheet No. 18 (Moos River). By B. V. Lombaard. Pp. 48. (Pretoria: Government Printing Office.) 5*s.* (including Map).

Society of Chemical Industry: Chemical Engineering Group. Proceedings, Vols. 11 and 12, 1929 and 1930. Pp. 153. (London.) 10*s.* 6*d.*

Journal of the Royal Microscopical Society. Series 3, Vol. 51, Part 3, September. Pp. xvi+221-346. (London.) 10*s.* net.

Battersea Polytechnic, London, S.W.11. Report of the Principal for the Session 1930–31. Pp. 43. (London.)

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Year ended March 31st, 1931. Pp. 51. (London: The Crown Agents for the Colonies.) 5*s.*

Heriot-Watt College, Edinburgh. Calendar, Session 1931–1932. Pp. 814. (Edinburgh.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1388 (Ae. 510—T. 2956): Velocity in a Wind Channel Throat. By T. E. Stanton. Pp. 3+2 plates. 4*d.* net. No. 1396 (Ae. 517—T. 2934a): Breakaway of Boundary Layer on a Cylinder and an Aerofoil. By J. J. Green. Pp. 8+2 plates. 6*d.* net. No. 1406 (Ae. 527—T. 2980, "a" and "b"): Take-Off and Landing of Aircraft. By D. Rolinson. Pp. 25+26 plates. 1*s.* 9*d.* net. (London: H.M. Stationery Office.)

Proceedings of the Royal Irish Academy. Vol. 40, Section B, No. 10: The Loo Valley, Co. Kerry. By A. Farrington. Pp. 109-120. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d.*

Department of Scientific and Industrial Research. Report of the Radio Research Board for the Period ended 31st December 1930. Pp. iii+90+4 plates. (London: H.M. Stationery Office.) 2*s.* net.

Western Australia. Annual Progress Report of the Geological Survey for the Year 1930. Pp. 16+10 plates. (Perth: Fred. Wm. Simpson.)

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 9, September. Abstracts Nos. 1547-1782. Pp. 295-330. (London: H.M. Stationery Office.) 9*d.* net.

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931. Vol. 43, No. 9, October. Pp 393-448+xxxviii (London.)

Proceedings of the Cambridge Philosophical Society. Vol. 27, Part 4, 31 October. Pp. 491-604. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 42, Part 3, October 28th. Pp. 217-303. (London: Edward Stanford, Ltd.) 5*s.*

Foreign.

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 737-D: Geology and Water Resources of the Middle Deschutes River Basin, Oregon. By Harold T. Stearns. (Contributions to the Hydrology of the United States, 1930.) Pp. v+125-220+plates 10-18. 35 cents. Water-Supply Paper 638-A: A Preliminary Report on the Artesian Water Supply of Memphis, Tennessee. By F. G. Wells. (Contributions to the Hydrology of the United States, 1931.) Pp. ii+34+2 plates. Water-Supply Paper 642: Surface Water Supply of the United States, 1927. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. v+103. 20 cents. Water-Supply Paper 651: Surface Water Supply of the United States, 1927. Part 11: Pacific Slope Basins of California. Pp. ix+299. 45 cents. Water-Supply Paper 652: Surface Water Supply of the United States, 1927. Part 12: North Pacific Slope Drainage Basins. A: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. v+111. 20 cents. Water-Supply Paper 653: Surface Water Supply of the United States, 1927. Part 12: North Pacific Slope Drainage Basins. B: Snake River Basin. Pp. vi+230. 35 cents. Water-Supply Paper 654: Surface Water Supply of the United States, 1927. Part 12: North Pacific Slope Drainage Basins. C: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. vi+142 20 cents. Water-Supply Paper 661: Surface Water Supply of the United States, 1928. Part 1: North Atlantic Slope Drainage Basins. Pp. vii+235. 35 cents. Water-Supply Paper 664: Surface Water Supply of the United States, 1928. Part 4: St. Lawrence River Basin. Pp v+119. 20 cents. Water-Supply Paper 666: Surface Water Supply of the United States, 1928. Part 6: Missouri River Basin Pp. vii+207. 35 cents. Water-Supply Paper 667: Surface Water Supply of the United States, 1928. Part 7: Lower Mississippi River Basin. Pp. iv+80. 15 cents. Water-Supply Paper 669: Surface Water Supply of the United States, 1928. Part 9: Colorado River Basin. Pp. iv+96. 20 cents. Water-Supply Paper 670: Surface Water Supply of the United States, 1928. Part 10: The Great Basin. Pp. v+95. 20 cents. Water-Supply Paper 671: Surface Water Supply of the United States, 1928. Part 11: Pacific Slope Basins in California. Pp. ix+304. 45 cents. Water-Supply Paper 672: Surface Water Supply of the United States, 1928. Part 12: North Pacific Slope Drainage Basins. A: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vi+138. 25 cents. Water-Supply Paper 665: Surface Water Supply of the United States, 1928. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. v+109. 20 cents. Water-Supply Paper 668: Surface Water Supply of the United States, 1928. Part 8: Western Gulf of Mexico Basins. Pp v+123. 20 cents. Water-Supply Paper 673: Surface Water Supply of the United States, 1928. Part 12: North Pacific Slope Drainage Basins. B: Snake River Basin. Pp. vi+172. 25 cents. Water-Supply Paper 674: Surface Water Supply of the United States, 1928. Part 12: North Pacific Slope Drainage Basins. C: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. vi+155. 25 cents. Water-Supply Paper 691: Surface Water Supply of the United States, 1929. Part 11: Pacific Slope Basins in California. Pp. ix+294 45 cents. (Washington, D.C.: Government Printing Office.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 325: The Isothermal and Adiabatic Compressibilities, the Specific Heat and the Heat Conductivity of Liquids. By Hikoichi Shiba. Pp. 205-241. 40 sen Nos. 326-327: Hyperfine Structure of Mercury, by Kiyoshi Murakawa; Note on the Zeeman Effect of Neon, by Kiyoshi Murakawa and Tatsuro Iwama. Pp. 243-259. 25 sen. Nos. 328-329: La malmoliĝo de *Moti*, Japana Rizmanĝajo, de Tutomu Maeda kaj Ryûzô Syôzi; Kial Alkoholoj Malakcelas la Malmoliĝon de Gipscemento? de Sigeru Yamana. Pp. 261-283. 35 sen. Supplement No. 14: The Effects of Iron on the Electrical Conductivity and Tensile Strength of Aluminium. By Masawo Kuroda. Pp 2. 10 sen. (Tokyo: Iwanami Shoten.)

Catalogues.

A Collection of Modern Books in all Classes of Literature offered at Greatly Reduced Prices. (No. 451.) Pp. 32. (London: Bernard Quaritch, Ltd.)

A Classified List of Scientific Periodicals and Publications of the Learned Societies. (New Series, No. 26.) Pp 56. (London: Wheldon and Wesley, Ltd.)

The B.D.H. Book of P.P.P. Standards. Pp. 35. (London: The British Drug Houses, Ltd.)

Nickel, B 8: Nickel Cast Iron in the Automobile Industry. Pp. 20. (London: The Mond Nickel Co., Ltd.)

Recent Purchases from the Libraries of the late Very Rev. H. Montagu Butler, Dr. Joseph R. Tanner, Mrs. H. M. Butler, and other sources. (No. 460.) Pp. 44. (Cambridge: Bowes and Bowes.)

After-Treatment in Photography. Pp. 12. (London: Burroughs Wellcome and Co.)

A Catalogue of Important and Rare Books on Botany, Agriculture, Forestry, Fruit-Culture, Gardens and Gardening, Herbals, Early Medicine and Surgery, Tobacco. (No. 450.) Pp. 124. (London: Bernard Quaritch, Ltd.)

NATURE

SATURDAY, DECEMBER 19, 1931.

CONTENTS.

	PAGE
University Training in Relation to Industry	1017
Early Man in Kenya	1019
The Development of Formal Logic. By Dr. Thomas Greenwood	1021
The Works of Scheele	1023
Coal and its Use. By R. Wigginton	1024
Short Reviews	1025
The Changing Outlook in Agriculture. By Sir John Russell, O.B.E., F.R.S.	1027
Faraday and Marine Boilers	1031
News and Views	1031
Letters to the Editor :	
Polarisation of Downcoming Wireless Waves in the Southern Hemisphere.—Prof. E. V. Appleton, F.R.S.	1037
Oxygen and Everest.—N. E. Odell	1037
Lead Content of Rocks.—Prof. G. Hevesy and Dr. R. Hobbie ; Prof. Arthur Holmes	1038
Limits of Gaseous Explosions.—M. Neumann and A. Serbinoff	1040
The Comma Butterfly in England.—F. Tutin	1041
Preservation of the Australian Flora and Fauna.—Sir James W. Barrett, K.B.E., C.B.	1041
Distribution of Agar-liquefying Bacteria.—Hugh Nicol	1041
Periodic Precipitation in the Absence of Colloids.—Prof. James W. McBain, F.R.S.	1042
Bands in the Spectrum of Barium Hydride.—Dr. A. Schaafsma	1042
Matter: Life: Mind.—Dr. Maurice Copisarow	1042
Research Items	1043
Astronomical Topics	1045
The Ramsay Memorial Laboratory of Chemical Engineering at University College, London	1046
Psychology and Organised Religion	1047
Orbit and Mass of Pluto	1047
A New System of Film Projection	1048
University and Educational Intelligence	1048
Birthdays and Research Centres	1049
Societies and Academies	1049
Diary of Societies	1051
Official Publications Received	1051

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University Training in Relation to Industry.

IN an address delivered at Oxford during the annual meeting of the Association of Special Libraries and Information Bureaux, Prof. A. M. Carr-Saunders suggested that in the tendency for the modern university to give professional training we are returning to the old tradition, when the prime function of a university was to equip its members for life, even though life was to them represented at first by no more than the Law or the Church. In this view he is supported by Prof. S. Alexander, who recently suggested to a Manchester audience that the inclusion of technology is the distinctive feature of university work and the best key to the understanding of the real business of a university (*Political Quarterly*, July–September).

At first sight this attitude may appear sharply opposed to the view of J. S. Mill that " Universities are not intended to teach the knowledge required to fit men for some special mode of gaining their livelihood. Their object is not to make skilful lawyers or physicians or engineers, but capable and cultivated human beings." The contrast, however, is more apparent than real, for Prof. Alexander's assertion that " What the University seeks to provide is the command of a subject, afterwards to be applied, which will make the application worthy of a free man " is scarcely to be distinguished from Mill's conclusion : " What professional men should carry away with them from an University is not professional knowledge, but that which should direct the use of their professional knowledge and bring the light of general culture to illuminate the technicalities of a special pursuit ". Essentially, however, Prof. Alexander, as much as J. S. Mill, is concerned that the graduate should acquire that sense of values which is essential to the intelligent use of knowledge. Sir J. J. Thomson, in his presidential address to Section A (Mathematical and Physical Sciences) of the British Association on Sept. 24, directed attention to the danger of over-specialisation in research courses, even in laboratories where the importance of mental training is fully realised, and asserted that the student often spends too much time in performing his experiments and too little time in thinking about them.

Sir J. J. Thomson's further remark, that methods of mass production cannot be applied to education without disaster, is of the greater interest in view of the attempts being made in Soviet Russia to provide the technicians required for the execution of the Five-Year Plan. The success or failure of this attempt at mass technical education is of intense interest to the rest of the world. The difficult conditions which prevail in industry at the present time make it indisputable that the nation whose industry commands the best brains, the most efficiently trained recruits, and the highest degree of technical skill, will have an advantage of which no artificial economic barriers can deprive it. Perhaps nowhere outside Great Britain is it more certain that the efficient training of personnel for industry is an essential factor in the permanent recovery of industrial prosperity.

Through our ubiquitous examination system, the rapid growth of knowledge in certain branches of science, notably in chemistry and in physics, has reacted on the successful candidate in a way that frequently detracts from his usefulness in industry. The danger is seen clearly enough by some, at any rate, of our teachers of science, but most of them are powerless in the grip of the system, and industry finds that its recruits are commonly well acquainted with a mass of scientific facts and lacking in the knowledge of scientific methods and principles. It must be recognised that the early specialisation in the schools, which our competitive examination system encourages, and the defective and limited teaching of general science in elementary and secondary schools, are real difficulties to the university in teaching independence of mind.

The task of utilising the sciences as a medium for imparting a training in the methods of science and of the philosophy of science is indeed herculean, and is not assisted by the suggestion that teaching is but an interlude in the proper work of a professor. The relation of research to teaching and to the examinations, which, in some form or other, can scarcely be avoided, is a crucial problem, and part at least of the present unsatisfactory situation is due to the absence of great teachers like Hofmann. Schools of science are founded by more than research, and the technique, which Major F. A. Freeth has rightly pointed out as one of their characteristics, is acquired as a result of teaching the methods and principles of science and not the imparting of facts or the prosecution of a research so as to obtain rapid results.

Although the right relation between research and teaching is the key to the situation, in Great Britain difficulties arise from the fact that, while our universities are not yet sufficiently advanced to insist on the advancement of knowledge as a necessary part of their existence, there are many who regard the prime work of a professor as research, and his teaching functions as purely subordinate and secondary. It is true that no great school of organic chemistry, for example, can be developed at a university apart from a flourishing research school. What may easily escape notice is that able teaching in the methods and technique of science inevitably results in the production of brilliant research workers whose services are widely sought and valued; whereas a brilliant investigator who cannot teach frequently gathers round him students who are schooled only in a narrow technique, the independent application of which they are unable to attempt.

The closer relations which are developing between industry and the universities may ultimately lead to a solution. In the first place, industry already recognises the importance of fundamental research work and also that this is most fittingly carried out at the universities, although not now confined to them. Once this is definitely established as a principle, the universities will have won the required public recognition that advancement of knowledge is part of their work, and can consider the relation between teaching and research without fear of prejudicing the position of the latter.

There is, however, further point in the clarification of industry's own ideas about the standard of recruit it desires, which is equally important. It is more and more widely asserted that, given an adequate training in scientific methods and principles, the particular facts which are the medium of that training matter little. Given recruits who have learnt the use of knowledge, industry will rapidly teach them the facts and problems upon which their ability is to be exercised, and more rapidly than is possible outside. Important industrial firms frequently devote much care to the training of their recruits and to discovering the particular sphere for which they are most suited, and an exchange of personnel designed to counteract the mental staleness or narrowness of outlook which doubtless account for Mr. Ford's distrust of the expert is not uncommon. Sir J. J. Thomson referred to the general experience that new ideas about a subject come when one is not thinking about it, or at least when the thread of one's thought is broken, and Prof. Graham Wallas, in " The Art of Thought ", makes the point that periods of incubation free from conscious thought on the particular problem are of vital importance to thinking. Undoubtedly, industry, no less than the university, is fully alive to the danger of mental sterility in the specialisation engendered in scientific research and to the importance of stimulating creative thought and originality.

This tendency is definitely opposed to that prevailing in Russia under the Five-Year Plan, where the old ‘ polytechnics ’ are steadily being converted into highly specialised ‘ monotechnics ’. The latter policy may be unavoidable under the present exigencies ; but, although the authorities may be alive to the importance of a proper adjustment between quality and quantity in this mass production of technicians, it seems inevitable that something of quality must be sacrificed to quantity, and there are other dangers. Science, like industry, has now reached a stage when advances come not merely from the work of specialists but also from the co-operative work of different classes of scientific workers upon specific problems, and especially from the contribution of minds which can both specialise and generalise. In this co-operative work a wider technique and wider outlook are demanded of the specialist, and this cannot be acquired in the ‘ monotechnic ’.

It is only one phase of this tendency that scientific research, whether prosecuted at the universities or in industry, is more and more concerned with the consequences of applying the new knowledge. More and more, a sense of values and of perspective is demanded of scientific as well as of industrial research, and the call for more attention to be paid to the social sciences is only one example. It should be noted that, as Flexner points out, in his recent work on “ Universities : American, English, German ” (see NATURE, Nov. 14, p. 811), this does not imply that the universities should be concerned directly with the conduct of business, politics, and industry ; but that they should select, as the material for their studies, problems of real value and bring to bear upon them a detached mind. In urging this, Flexner stresses that the business of a university is the advancement of knowledge, the study of problems from whatever source they come, and the training of men ; and he deprecates strongly the multiplication of subjects or even the prosecution of technical education at a university. The absence of values or proportion in so much of the so-called specialisation in American universities shows what a danger may lurk here. Perhaps, as already indicated, the best prospect for the application of scientific thought and method to national and world problems, enabling society to regain control over events, lies in this reflex action of industry on the universities. If society and industry look increasingly to the universities for the study of the fundamental problems of both the physical and social sciences and ensure adequate provision for the prosecution of such research, it should be easier for the universities to free themselves from the thraldom of an obsolete examination system and devote themselves to the production of graduates characterised not by their acquaintance with a multitude of unrelated and undigested facts, but by a sense of values and a judgment requiring only the ripening of experience to enable them to apply the methods and principles of science to the solution of any problem with which they may be confronted. The prime function of a university is to train intelligence, and industry cannot be satisfied with any education, university or not, which does not at least enable its possessors to attack new tasks or problems successfully.

Early Man in Kenya.

The Stone Age Cultures of Kenya Colony. By L. S. B. Leakey. With Appendices by J. D. Solomon, C. E. P. Brooks, A. T. Hopwood, H. C. Beck, and M. Connolly. Pp. xiii + 288. (Cambridge : At the University Press, 1931.) 25*s.* net.

LEAKEY here begins an account of a very marked advance of knowledge concerning early man. The luck of a good hunter and careful preparatory study along several lines have led to a great achievement. The text is commendably short, and Mrs. Burkitt has enriched it with large numbers of fine drawings. Solomon's studies of the deposits concerned add greatly to the value and interest of the book.

For beds near the Kariandusi river above Lake Elmenteita, and containing tools, Leakey and Solomon have adopted the name ‘ Kamasian ’, given by Prof. J. W. Gregory to beds he included in a Miocene series. There is obviously matter here for further investigation on both sides. All that concerns the main argument is that certain beds contain, as original constituents, Chellian and Acheulian *coups de poing,* often of fine type, many of which are flakes rather than cores. There are also chisel-like cleavers, such as have now been described for the Stellenbosch culture in South Africa and the Acheulian in Europe and North Africa.

The beds concerned include large amounts of diatomite, and bear witness to a period when large areas in the Rift Valley were under water. At the end of the period there were earth movements and volcanic eruptions, and there are indications that these occurred in a dry period.

Leakey describes next a Nanyukian culture which, for him, shows evolution from the Kenya Acheulian to the Kenya Mousterian, and may belong to the period of earth movements. This is a very tentative suggestion.

Then followed Leakey's Gamblian period, during which a lake in the Nakuru-Elmenteita region rose to 700 ft. above the present lakes, sank to below 300 ft. above them, so that parts of the lake floor became land surfaces, still recognisable by rootlet channels in the layers concerned, and then rose once more to 510 ft. (490-530 ft., for there was slight tilting later on). Above the Gamblian deposits are layers showing severe desert conditions.

During this long, but not uniform, wet period, cultures closely akin to European Mousterian and Aurignacian, but using mainly obsidian, existed side by side in Kenya, the former in the open, and over a very wide area from Kavirondo to Mombasa, as researches by Archdeacon Owen and by Mr Rickman are showing. The Kenya Aurignacian, on the other hand, belongs especially to caves. Though the Kenya Mousterian is, in Leakey's opinion, mainly a local evolution from the Nanyukian, it shows from the beginning the typical Mousterian points with faceted striking platform and secondary working. This culture develops into something akin to the South African Still-Bay phase with implements delicately worked on both faces. Burkitt thinks the Kenya Mousterians learned a lot from their Kenya Aurignacian contemporaries. Leakey apparently prefers the name Aurignacian to the name Capsian.

The Kenya Aurignacian culture lasted all through the wet period under discussion, but the evidence is chiefly from the time of the later maximum (the 510 ft. lake). Blunt-backed blades with Chatelperron points, and several types of burins, scrapers, and so on, occur. Leakey discusses specially long, thin flakes, triangular in section, often with one used edge and the opposite flake-surface showing a bulb of percussion. He thinks they are chipped-off worn edges of blocks that had been used for fine pressure-flaking. Some of these flakes were also used after being chipped away from the block; similar flakes had puzzled workers in other regions. Another type of implement has been named by Leakey a sinew-frayer; it has a rough and irregular edge used, he thinks, as are any jagged edges nowadays, by the natives. M. Breuil notes analogous tools in Europe. Leakey found some lunates in such a position as to leave no doubt that they had been mounted as barbs of a wooden arrow-head with their cutting edges forwards. Some burins were most useful tools for making grooves in wooden arrow-heads for insertion of lunates. At least two pieces of 'pottery' occurred definitely *in situ*; one was inclined to disintegrate when washed; the other was harder and patterned as if made by smearing clay inside a grass basket. Here, therefore, dies the venerable notion that agriculture antedates the invention of pottery, unless, indeed, this culture in Kenya is very late or the pottery is accidental. Other finds include ostrich egg-shell beads, some apparently deliberately stained. Human remains are more like those of ancient Europeans than of any peoples of torrid Africa, and they are to be described in a later volume.

After the intensely desertic period the lake redeveloped with diatomite deposits. This wet period, called by Leakey Makalian, is represented only by thin deposits containing a late and aberrant development of the Kenya Aurignacian culture with large quantities of pottery. To this culture Leakey gives the name Elmenteitan, and one may commend the care with which he has created separate names for cultures and for periods determined by climate. One site of this phase of culture yielded a number of non-African skeletons, some with very narrow noses.

Multitudes of microliths in Kenya, as in North Africa and Europe, end the palæolithic phase of culture. Leakey adopts for this industry the name of Kenya Wilton, because of resemblances to the Wilton industry in South Africa; there is a good deal of associated pottery.

The neolithic cultures of Kenya are briefly discussed, pending further work. They are named Gumban *A* (with pottery, lunates, scrapers, stone-bowls, etc.) and Gumban *B* (with stone-bowls, pottery, tools of obsidian, and bone and beads). These finds accompanied burials, and one cannot say which is earlier. The Njoroan culture yields burials which, unlike all earlier ones, are extended full length; one polished axe has been found in a burial and others occur casually. Obsidian flakes continued in use.

Absolute dates for this important series of cultures are a problem, and, with characteristic courage, Leakey, supported in large measure by Wayland, C. E. P. Brooks, and Miss Caton-Thompson, makes his chief pluvial periods contemporary with Pleistocene ice maxima in Europe. The Kamasian, containing Chellian and Acheulian tools, he associates with the older maxima, called, in the Alpine region, the Gunz and the Mindel. His succeeding dry interval would then be correlated with the long Mindel-Riss interglacial, a period, according to central European glaciologists, of climates warmer than the present one and fairly moist, as evidenced by the finds in the Hötting breccia. The second long wet period, the Gamblian, would, on the same basis, be correlated with the Riss and Würm maxima of the Alpine glaciation. This scheme is broadly useful as a working hypothesis.

The slighter Makalian wet phase is correlated by Brooks, and by Leakey and Solomon, with what used to be called the Bühl re-advance during the post-Würmian ice retreat. Here we have some doubts. There seems little indication that between the Würm and the Bühl stadia in the Alps, or between stadia that have been supposed to be more or less their contemporaries in the Baltic, there was any really warm period; and, if the correlation of European and African stadia is maintained, the intense desertic conditions between Gamblian and Makalian in Kenya would suggest a very marked climatic oscillation in Europe between Würm and Bühl. It might, therefore, be well to keep in mind as an alternative hypothesis, if the correlation of climates has anything in it, that the Kenya Gamblian covers what in the Alps includes Riss, Würm, and Bühl. This makes it conceivable that the upper Aurignacian of Kenya may not be of quite such immense antiquity as it would otherwise be necessary to imagine. The Elmenteitan culture, of the Makalian wet phase, might on this view be contemporary with one of the minor and later regrowths of glaciers in Europe, for example, that described for the Alps as the Gschnitz. In any event, however, this study of climatic correlations is only in its infancy.

If the lower Aurignacian reached Europe across the Mediterranean from North Africa, and the middle Aurignacian reached our continent from the Palestinian region, we can picture a little of early culture spreads from both north and south sides of what is now the great zone of hot deserts in northern Africa and south-west Asia, but was less desertic then. The resemblances in implements, and to some extent in human types, suggest that the two spreads (north and south) may not have been separated by a long period of time.

The poverty of evidence of anything analogous to the Kenya finds farther west in Africa seems not entirely due to lack of investigation, and one recalls Falconer's interesting conclusion in Nigeria, that, in Pleistocene times, before the Sahara had become fully desertic, a desert belt lay farther south, as one would expect if there is anything in the hypothesis of climate correlations based on shifting of the main climatic zones. A desert belt would limit the spread of early man, but the Nile might well give him a way southwards into the east of Africa. Orographical changes in the later Pleistocene in the Red Sea region may have helped movements between Arabia and Africa and southward in East Africa.

Those interested in prehistoric man will have noted the important parallels between some of the early Kenya cultures and those of South Africa. This is a subject receiving new illumination from van Riet Lowe, Goodwin, and Breuil, and from Armstrong's results from Bambata, Rhodesia, and more may be expected from the joint work of Reck and Leakey in Tanganyika. South African cultures seem to be the drifted descendants, having also sometimes intermingled *en route*, of some of those of Kenya. The later volume on physical types of men will link itself with Broom's interesting studies in South Africa.

Leakey's work bristles with points of wide interest and invites discussion of big principles; there may be modifications of hypotheses in the future, but the hypotheses are at any rate very promising and serviceable, and the work done is first-rate.

The Development of Formal Logic.

A Treatise of Formal Logic: its Evolution and Main Branches, with its Relations to Mathematics and Philosophy. By Prof. Jørgen Jørgensen. Vol. 1. Pp. xv+266. Vol. 2. Pp. iv+273. Vol. 3. Pp. iv+321. (Copenhagen: Levin and Munksgaard; London: Oxford University Press, 1931.) 60*s*. net.

OF all the branches of philosophy, logic alone has had the distinction of being claimed by the exact sciences as one of them. The event is of recent occurrence; in fact, it has happened only since logic has taken to mathematical symbolism. So long as logic reigned over philosophical logomachies, it was scarcely differentiated from normative philosophy; and it has cost a great deal of hard thinking to bring it by degrees within the favours of the exact sciences. Why logic slumbered in the linguistic bliss devised by Aristotle's genius, and how it was awakened to a nobler destiny, is a story of great importance and interest for the student of mental sciences. It is this story which Prof. Jørgensen tells us in his present work, in which real scholarship is happily federated with the easier ways of education.

Prof. Jørgensen points out very adequately that formal logic now consists of three main branches, which mark the three principal stages of its historical development: classical logic, the algebra of logic, and logistics. In the first volume, he gives a critical survey of the history of these three branches up to the present day: while he devotes the second volume to a systematic exposition of the principal parts of these branches, with critical observations on their relative advantages and defects. The third volume deals with the relations between formal logic and mathematics; it discusses the various methods of establishing the foundations of mathematics, and examines in particular the theory of logical types. Finally, the author investigates the relations between logic and philosophy, and certain aspects of psychology and linguistics, and indicates the grounds for the validity of formal logic.

A very useful background to the problems discussed is given by the historical development of logic, from the Greek works on mathematics which contain "the earliest known attempts at establishing rational, logically constructed, and abstract thought contexts", to the "Principia Mathematica" of Russell and Whitehead. What characterises this survey is the indication of the constant connexion between logic and mathematics. This, however, does not prevent the author from stigmatising classical logic as an "artificially restricted system, the fossilised form of a very early and imperfect stage in the evolution of the science", as "a mixture of faulty attempts at a formal deductive logic and the philosophy of formal logic".

On the basis of these drastic pronouncements—which, however, seem to us rather unfair in the light of history and of the services still rendered by classical logic—the author proposes to replace classical deductive logic by the algebra of logic and logistics, while the old philosophy of formal logic should give way to a more profound investigation and analysis of the real and ideal presuppositions of the sciences in question. Thus, he thinks that

> "formal logic disappears from the ranks of the philosophical sciences, and becomes a special science, the foundations of which, however, may still be subjected to philosophical investigation. So that the 'philosophy of formal logic' remains a philosophical science occupying the place of 'logic' in the system of philosophy, and having for its principal objects the discovery, analysis and arrangement of logical forms, an adequate symbolization of the logical forms, and the investigation of the conditions governing validity of the logical forms. It will require here the support of linguistics and psychology, especially the psychology of thought" (vol. 3, p. 294).

The technical outline of the algebra of logic and of logistics or mathematical logic (vol. 2) is a most welcome contribution to these difficult subjects, as the source books and memoirs are not easily accessible to the general student who approaches them for the first time. The epitome of the theories of the earlier mathematical logicians, such as Schröder and Frege, which is given in vol. 1, introduces very aptly this part, as it illustrates the progress in the analysis of the elements of thought and in the ideography employed. The distinction between the algebra of logic and logistics is worth mentioning here. The former is considered as "an attempt to apply the algebraical method to the exposition of the doctrinal system of logic and to the solution of logical problems". Originally, the algebra of logic was considered as a kind of algebraical translation of classical logic, which assumed thus a more general character in its new dress. Its later development, however, turned it into an independent mathematical theory; so that now its relation to logic lies only in the fact that logic is one of its possible applications. As the algebra of logic, however, asserts nothing as to the existence of objects satisfying its axioms and theorems, it is entirely a hypothetical deductive system, and as such, it assumes previous knowledge of the logical constants and the validity of the logical principles of deduction.

On the other hand, the "chief aim of logistics is to reduce pure mathematics to formal logic, so that these two sciences are made to form a systematic whole". Logistics differs from all other deductive theories in utilising the principles of deduction themselves as its primitive propositions, which must be therefore materially true. If the whole of formal logic and pure mathematics could be deduced solely from these principles, all dispute as to their foundations and validity would be at an end. Prof. Jørgensen thinks, however, that logistics is not yet elaborated to completeness. It has been obliged to establish three additional principles—the axiom of reducibility, the multiplicative axiom, and the axiom of infinity—the material truth of which is not yet proved.

This serious defect, along with other difficulties, lead Prof. Jørgensen to suggest the most important problems to be solved before the foundations of formal logic and pure mathematics can be regarded as quite in order. These are as follows: (1) How many different logical forms and constants are there? (2) How far is it possible to reduce their number by means of nominal definitions? (3) How can they be most adequately symbolised? (4) What is the relation between formal and informal premises in the various deductive theories? (5) Are all compound objective forms truth-functions? (6) Can the principle of the excluded middle be applied to infinite manifolds? (7) What are the conditions required to render a system of axioms complete in the sense that all problems concerning its objects can be solved unequivocally on the basis of its axioms? (8) Are the axioms of reducibility, the multiplicative axiom, and the axiom of infinity necessary, or can they be replaced by more satisfactory axioms or perhaps dispensed with altogether? (9) Wherein lies the paradoxical deception in the logical-mathematical paradoxes?

These are very serious difficulties, though Wittgenstein, Chwistek, and Ramsey seemed to have cleared the theory of logical types of some of its blemishes, indeed, and suggest to one that the ideal of absolute deduction is only a pious hope. It will be probably experienced that attempts to dispense with any of these difficulties will only change the terms of the problem. If we make up our mind that no perfect human science is possible, then we do not see why, as Prof. Jørgensen suggests, it is futile to discuss the general problems as to the nature and relations of logic and mathematics, grammar, or psychology until the major difficulties of logistics are satisfactorily solved. Science and philosophy cannot mark time; their greatness lies in their heroic uncertainty as to the ultimate nature of things.

THOMAS GREENWOOD.

The Works of Scheele.

The Collected Papers of Carl Wilhelm Scheele. Translated from the Swedish and German originals by Dr. Leonard Dobbin. Pp. xvi + 367. (London: G. Bell and Sons, Ltd., 1931.) 10*s.* net.

THERE has not previously been available an English account of the investigations of Scheele in a single volume. The present work supplies this defect, and, since it has been translated afresh from the original sources, it also has the character of a critical edition. The edition of Hermbstädt, in German, which has usually been considered authoritative, contains errors not present in the Swedish originals, this latter being the language in which Scheele wrote his memoirs. This is an important point, since it has often been considered that Scheele wrote in German and that the Swedish versions were translated from the German. Dr. Dobbin shows quite conclusively that the opposite course was, in fact, followed. The rugged style of the originals has been preserved in the translation, and although some modifications have been made in the punctuation and division of sentences, the text reproduces faithfully the individuality of the originals. This was a wise course of procedure and one which is much to be commended. The index is full, and there is a short but adequate appendix of modern equivalents of the chemical names used by Scheele.

The amount of chemical work done by Scheele in his spare time as a small retail tradesman in drugs in an insignificant Swedish town is amazing. His guiding theories were nearly all wrong and his contributions to chemical theory are as good as nothing. But it is very instructive to see him, guided step by step along the lines of a totally incorrect working hypothesis, reaching experimental results of the highest importance, and to perceive how it would have been possible to work back from these and to reach a different theoretical interpretation. His method of work was essentially qualitative, although he was very skilled in the use of the balance, and at some points, as when he was able to show that nitrogen was somewhat less dense than air, he turned this to advantage. He very often gives us the weights of the materials he employed and of the products obtained, but the data are usually given more from the point of view of preparative detail than from that of quantitative investigation.

Among the new substances discovered by Scheele, and his original investigations, may be mentioned the independent discovery of oxygen, the discovery of chlorine and of barium compounds, of the solubility of manganous carbonate in water containing dissolved carbon dioxide, of the formation of manganates and permanganates, of the action of the different parts of the solar spectrum on silver chloride, of the discovery of hydrocyanic acid and several cyanides, of glycerol and several organic acids, of manganous dithionate (see p. 18), of a new method of preparing benzoic acid, of arsenic hydride (of the poisonous properties of which, as well as those of hydrocyanic acid, he was not aware), of many analytical methods, of hydrofluoric acid, tungsten and molybdenum compounds, and a large number of improved methods of preparation of substances already known. All this work was carried out with the very simplest apparatus, such as glass and clay retorts, bottles, dishes, and bladders available in the pharmacist's shop. If Scheele had any fundamental philosophical guiding principle, it was probably that which he expresses as follows (p. 77): "My practice with chemical statements is never to believe any of them until I have proved them by making experiments"—an attitude which was afterwards adopted by Dalton.

It is impossible to give in a few words any adequate appreciation of Scheele's scientific importance. "Really to know and appreciate Scheele," as Dr. Dobbin says, "it is necessary to read and study his papers attentively in detail." The translation includes the famous treatise "On Fire and Air", which laid the foundation of its author's reputation throughout Europe. This treatise and most of Scheele's other papers contain innumerable discoveries, announced in short and unpretentious statements, which reveal a master of experimental method.

Dr. Dobbin's translation is to be welcomed as a careful and authoritative work, and one which makes available to chemists a collection of memoirs of the greatest interest and importance. The printing and paper are excellent, and the book is one which chemists will read with interest and with a growing admiration for the great Swedish experimenter.

Coal and its Use.

(1) *Entstehung, Veredlung und Verwertung der Kohle.* Vorträge, gehalten an der Deutschen Technischen Hochschule in Prag von W. Petrascheck, H. Apfelbeck, H. Tropsch, R. Heinze, A. Czermak, E. Kothny, H. Löffler, A. Rozinek, J. C. Breinl. Herausgegeben im Auftrag des Professorenkollegiums von Prof. K. A. Redlich, Prof. J. C. Breinl und H. Tropsch. Pp. vii + 359. (Berlin: Gebrüder Borntraeger, 1930.) 30 gold marks.

(2) *Die Chemie der Kohle.* Von Dr. Walter Fuchs. Pp. viii + 510. (Berlin: Julius Springer, 1931.) 45 gold marks.

(1) THIS book is a reprint, in an enlarged and revised form, of several lectures, by different authors, having reference to the general subject of the origin, improvement, and utilisation of coal. Naturally, the whole subject could not be covered. The individual lectures vary greatly in range of subject and thoroughness of treatment, with the result that the book has a somewhat disjointed character.

Nearly half the available space is taken up by R. Heinze's dissertation on the drying and carbonisation of brown coal (157 pages and 49 illustrations). This might well have been printed separately, and gives much information not so conveniently available elsewhere. There are sections on the nature of the raw material and of the products, besides illustrations of most forms of drying and carbonising plants. The value of the book to a given reader must depend largely on this chapter.

H. Tropsch is responsible for two lectures, one on the origin and chemical structure of coal, and the other on syntheses from gases obtained from coal. The former is a useful summary of the views of the German school of coal research; the latter deals with the preparation of liquid fuels by the pyrolysis of methane and ethylene, besides the now familiar hydrogenation of carbon monoxide to give methyl alcohol, etc. The recent experiments, in which liquid paraffins were obtained by working at atmospheric pressure, are described in considerable detail.

Of the others, the most interesting lectures are perhaps those of W. Petraschek (on the geological aspect of coal formation) and H. Apfelbeck. The latter has many interesting graphs showing changes in composition during the coal-forming process, but the lecture would be improved by more references to previous work. The remaining lectures can only be mentioned—E. Kothny, on the economic and thermotechnical significance of coal; H. Löffler, on the burning of solid fuels; A. Rozinek, on the Szikla-Rozinek process of firing with producer gas from pulverised fuel; and J. C. Breinl, on theoretical principles of the mechanical regulation of firing.

(2) The chemistry of coal has not in the past attracted many first-rate chemists. Numerous investigations have nevertheless been carried out, shedding a good deal of light on this difficult problem, and indicating many promising lines of future progress. Further information is, however, badly needed, especially in connexion with the newer methods of coal treatment, such as the Bergius hydrogenation process. Any organic chemist lacking a subject for research may be recommended to read the book under review.

Fuchs's method is to start with the living plant. The first chapter gives an admirable summary of present knowledge of the chemistry of plant products, and goes on to discuss the processes of decay that take place in Nature. Then follow lengthy chapters on peat, brown coal, and bituminous coal. These chapters have the character of self-contained monographs. The information on peat and brown coal should be especially useful to English readers. The matter is very systematically arranged—definition, varieties, and mode of occurrence; petrographic, physical, and chemical properties; chemistry of the constituents; response to various chemical, physical, and biological treatments; discussion of the mode of origin.

The final chapter restores the continuity by dealing with the comparative chemistry of the various fuels.

The author has succeeded in being comprehensive without undue prolixity. Every important piece of work seems to be mentioned, and references are given to the whole of the modern literature, both in German and other languages, up to the early part of the current year. Matters of purely historic interest are purposely omitted. One feature perhaps lending itself to criticism is the almost complete absence of graphs, which in many places might advantageously have been introduced to summarise experimental data.

The book is well printed and bound. The price is unfortunately high, but the coal chemist cannot afford to dispense with it. It is to be hoped that an English translation will be published.

R. WIGGINTON.

Short Reviews.

Handbuch der vergleichenden Stratigraphie Deutschlands. Herausgegeben von der Preussischen Geologischen Landesanstalt. *Alluvium.* Schriftleitung, J. Stoller. Unter Mitwirkung von K. von Bülow und W. Dienemann. Pp. xii + 424. (Berlin: Gebrüder Borntraeger, 1931.) 30 gold marks.

IN this " Handbuch ", issued under the auspices of the Prussian Geological Survey in association with other German surveys, it is proposed to furnish a complete account of the German stratigraphical succession. The distribution, especially with regard to facies, the petrography, palæontology, tectonics, economics, and the whole genesis of each geological formation are to be described ; where possible, geological maps are to accompany each volume. The " Handbuch " is to be completed in twelve volumes, of which this on alluvium is the first. The other volumes are to deal with Diluvium, Tertiary, Cretaceous, Jurassic, Trias, Zechstein, Rothliegendes, Carboniferous, Devonian, Silurian-Cambrian, and Crystalline Schists. The publication of a work of this scope is obviously an event of first-class importance in the study of European geology.

Fourteen authors have contributed to the present volume, " Alluvium " ; their work has been collated by the late Prof. Jakob Stoller, with the help of K. v. Bülow and W. Dienemann. All deposits formed since the melting of the last ice-sheet come within the scope of this volume. The treatment is based upon the facies classification of v. Bülow—marine, freshwater, continental. The North Sea and Baltic marshes and coastal deposits form the first facies, lacustrine and fluviatile deposits the second, whilst in the third are grouped dunes, calc-sinters, peat, and landslips and related deposits. The origin, distribution, and petrography of each type are exhaustively discussed. The flora and fauna of ' Alluvium '—in the sense used in this work —are employed in the elucidation of the climate of the time. The volume ends with a summary of the products of economic value derived from the alluvium. Lengthy bibliographies are appended to each section.

A large folding table, by v. Bülow, gives the classification and correlation of the various types of deposits considered in this work, with their corresponding floral, faunistic, and archæological characteristics.

Paläoklimatologie. Von Dr. Fritz Kerner-Marilaun. Pp. viii + 512. (Berlin: Gebrüder Borntraeger, 1930.) 39 gold marks.

DR. KERNER-MARILAUN, an Austrian mining geologist, has since 1895 issued a long series of papers on former climates, and his contributions have been marked by recognition of the uncertainty of evidence on which reliance was once firmly placed, and by ingenuity in the application of many different lines of investigation. In the present work he has summarised the nature of the available evidence and discussed its value.

The book is divided into six parts, as follows: the various kinds of evidence as to former climates ; the character of established ancient climates ; their causes, including elevation above sea-level, distribution of land and water, the influence of latitude, the wandering of the poles and variations of latitude, fluctuations in solar radiation, and the influence of sunspots and volcanic dust ; methods of estimation of climatic factors (or thermogeographical analysis) ; the evidence of palæogeography and geochronology ; and finally, consideration of the various theories of former climatic changes. The work consists mainly of a statement and discussion of the principles of palæometeorology, and its chief value is as a summary of the conflicting hypotheses rather than an exposition by the author of his own conclusions.

The book uses a highly technical terminology and fortunately thirty-one of the author's own terms are explained in a glossary: eight of them deal with the evaluation of the evidence. The author quotes a large number of authorities, but without references ; sometimes a clue is provided by mention of the date, but as a rule the author's name only is given. The lack of references is a serious defect, especially having in view the scattered nature of the evidence—botanical, geographical, geological, and physical. The index is also poor and incomplete.

Integrative Psychology: a Study of Unit Response. By William M. Marston and C. Daly King and Elizabeth H. Marston. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvi + 558. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1931.) 21*s.* net.

" INTEGRATIVE PSYCHOLOGY " stands midway between the classical school of introspection and psychoanalysis. It claims to organise the subject matter of psychology and to give its adherents practical knowledge about themselves, applicable to the personal problems of their everyday lives.

The fundamental principle of integrative psychology is to emphasise the 'You' instead of the 'I', and has many claims in its favour. For example, 'I' cannot observe himself without becoming a different 'I' from that which he set out to observe; and this change is likely to affect the truth and value of his observations. On the other hand, the study of an objective element such as 'You' allows for a more accurate application of scientific method to the various problems of psychology. Integrative psychology, however, does not imply contact of the organs by environment, and thus offers a more adequate analysis of personality than behaviourism, although it does not repudiate altogether the idea of being, in a sense, mechanical. Yet it regards the integrative mechanism of human beings as a spontaneously operating device whereby the human organism may be completely freed from environment or materialistic control.

On these fundamental principles the authors of the book under review build up a very comprehensive and attractive system of psychology, in which the biological background of that science helps to explain drives, sensation, emotion, consciousness, reasoning, and personality. It would be difficult to admit, however, that integrative psychology offers a complete and self-contained alternative to the older schools of psychology.

T. G.

Tales told in Togoland. By A. W. Cardinall. To which is added the Mythical and Traditional History of Dagomba, by E. F. Tamakloe. (Published for the International Institute of African Languages and Culture.) Pp. vi + 290. (London: Oxford University Press, 1931.) 16*s.* net.

In "Tales told in Togoland", Mr. Cardinall has made a valuable addition to the literature both of the folk-tale and of ethnography. His stories are drawn from the peoples of that part of the former German colony which has been attached to the Gold Coast for administrative purposes. In the belt of it with which he deals more particularly are peoples who are entirely unknown to anthropological science, some of them retaining traces of their ancient customs which are untouched by outside contact.

The tribes differ considerably one from another in culture. Among the more advanced the influence of Ashanti has been considerable. Notwithstanding these differences, the lore of the people and their fairy tales are very similar throughout the area and often identical. Mr. Cardinall has drawn his information from the people, peasants, hunters, and farmers, and not from the chiefs and priests. He offers some interesting comments on the stories, which range from "Just So" stories to native history. He suggests an origin for Brer Rabbit—not the chevrotain as usually held, but actually the hare—and puts forward an explanation of the transformation of the hero of the folk-tale into Ananci, the spider, which is more than probable. While thanking Mr. Cardinall for his diverting, but none the less highly instructive collection of tales and the accompanying commentary, we join with him in deploring the probability that these interesting tribes will have lost much of their primitive habit of mind and custom before they have been studied by a trained anthropologist.

Elementary Hyperbolics: for Technical and other Students; specially adapted to the Requirements of Beginners. By M. E. J. Gheury de Bray. In 2 vols. Vol. 1: *Hyperbolic Functions of Real and Unreal Angles.* Pp. xi + 351. Vol. 2: *The Applications of Hyperbolic Functions.* Pp. xii + 209. (London: Crosby Lockwood and Son, 1931.) 7*s.* 6*d.* each vol.

This work is by the author of "Exponentials Made Easy" and is in the same colloquial and humorous style, with chapter headings like "Where We meet again an Old Acquaintance, and with its Help, venture into a Maze and discover a Treasure Buried therein". On p. 294 we are told that "Infinity is a mysterious region: there things happen which do not happen anywhere else. There, for example, parallel straight lines meet, a thing which no properly brought-up parallel straight lines will ever do elsewhere (in Euclidean geometry). . . ." The first volume gives the ordinary mathematics of complex numbers, exponentials, hyperbolic functions, and the easier parts of analytical trigonometry, but in much more detail than usual, as the author is writing for engineers of limited mathematical powers. The proofs on pp. 64-66 are given without any mention of their weak points. The second volume, dealing with the application of hyperbolic functions, appears to be much more valuable. Most of it is concerned with electrical engineering; the rest deals with geography, navigation, strength of materials, suspension bridges, and cables.

H. T. H. P.

Der Smekal-Raman-Effekt. Von Prof. Dr. K. W. F. Kohlrausch. (Struktur der Materie in Einzeldarstellungen, herausgegeben von M. Born und J. Franck, Band 12.) Pp. viii + 392. (Berlin: Julius Springer, 1931.) 33·80 gold marks.

This book gives a summary of work on the Raman effect up to the middle of this year. It is necessarily largely a catalogue of numerical data, but does also contain both a good general elementary account of the subject and the essential parts of its rather complicated mathematical basis. The arrangement of the material—and it is remarkable how much has been accumulated in three years—is excellent and the author's comments authoritative and critical, so that there can be little doubt that the book will come to be the standard reference for early investigations in this still young subject. At the moment the most valuable parts for the research worker will probably be a table of Raman spectra for 482 substances, classified according to their chemical composition, and a list of 417 original papers. Incidentally, is it not time either that the phenomenon came to be described simply as the Raman effect, or that some generally acceptable designation were devised expressing its physical content?

K. G. E.

The Changing Outlook in Agriculture.*

By Sir JOHN RUSSELL, O.B.E., F.R.S.

AGRICULTURE as an art was already far advanced when the first meeting of the British Association was held in 1831. It was then entirely empirical. Scientific work was, however, beginning, and round about 1840 three important events occurred: Liebig published his epoch-making essay on the application of chemistry to agriculture, Lawes began the famous Rothamsted experiments which almost at once led to the founding of the artificial fertiliser industry, and the Royal Agricultural Society started its beneficent work of fostering the application of science to practice. Economic conditions favoured the growth of the home agriculture, and from about 1850 to 1890 British agriculture flourished. Then within a few years it collapsed. The chain of transport arrangements with the United States and Canada was completed and farm produce came on to our markets at prices with which British agriculturists could not possibly compete.

The overseas systems were inferior to our own in production per acre, but the shortage of population had necessitated the development of labour-saving machinery, so that the production per man was greater, and this higher efficiency of output won the day. British farmers suffered greatly; many became bankrupt.

Gradually it was realised that the way out of the difficulty was to specialise, and this specialisation favoured the application of science to agriculture. From 1889 onwards, when the Board of Agriculture was founded, agricultural colleges began to grow up. The pioneers of those days—Middleton, Wood, Gilchrist, Somerville, Percival, F. B. Smith—to name only a few, had a strenuous uphill task. But the pioneers kept on with their struggle, and, inspired by the faith that was in them, they carried agricultural education through the length and breadth of the countryside.

Then came the system of county agricultural organisers. These now play so great a part in British agriculture that one is apt to forget that they began only about 1900. The present widespread system was set up only in January 1919, when the Board of Agriculture, as it then was, circulated to the counties proposals for a comprehensive system of agricultural education, offering to pay 80 per cent of the organiser's salary and 66⅔ per cent of all other approved expenditure. With the organisers have grown up the farm institutes, and now there are springing up everywhere discussion societies where farmers meet to discuss technical and other matters of importance. At first no provision was made for research; then it was realised that agricultural education could not be carried on without research. Research on any important scale became possible only after 1909, when the Development Fund of £2,000,000 was set up at the instance of Mr. Lloyd George for a variety of purposes, including research.

The Development Commissioners at the outset adopted the wise policy of allocating the several sections of agricultural science to existing institutions, making grants on an adequate basis, and so ensuring a widespread interest and, perhaps more important, a widespread net to capture young and capable research workers. Crop production (soil, plant nutrition, and plant pathology) was placed at Rothamsted, animal nutrition at Cambridge and the Rowett Institute, plant genetics at Cambridge and Aberystwyth, animal genetics at Edinburgh, agricultural botany at Cambridge, dairy research at Reading, fruit at Long Ashton and East Malling, economics and engineering at Oxford, horticulture and low temperature research at Cambridge, veterinary research at Cambridge and Weybridge, helminthology at the London School of Tropical Medicine, glasshouse horticulture at Cheshunt.

The scheme is worked through the Ministry of Agriculture, and it is one of the best instances of successful combination of Government supervision of finance with adequate freedom of action for the research worker. The general result of all these activities has been that farmers have learned to cheapen production, to seek profitable outlets for their industry, to use machinery and any other aids to production. Results soon appeared. When Hall, in the years 1910–12, made his classical pilgrimage of British farming, he records as his general impression that "the industry is at present sound and prosperous". This was less than twenty years after the deep depression of the early 'nineties.

Then came the War. For the British, for the overseas Empire and the United States, it was a time of feverish activity to raise more food to sell to the Allies. Prices were fixed in England, so that money never abounded in the countryside as it had done in Napoleonic times. In spite of the sadness of the War years, the farmers of Great Britain put up a wonderful fight to produce food. After the War came three years of high prices; in 1920 wheat averaged 80*s.* 10*d.* per quarter, the highest since 1818. Then just as suddenly there came the slump; by 1922 wheat was down to 47*s.* 10*d.*

The high prices had done farmers very little good, and in the end they lost all that they had gained. Many landowners proceeded to sell their estates. The high price of produce induced many to bid for the land, and the sitting tenant had either to outbid or be dispossessed. Frequently he had to pay more in interest on loans and mortgages than he had paid in rent, and in addition he has also to maintain the buildings, gates, and roads which formerly the estate had done. He is therefore in a far worse position than the farmer of 1821 in the slump after the high prices of the Napoleonic wars.

Much worse has come. When the first rush of cleaning up after the War was over, it was realised that the world's power of producing food had grown far in excess of its power of consuming food. The population had increased but the power of food production had increased much more. In consequence, prices of farm produce have fallen far more than costs of labour and of other commodities. British farmers have turned, as in the 1890's, to live stock, raising lamb, young pigs, and milk so far as possible on grass with an increasing acreage of lucerne, thanks to the success of Thornton's inoculation method. Those who cannot produce grass cheaply and easily, but who have to depend on arable land, are in a sorry plight, and the difficulty is not confined to Great Britain; arable farmers in all civilised countries are deeply depressed.

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* From the presidential address to Section M (Agriculture) of the British Association, delivered in London on Sept. 25.

This certainly is not the result that was expected; on the contrary, experts had confidently predicted a food shortage. Sir William Crookes, in his presidential address to the British Association in 1898, forecast the probable world requirement of wheat for the next three decades, and showed that the sources and methods then available would continue to suffice only until 1931, when the world would begin to feel the pinch of hunger. Crookes's figures were remarkably accurate, and there can be no doubt that, had science and practice stood still since 1898, we should now be facing the horrors of world starvation. But they have not stood still, and the present position of farm prices is a measure of their advancement.

Two new and closely linked factors have come into play since 1898 and are largely responsible for the present position: the widening of the scope of science in agriculture and the agricultural development of the British Empire and of South America. In the nineteenth century agriculture had been mainly a branch of chemistry; its professors had been chemists, its laboratories chemical. Crookes suggested more chemistry as the way out of what he called the 'colossal dilemma' of world starvation; he proposed the manufacture of more nitrogenous fertilisers from the air—a fantastic idea at the time, yet now our chief source of supply.

The new scientific developments came from the biological side, and the new practical developments from the engineering side. The first great biological triumphs were in plant breeding. Canada affords some of the best examples of the plant breeder's success in opening up new regions of the world for settlement. Up to the middle of the nineteenth century the Canadian wheats were suited only to the eastern provinces, Ontario and Quebec; they were uncertain on the prairies. About 1842, David Fife, in Ontario, received for trial from a Glasgow friend several packets of wheat, which he sowed. Among the resulting plants was one that differed entirely from the rest, and also escaped damage from rust and frost, two destroyers of wheat in those times. How the seed got there, or whence it came, can never be known. It was a Galician variety. But the accident was a fortunate one for Canada, and did much to build up her wealth. The wheat plant was so good that Fife saved the seed and multiplied it, and in course of time it was widely taken up by farmers under the name of Red Fife. It proved to be eminently suited to the prairies, and as soon as the railway was completed in 1886 it was taken there by the new settlers and became the basis of their prosperity.

Man-power was long the limiting factor in Canadian farming, and this problem of saving labour has been attacked with devastating thoroughness by engineers all the world over. The tractor and the new cultivating implements at and before seeding-time, and the combine at harvesting, have revolutionised wheat-growing by dispensing with enormous numbers of men and greatly increasing the area of land needed per man as an economic unit for wheat farming. Not long ago 160 acres was the economic unit for the family farm; now 320 acres is the lowest limit, and 640 acres is nearer the most profitable size.

Australia also has developed as the result of the activities of the plant breeder and the engineer; the problem here was the conquest of the drought. Farrer began by producing wheats more resistant to rust and drought than the older sorts, and his pupils, Sutton and others, have continued the work. Agriculturists showed the great value of superphosphate for all crops; they further improved the methods of cultivation, and now, as A. E. V. Richardson has shown, for each inch of rain falling during the season, the farmers of Victoria obtain one bushel of wheat, while forty years ago they obtained only half a bushel.

South Africa owes much of its advances to two other branches of biological science—veterinary science and parasitology. No part of the white man's habitation seems so suitable for insects, and especially parasites, as South Africa. So long as the white man occupied the country only thinly he could do it without difficulty, but trouble began as soon as he wished to increase his hold on the land and multiply his flocks and herds. The first to attack the problem seriously was Arnold Theiler. He founded the Veterinary Research Laboratories at Onderstepoort, of which not only South Africa but also the whole Empire is proud, and he trained up a body of veterinary research workers and officers who now, under the distinguished leadership of P. J. du Toit, are extending the good work.

We are still far from security; in the past twelve years foot-and-mouth disease has cost the British Government more than 5½ million pounds sterling, paid to the farmers of Great Britain as compensation for animals compulsorily slaughtered, while the farmers themselves have suffered vastly more. Veterinary research is now developing at Cambridge and elsewhere, and the relationships between nutrition and disease are studied at the Rowett Institute.

The engineer has perhaps been the greatest force in the development of New Zealand agriculture. The invention of refrigeration paved the way for the great dairy and lamb industries, which are now among the most remarkable and efficient agricultural industries in the world. The exports are rapidly rising. In 1929 that of butter was valued at £13·2 millions, of cheese £7 millions, frozen meat (mutton and lamb) £9·9 millions; in all, more than

£30 millions by refrigeration transport, as against £15 millions of wool—a truly remarkable progress.

The development of the dairy industry, however, was not simply a matter of transport: it is a triumph for the bacteriologist. In Great Britain good work has been done at the Dairy Research Institute at Reading by Stenhouse Williams, Golding, and their colleagues. Australia has recently made great progress with the dairy industry, and is now going into the question of lamb. Canada has a highly developed dairy industry.

Another result of improved storage during transport has been a great development of Empire fruit growing. Apples and oranges were formerly obtainable in England only in winter; they are now obtainable in spring and summer, thanks to the marked developments in Tasmania, the Murray region in Australia, and South Africa. Plums, peaches, grapes come in abundance from South Africa, bananas from Jamaica; not only are the total imports of fruit increasing, but also the proportion from the Empire increases; it had averaged 24 per cent for the five years 1925–29, and rose to 33 per cent in 1930; home growers supplied 26 per cent—usually their share is nearer 30 per cent. The Empire still, however, supplies less than one orange out of every four that we eat, only 39 per cent of our bananas, 16 per cent of our grape fruit, and 10 per cent of our pineapples; there are therefore considerable possibilities of further development. Demand is increasing; in 1930 the consumption of fruit per head of population in Great Britain was nearly 83 lb., as against 70 lb. in 1924. Other countries are improving their production and transport. In Great Britain, Barker, Wallace, and their colleagues at Long Ashton, and Hatton at East Malling, have greatly strengthened the fruit growers' position, and for fruit the outlook is, as for other commodities, a power of production growing greater than the power of consumption. Another important factor in the fruit industry has been the development of canning, which affords a satisfactory way of dealing with excess produce.

Engineering science has further intensified agricultural production by developments in irrigation. The greatest triumphs of irrigation in our time have been in India. The cultivable area of India has been enormously increased, and land provided for millions of peasants who would otherwise have had none.

Irrigation schemes worked by white men are so costly that only valuable products can be raised. In all cases irrigation has greatly increased the output from the land and greatly increased the supplies for the world market. If time permitted, it would be possible to go through the whole list of products of the earth and show how modern science has increased output far beyond human needs, with a resulting fall in demand and lowered prices. One could dilate on the achievements of the Dutch in Java in producing their new sugar-cane, which quadrupled the output and so lowered the price of sugar that the West Indies are in terrible distress, the sugar-beet industry of Great Britain is threatened, and all Europe would be in trouble but that they artificially keep out the new sugar. Or again, one could speak of the achievements in rubber growing, of the change over from wild rubber to plantation rubber, of the extraordinary improvements in technique, which have in the past thirty years so enormously increased the output that even the most extensive new demands of modern civilisation—rubber tyres, rubber floors—have failed to keep pace with supplies, so that the price, which in 1910 was 12*s.* 6*d.* per lb., is now reduced to 3*d.*, and may fall still lower, causing great distress to the rubber growers.

Modern science, in short, has been so successful in increasing man's power over Nature that it has brought us harvests far more bountiful than we know what to do with. Yet, although we may think in our pride that we have achieved a wonderful control over Nature, our control is really very limited, our tenure uncertain, and our margin of safety very exiguous. How long mankind will have the wit to go on developing more powers we do not know. It is quite certain that any slackening of control or failure to utilise scientific discovery by any one group of cultivators would speedily eliminate them through pressure of more enlightened and therefore more successful competitors. It is, however, not so much human competition as the opposing natural agencies that must continuously be watched. The weather can still defeat our best laid farming plans. Over large parts of our Empire there is a continuous struggle for possession between insects and men, and the margin of victory, even when we get it, is never very great.

There are also new troubles as yet only dimly seen that may easily cause great difficulty in future. The remarkable development of rapid transport has carried all over the world not only the blessings but also the evils of this earth. Pests and diseases of animals, and particularly of plants, have only to appear in one corner of the globe to spread elsewhere with great rapidity despite all regulations to the contrary, often causing enormous losses. Among the most serious troubles of modern times are the virus diseases of plants. These diseases are apparently not caused by any recognisable living organism, nor are they simple physiological disturbances; they cannot yet be attributed to any definite causal agent. They spread rapidly, being frequently carried by small insects, sometimes by mere contact, and they cannot be cured—one can only stand by and see the plants perish.

All kinds of crops are affected: sugar-cane, tobacco, cotton, sugar-beet, groundnuts, bananas, potatoes, maize, timber trees (for example, sandal), large and small fruits (for example, peach and raspberry), and most greenhouse and horticultural plants. Moreover, it is not so much sickly plants as healthy ones that suffer In Gambia the Rosetta disease cut down the crop of groundnuts to about one-third of the normal yield. In the United States in 1926 two virus diseases reduced the crop of potatoes by no less than 16 million bushels. In Great Britain the total loss cannot be estimated, but the figures recorded for various attacks vary from 35 to 75 per cent loss of crop. Worse still is the deterioration of stocks: stocks apparently healthy and vigorous may become worthless in two to four years. Cotton growers are becoming seriously perturbed. In the Gezira last year the losses were considerable, although until recently the leaf-curl disease was unknown there. Sugar-beet in the south-western region of the United States is so seriously imperilled by the curly-top disease that the Government has set aside 300,000 dollars for its investigation. In England special grants are made to Rothamsted, Cheshunt, Bangor, and other institutions to study these diseases. Tobacco is now being badly attacked, also tomatoes and potatoes; the latest sufferers are the narcissi and daffodils in our own gardens; these cease to flower and shortly perish. Virus diseases are quite recent as serious plagues; if they are old, they have hitherto been unimportant or unnoticed. Clearly, Pandora's box is not yet empty.

The United States stands easily first in elaboration of agricultural research, organised not only by the Government but also by private endowment. Both in England and in the United States, men who have made fortunes in the city have spent their money in developing agriculture or agricultural science. The America patron has spent his money on a college or research station, setting up a laboratory or some other new building, or endowing fellowships, so that a succession of vigorous young people could develop the subject, adding also greatly to their own value as workers for agricultural progress. So the gift has fructified and enriched the community in ever-widening circles. The British patron, on the other hand, has usually spent his money on his own estate, making his own experiments in farming. Some have rendered service by carrying pedigree live stock over periods of depression when the commercial farmer might perforce have had to let them go. But many have simply experimented on no very definite basis and with none of the continuity essential to the success of agricultural investigation. While, no doubt, getting much amusement out of it themselves, they have not achieved results commensurate with the time and money expended.

Without disputing the inalienable right of the Englishman to spend his money in any way he may think fit, we can still commend to the English patron the wonderful possibilities of the endowment of agricultural research. To say nothing of Lawes and Rothamsted, think what the world has gained through John Quiller Rowett's gift in 1920 of land near Aberdeen, and of £10,000 to erect buildings, thus founding the Rowett Institute. Scotland has recently had a further benefaction in the Macaulay Soil Institute set up to study the peat soils of Scotland and to help the farmers there so long as any men farm in Scotland. We remember with gratitude, and we know that our children will do so, the names of Molteno, William Dunn, Thomas Harper Adams, Charles Seale-Hayne, John Innes for their foundations in England; Peter Waite and John Melrose for the Waite Institute in Australia, William Macdonald for the Macdonald College in Canada, Thomas Cawthron for the Cawthron Institute in New Zealand. To-day the need is not so much for new institutions as for the strengthening of some of those already in existence.

Within the Empire all agricultural experts are now in touch with the central clearing houses in Great Britain, the Imperial agricultural bureaux, the function of which is to search the world for information likely to be useful and then pass it on to the persons likely to want it. The system is working well.

World organisation of scientific investigation is proceeding rapidly. Of the three factors involved in the agricultural situation, production, marketing, and the scientific advisory and technical system, the last is by far the best organised. Much has recently been done, however, in developing better and more efficient marketing by the Empire Marketing Board and the Ministry of Agriculture.

Our greatest need, however, is a better organisation of agricultural production. A beginning has been made by the overseas farmers; the necessity for sending all produce through one or two ports has compelled them to work through large organisations for grading, transporting, and selling the produce, with skilled representatives in Great Britain. Dealing in hundreds or thousands of tons, they reduce all costs and all wastage to a minimum. Gradually the British farmer is organising. But greater organisation is highly desirable. At present British farmers, Empire farmers, and farmers from all over the world indulge in deadly competition in the British market. In the end they obtain wholly inadequate prices. But the community as a whole does not gain because they lose.

Thanks to the inquiries made by the Ministry of Agriculture and the Empire Marketing Board, the food requirements of Great Britain are fairly well known. Our next great step forward will be to organise production on a contract basis so as to satisfy these requirements with a reasonable margin of safety, but without the terrible waste involved in those large excesses which injure the grower without benefiting the consumer.

Something of the sort is essential if farming is to survive as an occupation for the best of our people. Organised production and the development of the contract system which has done so much for the milk producers, would permit of a renewal and development of country life to the fullest extent now made possible by scientific and technical advances. By common consent many of the ills of to-day arise from the fact that for nearly a century the industrial side of our national life has been fostered at the expense of the rural side, producing an over-industrialised town population peculiarly susceptible to world economic disturbances, and now largely without employment or prospect of employment. The rural population, on the other hand, is far less sensitive to economic disturbances; the low rate of unemployment in the countryside shows the greater independence and resilience of the conditions of country life, and points clearly to the fact that improvements in our rural life would benefit not only the countryman but also the whole community.

Faraday and Marine Boilers.

FARADAY was probably the first man of science in Great Britain to be called upon to give advice on the working of marine boilers. There is little to show that his views affected marine engineering practice at the time, for his evidence was hidden away in a Government report which few engineers read, but it is not without interest to find that subsequent experience led to the adoption of methods the germs of which are to be found in what he said.

The circumstances in which Faraday came to be associated with the matter of marine boilers were as follow. In 1822 a Select Committee of the House of Commons was appointed to consider the question of steam navigation as relating to the communication between Great Britain and Ireland by steam. The committee, of which Sir Henry Parnell, Bt., was the chairman, became known as the Holyhead Roads Committee, and it sat when Telford was busy with the great Holyhead road and the suspension bridge over the Menai Straits. At the time the inquiry was held, ten years had elapsed since Bell's *Comet* had inaugurated regular steam navigation in Europe, and in Great Britain alone there were about 150 steam vessels afloat. Most of these were running on the rivers, but the eminent marine engineer, David Napier, had proved that steam vessels could be built for work in the open sea and had successfully established services between Dover and Calais, Holyhead and Dublin, and between Glasgow and Belfast. This success in turn led to the dispatch of mails to France by steam, and in 1821 the Post Office decided to have its own steam boats. That year, therefore, the *Dasher* and *Arrow* were built for running between Dover and Calais, and the *Royal Sovereign* and *Meteor*, somewhat larger vessels, for the Holyhead and Dublin route. As these were the first steam vessels owned by any Government department, they were regarded with great interest, and the committee of 1822 was mainly concerned with the construction, maintenance, and running of the *Royal Sovereign* and *Meteor* and other vessels which it might be decided to build.

The committee sat on various days between March 21 and June 1, 1822. Among the witnesses examined were officials of the Post Office, captains of steam vessels, and well-known engineers such as Joshua Field, Bryan Donkin, Timothy Bramah, James Brown, and others. These all gave valuable information as to the size and construction of the boats, the types of engines and boilers, the staffing of the engine rooms and such matters, but it was left to Faraday, who described himself as "chemical assistant at the Royal Institution to Mr. Brande", to enlighten the committee on the chemistry of steam raising. He had to tell the committee all about the composition of sea water, what salts it contained, what happened to the salts when the water was evaporated, what action the salts had upon iron and copper, what was the effect of incrustation, what could be done to prevent deposits forming, how fires in bunkers could be avoided, and so forth.

In 1822, and for many years afterwards, marine boilers were just great rectangular tanks with internal furnaces and flues of square or rectangular section, and they were invariably fed with sea water. The engines had jet condensers, not surface condensers, and there was no way of keeping the boiler water fresh even if the boilers were filled with shore water before starting on a voyage. As, however, the steam pressure was only about 2 lb. or 3 lb. per sq. in., by taking proper precautions the density of the boiler water could be kept down, and engineers who knew their work could keep their boilers remarkably clean. In other cases there was much incrustation, while corrosion was rampant. Iron boilers in some vessels only lasted two years, and so a good many engineers adopted copper for the material for boilers.

These facts were all known to Faraday, who had prepared a long memorandum for the committee, dated from the Royal Institution, May 7, 1822, and it was in this and in his evidence he made his many valuable suggestions. One of these was that engineers should be provided with hydrometers, another that the density of the water in the boiler could be kept down by a continuous system of brining, and a third that the action of acids could be neutralised by the use of lime, potash, or soda. If copper boilers were to be used, iron bolts and fastenings should not be used, while if there was fear of fire in bunkers it would be an easy matter to fit horizontal temperature tubes of iron through which thermometers could be passed. Many strange practices were in vogue among marine engineers in the early days. Dung, potatoes, and oatmeal were all put into boilers for stopping leaks, and other substances were used with the idea of preventing incrustation. It therefore occasions no surprise to find that Faraday was asked, "Would a dry holly or thorn bush introduced, if practicable, into the boiler take off a part of the crystallisation which would otherwise adhere to the bottom of the boiler?"

News and Views.

DEC. 12 was the thirtieth anniversary of Marchese Marconi's first successful attempt to transmit a radio signal across the Atlantic. In 1901 there were no valves, no amplifiers, no sensitive receivers, and no means of making continuous waves. All that was available for transmission was a system of damped waves produced by irregular spark discharges; the coherers then used for reception were very insensitive. In 1900 a station was erected at Poldhu in Cornwall and another at Cape Cod, Mass. In designing these stations, Marconi had the help of Sir Ambrose Fleming, R. N. Vyvyan, and W. S. Entwistle. When the

Poldhu station was nearly completed, a terrific gale wrecked the tall masts that had been erected. Although greatly discouraged, Marconi erected a much less ambitious aerial system. In November 1901 another gale destroyed the antenna system at the Cape Cod station. Marconi then determined to try aerials suspended by kites and balloons. As the letter ' s ' is easy to transmit, he arranged that a series of these signals should be emitted at a prearranged speed from the Poldhu station during certain hours of the day. After several unsuccessful trials, Marconi heard three faint clicks in the telephone at 12.30 P.M. on Dec. 12. They were also heard by his assistant. These signals led to the building of the high-power radio station at Glace Bay in 1902, and at the beginning of 1903 commercial radio communication across the Atlantic was established. Remembering that in those days physicists and mathematicians did not know of the existence of a conducting layer in the upper atmosphere, and that consequently most of them anticipated that no result would follow from these costly experiments—and did not hesitate to say so—it will be seen how much indebted we are to Marconi's pioneering work.

IN an article in the *Nineteenth Century* for December, on Erasmus Darwin, 1731–1802, the bicentenary of whose birth was referred to in NATURE of Dec. 5, Mr. H. Pearson refers to him as the greatest English doctor of his time. No one, perhaps, knew better than Darwin the futility of many of the notions prevalent, and much of his own success depended on his insight into human nature. His methods were often experimental and sometimes risky, but a man who never tried an experiment he declared to be a fool. His great originality of mind, his independence of character, and his versatility were shown in many ways, and he was every bit as interested in human progress and the sciences and arts as he was in the ailments of his patients. Wells and witches, canals and candlesticks, pumps and ploughs were only a few of the things on which he had ideas. He was certainly a pioneer in the use of electricity for medical purposes, and when Priestley discovered oxygen, he at once envisaged the submarine vessel which " Buoy'd with pure air shall endless tracks pursue ". Then, too, as Dr. Krause said, he was the first who proposed and persistently carried out a well-rounded theory of evolution. Like some of the other members of the Lunar Society, which he founded, Darwin was a sympathiser with the French revolutionists and the American colonists. Mr. Pearson gives brief biographical notes on some of the most distinguished members of that small but influential society: Keir, Galton, Wedgwood, Watt, Priestley, and others, all of whom owed something to the free and stimulating conversation of Darwin. In person, as Mr. Pearson says, he was somewhat corpulent, his face was marked by smallpox, he was clumsy in his gait, careless in his dress, and stammered excessively. Like his famous contemporary Johnson, with whom he had some resemblances, he practised an unbounded benevolence.

THE Prince of Wales was the guest at the tercentenary dinner of the Clockmakers' Company, held on Dec. 9 in Merchant Taylors' Hall to commemorate the three-hundredth anniversary of the incorporation of the Company by charter. The Master, Sir Frank Dyson, Astronomer Royal, presided. The charter was granted on Aug. 22, 1631, when the Company was styled " The Master, Wardens, and Fellowship of the Art or Mystery of Clockmaking of the City of London ". It was constituted a livery company in 1766. Though to-day the Company does not exercise the same control over the trade as of old, it serves its interests in many ways. Its library of works on horology and its collection of clocks and watches are deposited in the Library and Museum of the Corporation of the City of London in Guildhall, where they are open to inspection by visitors. David Ramsey was the first Master of the Company, while among his successors have been Edward East; the Fromantels, father and son; Thomas Tompion and George Graham, both of whom are buried in Westminster Abbey; John Harris, Daniel Quare, and Thomas Earnshaw. When proposing " The Clockmakers' Company ", His Royal Highness said that he was proud that the clockmakers had selected him, as the first master of the Master Mariners' Company, to propose the toast. There is no doubt, he said, that we have always been first in the field as regards chronometers, or machines for finding longitude. Some of the members of the Master Mariners' Company would be able to say what splendid instruments English chronometers are, and he expressed the hope that the Clockmakers' Company will continue to flourish and maintain the high standards for which English skill and workmanship have so long been renowned.

THE Humber ports are the largest fishing centre in the world and it was intended from the first that the Department of Zoology in the University College of Hull should co-operate with the fishing industry. To this end, A. C. Hardy, who served as marine biologist on the *Discovery* Expedition of 1925–27, was appointed as the first professor of zoology and oceanography in the College. A scheme for fisheries research was drawn up by Prof. Hardy and additional accommodation has now been provided by the College. The interest of the fishing industry in this development was shown by Sir John Marsden, president of the British Trawlers' Federation, when he formally opened the new department on Dec. 8. Sir John commented on the fact that, in the past, the fishing industry paid little attention to scientific investigations, partly because the industry itself consisted of a number of individual units working independently. This has now been changed and the Federation over which he presides represents ninety-nine per cent of the steam trawlers of Britain. The Federation, he said, is ever vigilant of its members' interests, and, we may add, is fortunate in having as its leader one who appreciates the importance of scientific research. Sir John commended the good work already being undertaken by Prof. Hardy and his staff, and said that even closer co-operation between the College and trawler owners would be to the lasting benefit of the fishing industry. The capital cost of the new laboratories has been borne by the College, but the greater part of the maintenance will be met by a Government grant, on the recommendation of the Development Commissioners. The work to be undertaken—in brief, the distribution of the plankton of the North Sea in relation to the movements of fish, particularly the herring—was described in an article which appeared in Nature of June 13, page 911.

The Fourth Pacific Science Congress met at Batavia-Bandoeng, Java, in 1929, with Dr. O. de Vries as general president, and five bulky volumes of proceedings—general part and reports on oceanography, physical papers (two vols.), biological papers, agricultural papers (The Hague: Martinus Nijhoff, 1930, 60 guilders)—have recently been published. The idea of conferences for the joint discussion of Pacific problems was first mooted at the meeting of the British Association in Australia in 1914, and came to fruition in the Congress in Honolulu in 1920. Eventually the Pacific Science Association was formed as a permanent organisation of the institutions and individuals engaged in research on the scientific problems of the Pacific region, and the Java conference in 1929 was the first to meet under its auspices. Discussions and papers were confined strictly to problems of Pacific interest, and agricultural science was included for the first time. The agricultural division, however, scarcely supplies any problem of circum-Pacific scope, the Pacific Ocean being in this respect rather a barrier than a link between the countries west and east of its waters, the range of climates extending from the arctic and antarctic to the tropical types, and agriculture, therefore, may find it more suitable in the future to organise along other lines.

A wide range of subjects was dealt with in the physical, biological, and agricultural sections of the Fourth Pacific Science Congress. The papers, numbering about 270, were mostly short but comprehensive, and touched on problems of fundamental and practical importance. Some twenty-six countries were represented, and the foreign members were given the opportunity of joining excursions to make first-hand acquaintance with the conditions and problems under discussion. The advantages of personal contact offered by the Congress were enhanced by the facts that a total eclipse of the sun occurred during May and the Third Congress of the International Society of Sugar Cane Technologists met during June, which brought together a number of other scientific workers, who found the Pacific Science Congress a suitable meeting-place to exchange views and results.

Dr. M. McClintock, of Harvard University, gave an interesting radio talk over the Columbia Broadcasting System on Oct. 30, on street traffic engineering. He pointed out that the safe and orderly movement of traffic over streets and highways is a great national problem in America. It is estimated that more than two million pounds are wasted annually in the United States because of the delays occurring from traffic congestion. Every year there are more than 32,000 fatalities and more than a million personal injuries owing to motor-car accidents. There is an urgent demand for the mitigation of this evil. Dr. McClintock thinks that one of the most promising remedies is to be found in properly designed motor vehicles. The modern motor-car has made great strides in this direction during the last ten years. We have now four-wheel brakes, splinter-proof glass, shock absorbers, more flexible power plants, stronger bodies, and better headlights. Statistics prove that the motor of to-day is four times safer than the motor of ten years ago, but it is not yet ideally designed to function in modern traffic. Great progress has been made in securing national uniformity in the rules of the road. In the installation of 'stop' and 'go' visual signals there is still much room for improvement. Many engineers assumed that they were a panacea for all traffic difficulties. The result is that they have been installed in many cities in places where nothing but added delay, increased risk, and irritation of the driver can result. When the problem has been properly studied and all the facts obtained by statistical researches taken beforehand, smooth running has resulted. The knowledge recently gained as to the best systems of automatic control leads to the belief that in the future there will be very few traffic policemen. It has to be remembered always that, no matter how perfect the scientific control of traffic may become, the most important element is still the human one.

In a report just issued by Steatite and Porcelain Products, Ltd., of Stourport, Worcestershire, many experiments are described which prove the value of modern research methods in improving the devices used in industry. The report discusses the design of protective fittings for the long strings of insulators used in connexion with the National Grid in Great Britain. Many have wondered why large metal rings are put at the ends of these sets of insulators. Apparently the original idea was that they would level down the voltage stresses between the individual units and thus diminish the maximum electric stress on the set. In practice the insulators when clean and dry provide an insulation far in excess of the maximum permissible. It is found that when soiled and wet the stress distribution is automatically altered for the better, and so this detracts from the usefulness of rings for this purpose. They are, however, of great use in protecting the insulators from damage when a low frequency arc occurs, as it is kept at a distance from them. Well-designed insulators withstand transient flash-overs, but a prolonged arc will damage any insulator. The report shows photographs of arcs taking place at 400 kilovolts between arcing horns, and many cinematograph and oscillograph records of arcs and flash-overs between arcing horns protecting strain insulator sets under all kinds of atmospheric conditions. These prove conclusively that the double horn type of protector serves the purpose of keeping the arc away from the insulator set and also breaks the arc. When the insulator set is used horizontally, protectors for it are much easier to design. In this case the arc is kept clear of the insulator by the convection currents of hot air. Horns in conjunction with an arcing ring were found very satisfactory. The arc started between the horns and the ring, and then rose and broke very quickly.

THE Smoke Abatement Handbook recently issued by the National Smoke Abatement Society gives a concise but comprehensive summary of information relating to smoke abatement. The numerous facts cited include data not only on the composition and deposition of soot, the production of smoke, its effect on health, vegetation, and buildings, but also on the various smokeless fuels, their production and sources of supply, together with a directory of associations, and a list of local authorities represented on the Council of the National Smoke Abatement Society. Estimates are given of the cost of smoke to various towns; for London this is given as £6,815,000; for Manchester, £2,900,000; for Birmingham, £2,350,000; for Liverpool, £2,308,000, and for Glasgow, £1,809,000. A useful summary of both the English and the Scottish law relating to smoke emission reveals the absence of any legislation concerned with the domestic smoke which is responsible for upwards of seventy-five per cent of atmospheric pollution. Other sections on industrial smoke abatement and the domestic smoke nuisance are included, in which the factors tending to produce smoke are analysed and methods of dealing with the domestic problem are outlined. The British Electrical Development Association contributes a note on "Electricity and Smoke Abatement", and a further section outlines the contribution of the gas industry. Gas coke is fully discussed, and reference is made to the new portable inset grate which facilitates its use in open fires. The measurement of atmospheric pollution is described, and also the measurement of the obstruction of light by atmospheric pollution. The booklet provides, in accessible form, information indispensable to all who may have occasion to speak or write on the subject.

THE requirements of artificial illumination for grading grain fall under three heads: (1) colour or composition of the light; (2) intensity of illumination; (3) diffuseness of the illumination. D. C. Rose (*Canadian Journal of Research*, vol. 5, p. 64; 1931) has tested various combinations of lighting units, and finds satisfactory working from two Ivanhoe Glassteel Diffuser fixtures of 500 watts each, with a 'Trutint' glass globe, and from certain arrangements of a Cooper Hewitt mercury vapour lamp, *M* Tube type, a Cooper Hewitt hot cathode neon lamp, and a General Electric Type *S*1 sun lamp. The colour of the light is, if anything, less important than its intensity and diffusion, provided it does not differ too greatly from that of noon sunlight, which is adopted as the standard white light, with a colour temperature of from 5000° K. to 5400° K. Certain precautions need to be observed by the inspectors using the lamps to ensure accuracy of grading, but if the instructions given are duly carried out, it becomes possible to grade wheat throughout the day and night during rush periods, instead of only during a few hours with ordinary daylight. Various methods of increasing the intensity of reflected light have been tried for grading wheat by physical means, but so far none has given results of any value. Chemical tests are too lengthy, and in any case the protein content of wheat does not seem to follow the grade in any regular manner. It would seem, therefore, that the only improvement in method that is possible at present is the use of artificial light for examination as indicated above.

DR. FREDERICK V. COVILLE, botanist of the United States Department of Agriculture, and chairman of the Research Committee of the National Geographic Society of America, has been awarded the George Robert White Gold Medal of Honor, the highest horticultural award in the United States, made by the Massachusetts Horticultural Society. Dr. Coville is known for a series of botanical discoveries and experiments. For example, his adaptation of the wild blueberry to the pine barrens of New Jersey has covered hitherto desolate areas with highly productive crops. Other studies he made, such as that of a method of restricting sheep grazing in national forests, have conserved vast tracts of valuable forage. Dr. Coville is joint author of "Standardised Plant Names", which gives authoritative names and spellings of 20,000 species and varieties of plants of the United States. While experimenting with the blueberry, Dr. Coville demonstrated the effect of cold in stimulating the growth of plants, and found that the wild crab, the cranberry bush, the tamarack, trailing arbutus, and the seeds of the bunchberry would not grow until chilled. He is acting director of the National Arboretum in Washington, for which the Government has already acquired 190 acres at Mt. Hamilton, and is negotiating for more. He is a former president of the Biological Society of Washington, the Botanical Society of America, and the Washington Academy of Sciences. Forty years ago he made the first botanical survey of Death Valley, publishing his findings, which ever since have been the standard work on the plant life of that region. He has also made several other botanical surveys. Other recipients of the George White medal have included Charles S. Sargent, for many years director of the Arnold Arboretum in Boston; George Forrest, of Edinburgh, who explored Tibet and western China to bring ornamental plants back to Europe; and Dr. Liberty Hyde Bailey, the well-known writer on horticulture, of Cornell.

THE extensive museum formed by Dr. William Hunter, court physician to Queen Charlotte, consort of George III., and bequeathed by him to the University of Glasgow, contains a number of specimens of insects. Particular interest and importance is attached to these, since many of them are the actual types of species founded by the great systematist, J. C. Fabricius. In order to make these Fabrician types more accessible to systematic entomologists throughout the world, it was deemed desirable that the specimens should be accurately figured and provided with up-to-date technical descriptions. This project has been rendered possible through the generosity of the Carnegie Trustees for the Universities of Scotland,

and the first instalment of the scheme has taken shape as a volume entitled "The Fabrician Types of Insects in the Hunterian Collection at Glasgow University. Coleoptera, Part I.", by Mr. Robert A. Staig, lecturer in zoology (entomology), University of Glasgow, and published by the Cambridge University Press, 1931, price 25*s.* net. This book is well illustrated by 28 three-colour process plates with appropriate letterpress. The Fabrician specimens, it may be added, are more than one hundred and fifty years old, but the great majority are still in a remarkably good state of preservation. The coloured plates and descriptions in Mr. Staig's book are based upon the actual specimens, without attempts being made to rectify defects, etc., due to age.

THE *Comptes rendus de l'Assemblée de Stockholm*, held on Aug. 15–23, 1930, for the Section of Terrestrial Magnetism and Electricity of the International Union for Geodesy and Geophysics, is a bulky volume of 479 pages. The major part of the volume consists of reports of national committees (170 pages) and communications from individuals and institutions (184 pages). Nineteen countries contribute national reports, including Germany, which was represented, by invitation, at the Assembly, though Germany does not at present adhere to the Union; among the countries not reported on are India, South Africa, New Zealand, and the South American republics; fortunately the absence of a report does not necessarily imply inactivity in this branch of science. Among the individual communications of special interest may be mentioned an account of Swedish methods of geo-electrical prospecting, and a discussion by H. W. Fisk, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, of the secular magnetic variation in recent years. These are among the few contributions that exceed ten pages in length, the volume being in the main made up of very short reports and papers. The portrait of the late Dr. Chree, former president of the Section, forms the frontispiece.

PROF. P. LANGEVIN, of the Collège de France, Paris, who has been in China for some time on an international educational mission on behalf of the League of Nations, has accepted the joint invitation of the National Academy of Peiping, the National University of Peking, and the National Tsing-Hwa University in Peiping, China, to give a series of lectures to physicists and advanced students of physics there. The lectures were scheduled to start about the middle of December and will probably last for one month. The subject chosen by Prof. Langevin is "Les nouvelles dynamiques de relativité et des quanta et leurs applications à quelques problèmes de la théorie du magnétisme." It is hoped that the presence of Prof. Langevin, and his lectures, will serve as stimuli to the creation of an atmosphere and an active centre for research in physical science in that region. In Peiping there are six universities having physics as a department, besides one institution purely for research on that subject. Steps are also under way towards the formation of a physical society, with its aim and its organisation along the lines of those existing in other countries.

AN interesting glimpse of primitiveness in a civilised society is afforded by a cutting from the *Age*, sent to us by Prof. W. A. Osborne, of Melbourne University. The article describes the hearing of an appeal in the High Court by the Australian Pastoral Co., Ltd., against taxation imposed by the Commissioner of Land Tax. Evidence by the general manager of the company revealed the fact that the company suffered so much from the depredation of emus in the Maranoa district that at one period head money was paid for the destruction of the birds. The company used to pay 2*s.* each for grey heads (old birds), 1*s.* 6*d.* for black heads (young emus), and 1*s.* for each egg secured. They were obliged to discontinue the payments, not because of scarcity of emus, but because the company's employees would do nothing but look for emus. The interesting feature is that the standard rate of value of emus' heads during the period of proscription led to their becoming a sort of currency. Bets were made with the heads, and they were often brought into use in the making of purchases, so that they came to be looked upon as a common means of exchange.

SIR JAMES BARRETT writes from Melbourne in reference to our article "Nationalism and Science in China" (NATURE, Sept. 19, p. 469) confirming from his own knowledge and experience the extension of Chinese anti-foreign nationalism to scientific matters. "Personally", he says, "my contact with Chinese surgeons, both men and women, could not have been more pleasant, but one cannot shut one's eyes to the intensity of national feeling." He quotes, as an example, from remarks made by a Chinese surgeon at the recent Pan-Pacific Surgical Congress at Honolulu. While cordially agreeing with Sir James in certain remarks that he had made about science having no national boundaries, he deplored the fact that for three hundred and twenty to four hundred million Chinese there were only about five thousand properly qualified Chinese medical men, and went on to say that there were in effect three medical schools only in China—the Union College, Pekin, the South Manchurian Japanese Medical School, and the Hong-Kong British Medical School.

THE *Chemiker-Zeitung* for Nov. 25 directs attention to two new reagents called 'intrammon' and 'locron', which have been introduced by the I. G. Farbenindustrie Aktien-Gesellschaft for rendering wood and various textile materials fireproof. Intrammon is used for impregnating wood, and is said to be superior to other preparations of the kind, since it can be very uniformly distributed throughout the mass of the material when applied under pressure, instead of merely saturating the outer layers. This property is due to an important constituent which the manufacturers call an activator. Intrammon provides a safeguard not only against fire but also against dry-rot and mildew. Locron, on the other hand, is applied to the surface of the material, and is not brittle like preparations containing water-glass. Under the action of radiant heat, locron swells into a voluminous, frothy crust, which acts as an insulating layer, thus protecting the underlying fibres from ignition. It can be applied to textile fibres by means of a spray.

How greatly the work of the Hawaiian Volcano Observatory is growing is shown by the appointment of two additional assistants during the last few months. In a recent *Volcano Letter* (No. 351, Sept. 17), Prof. T. A. Jaggar describes the organisation of the work at the observatory, and especially two lines of investigation on which the Volcano Association is now engaged. One is the study of the local tiltings of the ground in Hawaii in connexion with faults, earthquakes, etc., and the outlining of the boundaries of the various fault-blocks. The other is the determination of the surface-positions and depths of the foci of Hawaiian earthquakes from the duration of the preliminary tremors at three stations. The method adopted is one that has been in use for some years in Japan, but the labour of applying it is lessened by new and simple apparatus.

DR. H. R. LANG, acting secretary of the Institute of Physics, has been appointed secretary of the Institute and editor of the *Journal of Scientific Instruments*. Dr. Lang carried out research with the late Prof. H. L. Callendar, and was afterwards demonstrator in physics at the Imperial College of Science and research fellow of the Institution of Petroleum Technologists.

A SERIES of lectures on "Mycorrhiza", "Mycorrhiza in Relation to Forestry", and "Recent Researches on Tree Mycorrhiza" were given by Dr. M. C. Rayner at a number of American universities and research stations during the months of October and November. Lecture engagements at several of the Canadian universities and at various universities and research stations in the western United States were cancelled, with the intention of including them in a more extended tour during the autumn of next year.

IN connexion with the twenty-second annual Exhibition of Electrical, Optical, and other Physical Apparatus arranged by the Physical and Optical Societies to be held on Jan. 5–7 at the Imperial College of Science and Technology, South Kensington, discourses have been arranged for each evening at 8 P.M. On Jan. 5, Mr. C. C. Paterson will lecture on photocells; on Jan. 6, Mr. T. Smith will speak on photographic shutters; and on Jan. 7, the discourse will be given by Sir Oliver Lodge, on "Reminiscences".

DR. BURGESS BARNETT, who has been appointed by the Council of the Zoological Society of London to succeed the late Miss Joan Procter as Curator of Reptiles, is an old student of St. Bartholomew's Hospital. He qualified in medicine and surgery in 1915, and served as a captain in the R.A.M.C. during the War. On being demobilised, he returned to take up the post of house-physician at his old hospital, after which he was appointed medical officer to the Lobitos oil-fields in Peru. Since he has been in South America, he has collected and sent home several valuable collections of living reptiles to the Zoological Gardens. In this way he became acquainted with Miss Procter, and when on leave used frequently to help her in the treatment of difficult cases of reptilian disease. Dr. Barnett is still in Peru, and will not take up his appointment until May 1932.

WE commend to those whom it may concern, and they are many, the pamphlet on "Rats and Mice as Enemies of Mankind", by M. A. C. Hinton, issued by the British Museum (Natural History). Ten years have passed since the second edition appeared, and the third contains additional information and marks a progressive step in the national view of the rat plague, for it records the provisions of the Rats and Mice Destruction Act of 1919, which was passed while the former edition was in the press.

VOL. 2 of the *Veterinary Bulletin* will be issued monthly from Jan. 1, 1932, and will run to about 864 pages, including the index for each monthly issue and the final classified volume index. It will cover the same ground as vol. 1, but will be much more complete and will include references to all important British and foreign scientific work relating to veterinary research, administration, public health, and education. Although it was originally intended that the issues for 1932 and onwards should cover only 600 pages annually, expansion has been necessary in order to deal with the amount of material available. All communications should be addressed to the Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture and Fisheries, Weybridge, Surrey, England.

MR. J. H. KNOWLES, 23a Beulah Hill, Upper Norwood, S.E.19, offers, in list No. 18, some two hundred second-hand books of botanical and zoological interest.

WE have received from Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, a copy of catalogue No. 450, giving particulars of some 1150 second-hand works having reference to botany, agriculture, forestry, fruit-culture, gardens and gardening, herbals, early medicine and surgery, and tobacco. The catalogue is interesting and valuable in that it contains bibliographic notes on many of the volumes listed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant at the Mining and Technical Institute and Junior Technical Day School (Boys), Bridgend—The Director of Education, County Hall, Cardiff (Dec. 22). An inspector of schools under the City of Liverpool Education Committee—The Director of Education, 14 Sir Thomas Street, Liverpool (Dec. 31). A director of education for the Urban District of Rhondda—The Clerk of the Council, Council Offices, Pentre, Rhondda (Jan. 1). A principal of the Thomason Civil Engineering College, Roorkee, India—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Jan. 9).

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Polarisation of Downcoming Wireless Waves in the Southern Hemisphere.

In the course of experiments carried out some years ago at the Peterborough Radio Research Station of the Department of Scientific and Industrial Research, Mr. Ratcliffe and I made some observations [1] on the state of polarisation of wireless waves after their reflection by the upper atmosphere. On all occasions on which it was possible to obtain reliable measurements it was found that the downcoming waves were very approximately circularly polarised with a left-handed sense of rotation. Since it was known that the waves originally emitted by the sending stations (emitters at both Teddington and Birmingham were used) were plane polarised, with the electric vector in a vertical plane, the experiments showed that the conversion to left-handed circular polarisation had been effected by ionisation in the upper atmosphere during the process of refraction.

In attempting to explain this result it was pointed out that the influence of the earth's magnetic field is such that, for the range of wave-lengths employed (300-400 metres), there is a considerable difference between the absorption coefficients and phase velocities of the two components propagated within a refracting medium containing electric charges of electronic mass. It seemed reasonable, moreover, to suppose that the polarisation of the waves observed at the ground was produced during their emergent passage through the lower part of the refracting region. For this portion of the wave track it was estimated that the direction of propagation would not differ very markedly from that of the lines of magnetic force of the earth. For propagation along this direction the theory showed that, of the two circularly polarised components which travel, the right-handed component would be much more absorbed than the left-handed, so that waves of predominantly left-handed polarisation would emerge from the ionised layer. The account of this attempt to explain the experimental results was, however, concluded with the following sentence: "But it will easily be seen that the most direct test of the above interpretation would be to carry out similar experiments at corresponding points in the Southern Hemisphere, where the resulting polarisation should be right-handed if the effect is due to the action of the earth's magnetic field".

The Australian Radio Research Board, on its formation by the Commonwealth Council of Scientific and Industrial Research in 1929, gave the prosecution of such polarisation experiments high priority on its programme, and Mr. A. L. Green (formerly of King's College, London, and of the Radio Research Stations, Peterborough and Slough), who had assisted in the English experiments, was entrusted with the task of carrying them out. Working in New South Wales, Mr. Green was able to carry out the tests under conditions which were exactly those required for a strict comparison of results in the northern and southern hemispheres. The emitting station was situated at Coogee, Sydney, and the receiving station at a point 142·7 km. south, at Jervis Bay. For these conditions the downcoming waves must have travelled along a direction only slightly inclined to that of the earth's magnetic field. In his lengthy series of observations Mr. Green has found that all his reliable records show the downcoming waves to be approximately circularly polarised with a right-handed sense of rotation. At his request I have also compared some of his records with those obtained by us in England and have confirmed his result that, under comparable conditions, downcoming waves are polarised in opposite senses in England and Australia.

An account of the complete series of Australian experiments on upper atmospheric influence on wireless transmission will, I understand, be published in due course. Meanwhile, after having had an opportunity of comparing the records in question, I have been requested to announce this very interesting difference between the results in the northern and southern hemispheres.

Experiments on the polarisation of downcoming wireless waves are of more than scientific consequence. The home Radio Research Board, on its formation in 1920, instituted a fundamental inquiry into the cause (and, if possible, the elimination) of night errors in direction-finding. It was recognised at that time that such errors were caused by the arrival at the point of observation of waves which were abnormally polarised, but the origin of such abnormal polarisation was unknown. As a result of Mr. Green's experiments it can now be regarded as certain that the influence of the earth's magnetic field is such as to produce this polarisation. We can say that 'night errors' in wireless direction-finding are due to the arrival at the receiver of waves which leave the emitter as plane polarised waves in a direction inclined to the horizontal and reach the highly ionised regions in the upper atmosphere. There, under the influence of the earth's magnetic field, they are separated into their two component circularly or elliptically polarised waves, which undergo differential absorption and changes in polarisation and are bent round until they leave the ionised regions with a direction of propagation towards the earth. On reaching the receiver they cause fading and errors in the observed direction of the emitting station. It is also gratifying to note that, in connexion with the other aspect of the inquiry instituted by the home Board, Dr. R. L. Smith-Rose and Mr. R. H. Barfield, following suggestions of Mr. F. Adcock, have developed at the Radio Research Station, Slough, a practical direction-finder which is substantially free from errors even under conditions when downcoming waves of abnormal polarisation are being received.

E. V. Appleton.

Potters Bar,
Nov. 23.

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[1] "A Method of determining the State of Polarisation of Downcoming Wireless Waves", *Proc. Roy. Soc.*, A, 117, 576; 1928.

Oxygen and Everest.

Dr. Raymond Greene's article [1] "Oxygen and Everest" is the substance of his contribution to the discussion following Prof. J. Barcroft's paper to Section I of the British Association at the centenary meeting, on "The Limits placed by Altitude to Physical Exercise".

In that paper it was recorded that recent experiments in the pressure-reducing chamber at Oxford have shown how work, claimed to be equivalent to ascending 1000 ft. per hour, can be done by human beings breathing oxygen, at a pressure much below that prevailing at the top of Mount Everest, 29,002 ft. The conclusion arrived at was that for the last 5000 ft. of the mountain, up and down, 700 litres or 30 cub. ft. of oxygen per man would be indispensable, involving in the containers and apparatus necessary an altogether too heavy load. The problem, therefore, of climbing Everest was deemed one less for the mountaineer than for the engineer, on whom should devolve the responsibility of devising some kind of light cylinder of high tensile strength capable of containing under great pressure the requisite quantity of gas.

I may perhaps be allowed to give in brief the substance of my remarks in the discussion on Barcroft's paper, and add one or two *à propos* of Dr. Greene's views.

Following the second expedition to Mount Everest, which was the first actual assault above 23,000 ft. on the main summit, opinions differed as to the value of an artificial supply of oxygen. Finch and Geoffrey Bruce had reached 27,200 ft. using an oxygen apparatus all the way from 21,000 ft. But Mallory's party of four climbers had also attained almost an equivalent altitude, namely, 26,900 ft., entirely without oxygen equipment and relying upon their own inherent powers of acclimatisation.

The third expedition of 1924 was equipped with apparatus of an improved kind, including three cylinders of a specially light alloy ('Vibrac') steel, with a total capacity of 1605 litres, or about 57 cub. ft. of oxygen. This amount at the prescribed continuous consumption of 2 litres per minute was to provide for a 13 hours' climb, ascent and descent. But the total weight of the apparatus was about 33 lb. This, however, was later reduced to 22 lb. by discarding one cylinder and modifying the breathing apparatus.

Owing to various defects in the apparatus, to some extent consequent upon rough handling on the outward journey across Tibet, considerable delay was occasioned by the necessary repair work before a sufficient number of apparatus were available for use on the mountain. In the meantime high camps were pitched and plans laid for attempts on the summit without breathing apparatus; and these very efforts of the climbing party were the means of bringing about a degree of acclimatisation never before attained by previous climbers. Geoffrey Bruce, who had depended on oxygen in 1922, now found no perceptible relief when using it. On one occasion I carried an apparatus up to 27,000 ft., and as I was getting no benefit at 26,000 ft. I turned off the supply of gas and continued climbing with no noticeably enhanced fatigue. By living at an altitude of not less than 23,000 ft. for 11 days a very high degree of acclimatisation had been acquired.

It must not be supposed that the failure to find relief, or advantage, when using oxygen was due, as Dr. Greene has suggested, to some inherent defect in the apparatus and its supply of oxygen to the lungs. On the contrary, every apparatus eventually repaired was in perfect gas-tight condition, and by practice a suitable habit of inhaling from the mouth-piece of the supply tube had been acquired by the users.

Acclimatisation to an altitude of 27,000 ft. has been demonstrated, and there seems no valid reasons why it should not be possible to above 29,000 ft., or the top of Everest. In their record-making ascent to 28,000 ft. and above without oxygen supply, Norton and Somervell were admittedly reduced to extremely slow upward progress, but it must be remembered that neither of them was a fit man at the outset, largely owing to their having taken part in an exhausting rescue expedition not long previously. Mallory and Irvine set out on their last tragic climb with breathing apparatus, but we may never know what benefits, if any, they derived from it. In any case, there is nothing to warrant Dr. Greene's supposition that their failure to return was due to a breakdown in the oxygen apparatus.

Our general conclusions regarding the use of oxygen were long ago stated in "The Fight for Everest", 1925, page 329, wherein it was maintained that for a mountain of exceptional altitude, such as Everest, a future climbing party might advisably be provided with a light form of apparatus supplying a sufficiency of gas for the last few hundred feet of the mountain. It was strongly recommended, however, that such apparatus should be considered an emergency measure only, and acclimatisation to the highest altitudes should be resolutely aimed at. In practice, such altitudes on Everest would be about 27,000-28,000 ft., the height of the highest camp, and one to which carrying parties must ascend, unhampered by the extra individual load of breathing apparatus. For in this connexion it should not be forgotten what a high percentage of available porterage can be consumed, as it was on the Everest Expeditions, in carrying up oxygen supplies merely for the summit climbing parties.

With these things in view, a lightened and simplified apparatus was devised in 1925, and trials of its suitability for mountain use made in Snowdonia. The equipment provided for about 15 cub. ft. of gas, and its weight was not more than 12 lb.

Thus the load involved becomes a manageable one, and from the experience gained thus far it should provide ample oxygen for emergency purposes if due regard has been given to acclimatisation. The problem of the engineer, as conceived by Prof. Barcroft, would appear, therefore, to have been already largely solved by the mountaineer, though not without the earlier advice of the former. But both engineer and physiologist may be reminded that among many mountaineers the opinion prevails that if Mount Everest and other high Himalayan peaks are worth climbing at all, they should be ascended without such artificial aids as may reduce a sport to a mere laboratory experiment. If, however, in the interests of physiology the opportunity should not be missed, where, it may be asked, can this important problem of acclimatisation be better studied than under actual mountain conditions? It would seem to be as important for study as a mere duplication of the experiments carried out in a pressure chamber, where it has been shown that man can survive, when primed with oxygen, at a pressure much below that obtaining at the top of Mount Everest.

There is, however, much besides which might with profit be investigated. Dr. Greene makes no mention of the experiments which he conducted upon himself and another member of the Kamet party, namely, dosing with ammonium chloride to counteract 'alkalosis', apparently with good results. Research into all these matters, as suggested should be undertaken by the committee appointed by the British Association, might be diligently pursued as soon as possible in order that the next Everest Expedition, whenever it may receive permission to embark again on the great unfinished task, shall have all the tried advice which physiologists can provide.

N. E. Odell.

Clare College, Cambridge,
Nov. 30.

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[1] Nature, 128, 893, Nov. 28, 1931.

Lead Content of Rocks.

In recent years various geochemical problems have arisen which make it important that our scanty knowledge of the lead content of rocks should be amplified and made more precise. To this end we have determined the lead in a series of samples, representing in all about 220 rocks, some of which we owe to the kindness of Prof. Arthur Holmes of the University of Durham.

The sample to be analysed was brought into solution; silver sulphate was added and the silver and lead present in the solution were simultaneously precipitated as sulphide. The precipitate was then brought into solution and the lead deposited electrolytically as peroxide. That the deposit was actually lead peroxide was confirmed by a colorimetric test, tetramethyl-diamino-diphenylmethane being added to the solution of the deposit. To ascertain that the total lead content was actually recovered, we used the method of radioactive indicators. We added to the rock sample a known amount of the lead isotope radium D, prepared from radium emanation, and checked the yield obtained by measuring the activity of the lead peroxide deposit. As the purest chemicals commercially obtainable were found to contain quantities of lead that would have influenced our results, all the chemicals used were first purified from lead. Moreover, every precaution was taken to avoid contamination of the samples by dust which might have contained traces of lead. The results obtained are listed in Table I.

TABLE I.—LEAD CONTENT OF IGNEOUS ROCKS.

Rock Types.	Gm Lead per gm. Rock.
Basalt, Giant's Causeway	4×10^{-6}
Gabbros and related types (composite of 67 samples)	5×10^{-6}
Essexites and related types (composite of 40 samples)	10×10^{-6}
Shonkinites (average of 2 samples)	10×10^{-6}
Soda-granites and soda-syenites (composite of 26 samples)	11×10^{-6}
Potash-granites and potash-syenites (composite of 24 samples)	14×10^{-6}
Amphibolite, inclusion in Kimberlite, Wesselton Mine, S. Africa	15×10^{-6}
Kimberlite ('basaltic' type). Dyke from 1350-foot level, Dutoitspan Mine	16×10^{-6}
Lherzolite, Baltimore, Maryland	19×10^{-6}
Granitic rocks (composite of 58 samples of widely different localities)	30×10^{-6}
Dunite, Jackson Co., North Carolina	42×10^{-6}

The average value found is 16×10^{-6} gm. lead per gm. rock, a somewhat larger value than that given by Clarke and Steiger,[1] who found $7\cdot5 \times 10^{-6}$ gm. per gm. rock. As shown in the communication that follows, the amount of lead accumulated in the rocks since the solidification of the earth's crust (as a result of the decay of uranium and thorium) is very much smaller. Thus, as between the atomic weights of rock-lead and ore-lead we have in most cases to expect differences only in the second decimal place. That the ore-lead must have been formed in the ancestral sun, or during the events that attended the birth of the solar system, was already pointed out some years ago by Prof. Holmes.[2]

We conclude from the above determinations that the greater part of rock-lead is also of the same origin. Although acid rocks, which have a relatively high uranium and thorium content, are found to contain more lead than basic rocks, this difference is not to be interpreted as an argument in favour of the radioactive origin of the whole of the lead in rocks, but an expression of the fact that lead, like uranium and thorium, shows a marked affinity to siliceous magmas.

It is of interest to compare the lead content of basic and ultrabasic rocks with that of meteorites as determined by Noddack.[3] The lead content of stony meteorites is near that of basalt and average gabbro, and is markedly lower than that of terrestrial ultrabasic rocks. The lead content of iron meteorites, as confirmed in this laboratory, is about ten times greater than that of stony meteorites, while that of troilite (the high lead content of which was predicted by Prof. V. M. Goldschmidt) is more than a hundred times greater (700×10^{-6}). These results show that when the earth was formed the silicate shell received only a modest share of the total lead available for partition, and that this uneven distribution has so far been compensated only slightly by the formation of lead from radioactive decay.

TABLE II.—LEAD CONTENT OF BASIC AND ULTRABASIC ROCKS AND OF METEORITES.

	Gm per gm Rock.
Gabbros (average)	5×10^{-6}
Kimberlite	16×10^{-6}
Lherzolite	19×10^{-6}
Stony meteorites (average)	5×10^{-6}
Iron meteorites (average)	50×10^{-6}

G. HEVESY.
R. HOBBIE.

Institute of Physical Chemistry,
University of Freiburg im Breisgau.

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[1] *Jour. Wash Acad. Sci*, 4, p. 58; 1914.
[2] NATURE, 117, 482, April 3, 1926.
[3] *Die Naturwiss*, 18, p. 761; 1930.

IN two earlier communications on this subject [1, 2] I directed attention to the bearing on geological time and geochemical problems of Clarke and Steiger's determination of lead in a composite sample of 329 igneous rocks. The amount of lead found by these analysts was $7\cdot5 \times 10^{-6}$ gm. per gm. Adopting this result as the best then available, and combining it with other data, such as the uranium and thorium contents of rocks and the atomic weights of lead from different sources, I pointed out that the following inferences could be drawn:

(*a*) that the age of the earth could not be greater than some 3200 million years;

(*b*) that the atomic weight of rock-lead should fall about midway between 207·2 and 206·9, these being the respective atomic weights of common lead (that is, ore-lead) and lead of radioactive origin generated in the rocks; and

(*c*) that ore-lead could not have been derived from igneous rocks or their magmas, since the atomic weight estimated for rock-lead, 207·05, differed widely from that actually found for ore-lead.

The third of these inferences was supported by the remarkable coincidence that in the one measurement on record of the atomic weight of a sample of rock-lead (from cotunnite, 1906 eruption of Vesuvius) the average value found was 207·05 (Piutti and Migliacci, 1923), whereas for ordinary lead the same investigators obtained the value 207·19. Nevertheless, the inference has proved sufficiently disturbing, as I hoped it would, to stimulate workers in various research centres to revise and amplify the data on which it was based. If, for example, Clarke and Steiger's figure for the lead content of rocks were not fairly representative, then the whole argument would stand in need of revision. Similarly, if the ratio Th/U in rocks were greater than 2·2, then the atomic weight of generated lead would be correspondingly higher than 206·9. Moreover, the Vesuvius magma is of a rather uncommon type, widely different from that with which lead ores seem generally to be associated. An atomic weight determination of lead from rocks of the rhyolite-andesite series might therefore be expected to throw fresh light on the problem. All these lines of attack are now under active investigation, and the results announced above by Prof. Hevesy and Dr. Hobbie may be regarded as the first fruits of the campaign.

These results show that Clarke and Steiger's figure can no longer be regarded as representative. The following table makes this clear. The age of the earth is taken as 1600 million years, and the amount of lead, Pb, generated in the material of each rock or composite sample during that time is compared with the total amount of lead, **Pb**, found by analysis. It will be seen that whereas the Clarke and Steiger figure (C. and S. average) implies that the total lead is three times the lead generated during 1600 million years, the Hevesy and Hobbie figures show that the total lead ranges from four to fifty-three times the generated lead. Dr. J. A. Smythe has recently found that a composite sample of 2950 specimens of the Whin Sill contains 24 × 10^{-6} grams of lead per gram.[3] The average contents of uranium (0·8 × 10^{-6}) and thorium (3 × 10^{-6}) are also accurately known from the work of Dr. V. S. Dubey. These results imply that the total lead in the Whin Sill is sixty times the generated lead.

Type of Rock.	U	Th.	Pb.	**Pb.**	**Pb**/Pb
C. and S. average .	6·0	15·0	2·6	7·5	3
Gabbros (average) .	2·4	5·1	1·0	4·0	4
Granites (average) .	9·0	20·0	3·7	18·0	5
Basalt . . .	1·5	1·7	0·5	4·0	8
Kimberlite . .	3·2	4·7	1·1	12·0	11
Amphibolite . .	0·9	3·1	0·5	10·0	20
Dunite . . .	1·4	3·4	0·6	32·0	53

Note.—The figures for U, Th, Pb. and **Pb** are the amounts in grams in 10^6 grams of rock.

From the point of view of the genesis of lead ores, the most significant of the results of Hevesy and Hobbie is that for granitic rocks. The latter include pre-Cambrian, Caledonian, and Hercynian granites from various parts of Europe (ranging petrographically from granite to granodiorite), and similar North American rocks of various ages from pre-Cambrian to Tertiary. In this representative composite sample the total lead is five times the generated lead. The atomic weight of the latter may be calculated and is found to be 206·96. If the atomic weight of the lead originally present in the earth be taken as 207·23, then that of the lead now present in granitic rocks should be between 207·17 and 207·18. Thus, if lead ores have been derived from granitic magmas, the atomic weight of ore-lead should vary between 207·23 and 207·17 according to the age, the higher value referring to ores dating from the beginning of geological time and the lower to ores formed at the present day. The values for actual ores should lie within these figures, and as shown in the list I have already compiled,[2] the most accurate determinations made since 1915 do, in fact, range from 207·22 to 207·18.

Thus, in the light of the new data now available, there is no longer any serious reason to doubt the usually accepted conclusion that lead ores have been derived from granitic and related magmas, always provided that the age of the earth is not considerably greater than 1600 million years. The maximum age previously calculated from Clarke and Steiger's figure for lead (on the extreme assumption that *all* the lead in the rocks has been generated within them) must now be replaced by a maximum several times higher than 3200 million years, a maximum so high that it ceases to have any immediate practical interest.

ARTHUR HOLMES.

The University, Durham, Nov. 16.

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[1] NATURE, 117, 482, April 3, 1926.

[2] NATURE, 124, 477, Sept. 28, 1929

[3] *Trans. Nat. Hist Soc, Northumberland, Durham, and Newcastle-upon-Tyne*, p. 32; 1930.

Limits of Gaseous Explosions.

It was stated long ago that the kinetics of gaseous reactions do not submit to the laws of classical physical chemistry. In particular, deviations from the law of mass action are best of all illustrated by the presence of the pressure limits for a thermal ignition.

The lower limit was revealed by Sagulin,[1] and its existence was confirmed by the work of Garner[2] and Hinshelwood[3] and others. Yet the upper critical pressure was known to Labillardiere[4] and was studied by Davy and Van 't Hoff.

However, the region of explosion between these two pressure limits has become clear only during recent years, owing to the works of Hinshelwood and Thomson,[5] and especially to those of Semenoff, Sagulin, Kovalsky, and Kopp.[6]

Recently, in the laboratory of the Institute of Chemical Physics in Leningrad, we have succeeded in establishing a complete picture of the region of explosion for a stoichiometrical mixture of methane and oxygen. It has been found that, for a certain range of temperatures, there really exist three pressure limits of ignition. The region of ignition of the above mixture in a cylindrical vessel of quartz with a diameter of 3 cm. is given in Fig. 1, which indicates the relations experimentally obtained between limiting pressures and temperatures. The lower ignition limit is represented by the curve *AB*, above which an ignition occurs. Corresponding to this part of the curve 'time lags' from 2 min. to 20 min. are observed in dependence on temperature. Curve *BC* is referred to the upper ignition limit, with the 'time lags' from 12 min. to 20 sec. Finally, the third limit of ignition is shown in the figure by the line *CD*. In this region, for an examined temperature interval, the 'time lags' are appreciably constant and equal to 6 sec. To the point *B* correspond the pressure of 6 cm. and the temperature of 650° C.; for *C*, 19 cm. and 701° C. respectively.

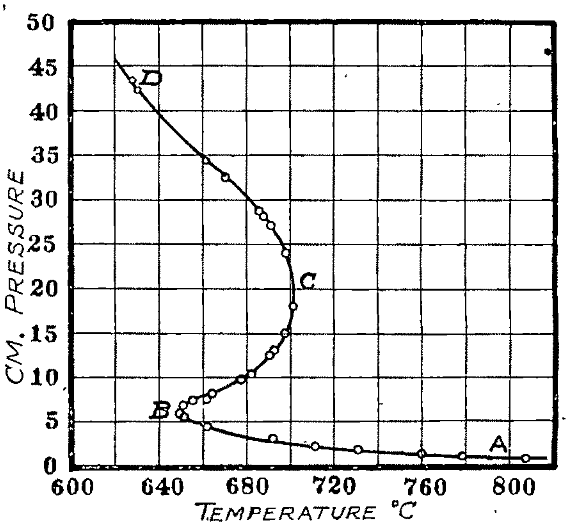

FIG 1.

The explosion is possible only to the right of the curve *ABCD*, while to the left it does not occur.

For the region of explosions between gas pressure *p*, absolute temperature *T*, and 'time lags' τ there exists a relation

$$\tau . p^n . e^{-\frac{\gamma}{T}} = \text{const.}$$

In our case $n = 1{\cdot}8$ and $\gamma = 42{,}000$.

We hope later on to give a detailed account and interpretation of the results we have obtained, on the basis of a theory of chain reactions.

In conclusion, we wish to express our sincere thanks to Prof. N. N. Semenoff, the director of the Institute of Chemical Physics, for his interest and advice during the course of this work.

M. Neumann.
A. Serbinoff.

Institute of Chemical Physics,
Leningrad, Oct. 10.

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[1] *Zeit. physik. Chem.*, B, 1, 125; 1928.
[2] *Trans. Far. Soc.*, 24; 1928.
[3] *Proc. Roy. Soc.*, A, 125, 294; 1929.
[4] *Ann. Ch. Phys.*, V, 6, 304; 1817.
[5] *Proc. Roy. Soc.*, A, 5, 122; 1929.
[6] *Zeit. physik. Chem.*, B, 6, 307; 1930.

The Comma Butterfly in England.

I have just seen the correspondence in Nature for Oct. 31 regarding the Comma butterfly in England, and it occurs to me that some observations I have made in the south-western parts of the country may throw some light on the increasing frequency of this insect.

About twelve years ago it was usual to see perhaps four or five specimens of the Comma each year, sunny days during early October being the time when most were to be seen, but hybernated specimens were also seen on warm days in March. During more recent years, however, the number of Commas seen has very much increased, particularly during the last three or four years, not only in Somerset, but also in Dorset and Hants as well. I have noted several occasions during the last two years, both here and in the New Forest, upon which the Comma has been quite the most abundant butterfly to be seen. I have seen as many as thirteen simultaneously on one small *Buddlea* bush in the town of Bournemouth.

What appears to me, however, to be the most striking change with regard to this butterfly lies in the fact that formerly it used only to be seen here in spring and autumn, whilst during the last three years at least it has been double-brooded in this district, numerous specimens being seen about the end of June and during July also. This double-broodedness has been confirmed by finding larvæ of both broods and also a pupa of the first brood. In addition to this, in Somerset at all events, the larvæ do not now feed exclusively on hops, but also on the common elm. The perfect insect has been successfully reared from larvæ found feeding on each of these plants. Without any special search being made, twenty-five larvæ have been found during the last two years. These observations seem to suggest that the habits of the Comma butterfly have undergone a change which may well account for the greater numbers observed during recent years.

F. Tutin.

Rose Cottage, Flax Bourton,
near Bristol,
Nov. 25.

Preservation of the Australian Flora and Fauna.

On behalf of many people and organisations who are trying to save the Australian flora and fauna, I desire to thank you for the very sympathetic reference to the preservation problem made in Nature of Sept. 12, 1931. Recently both governments and people have shown an increasing desire to try to save the disappearing animals and plants. This has been evidenced by the passing of the Wild Flowers Preservation Act both in New South Wales and Victoria, and by the extension of the Wyperfeld (Mallee) National Park in Victoria by the present Minister of Lands in Victoria, Mr. Bailey. Other proposed reservations are under consideration.

Particular acknowledgment should be made to Mr. F. Lewis, Chief Inspector of Fisheries and Game in Victoria, who has been most helpful in co-operating with various societies in the endeavour to preserve the unique creatures which at one time existed in Australia in very large numbers.

The Wyperfeld Park, situated about three hundred miles north of Melbourne, now covers thirty-six square miles of country and is one of the most interesting places on an interesting earth. The rainfall is very small, but the Park is traversed by the bed of the ancient Wimmera River, which in geological times flowed into a huge gulf of the sea in the north. The river now runs through the Park about once in ten years and then disappears in the sand north of the Park, but the water remains in the water-holes for three or four years before it evaporates. During the wet period, aquatic birds abound. Water is obtained in the dry period by wells and is used by the birds and animals. Along the bed of the river, red-gum (eucalyptus) grows profusely. Away from the river there is the usual semi-desert Mallee country. The birds nest in the red-gums, but apparently feed mainly in the outside country.

The Park is the home of the parrot and cockatoo family, which is increasing in numbers. It also contains emu and some of the black-faced Mallee kangaroo. Its profound interest is the way in which forms of life have survived and thrived in comparatively rainless conditions. The adaptation is remarkable.

Owing to the cultivation of the Mallee, the Leipoa or Mallee hen, popularly known as the Lowan, has practically been driven to seek refuge in the Park, and on a recent visit at least three of the nest mounds were found. There may have been many more, but they are not easy to find in the Mallee scrub, as there is no indication of their presence until one walks on to them.

Since the Park has been declared a National Reservation and has been patrolled, birds and animals have increased in numbers. Perhaps one of the most important features of the change is that the people living in the district have begun to take a pride and an interest in this unique portion of the globe.

James W. Barrett,
President, Wyperfeld National Park
Committee of Management.

103-105 Collins Street,
Melbourne, C.1,
Oct. 22.

Distribution of Agar-liquefying Bacteria.

Several strains of an organism which attacks and softens agar-agar have recently been isolated in this laboratory. The organism forms small, slowly growing, yellow colonies which grow well in the usual agar media; the colony is invariably situated in the centre of a circular area of softening. The 'hammered copper' appearance thus given to the plate is characteristic. No strain liquefies the agar. In stroke cultures the whole of the agar is in time softened, though growth does not proceed except on the surface.

The sources of the organisms were a swampy garden soil from Palmer's Green, London, and the clover side of Agdell Field, Rothamsted, both sampled in wet weather this spring. Most strains appear to be common to both soils. The optimal growth of most of the strains occurs in a medium containing about 0·3 per cent of sodium chloride, but one strain from Palmer's Green has grown on a medium similar to

Gran's, containing 3 per cent of salt. The presence of glucose depresses the growth of most strains.

The organisms have not been fully studied. While the finding of a halophilous organism in inland soil suggests several points of interest, the purpose of this letter is to direct attention to the probability of wide occurrence of organisms attacking agar, rather than to create new species. Such organisms have already been found in the Norwegian and West Indian seas, in Dutch soil and canal water, on Polish beetroot and Spanish raisins, and elsewhere. It seems likely that the discovery of bacteria able to attack hemicelluloses awaits but the search.

In view of the fact that such organisms have not been found here on thousands of 'count' plates, made directly from soil suspensions, it may be of value to mention that the present organisms, as some others have been, were isolated from filter-paper strips in the course of a search for cellulose-decomposing bacteria. With these latter the agar-liquefiers were frequently associated.

Hugh Nicol.

Department of Bacteriology,
Rothamsted Experimental Station,
Harpenden, Herts, Dec. 9.

Periodic Precipitation in the Absence of Colloids.

Several writers[1] have recently discussed periodic precipitation in the presence of gels and other related phenomena. It is the object of this note to direct attention to one of the most important and significant papers[2] in this field that appears, however, to have been overlooked.

Morse and Pierce[3] indicated in 1903 that periodic precipitation and formation of Liesegang rings is not dependent upon the presence of a jelly. In his beautiful experiments described, with many photographs, in 1930,[2] Dr. H. W. Morse summarises his work of the intervening years and demonstrates the formation of Liesegang rings in pure aqueous inorganic substances. One of the most interesting is the series of rings of an alum, each ring consisting of a single branched crystal of the moderately soluble salt. Morse was able to explain his results without invoking anything more mysterious than the ordinary laws of diffusion and the very rapid increase in instability as supersaturated solutions rise in concentration.

Some of the first-named writers had queried the formation of rings of silver chloride in the presence of gelatine. It is interesting that this is one of the substances which Morse has photographed in periodic stratification as formed even without gelatine.

James W. McBain.

Stanford University,
California.

[1] Nabar and Desai, Nature, April 25, 1931, **127**, 628; Bolam, Aug. 8, 1931, **128**, 222; Bradford, Aug. 8, 1931, **128**, 223; Desai, Aug. 8, 1931, **128**, 223; and Hedges, Sept. 5, 1931, **128**, 401.

[2] H. W. Morse, *Jour. Phys Chem.*, **34**, 1554; 1930

[3] Morse and Pierce, *Zeit. physik. Chem.*, **45**, 589; 1903.

Bands in the Spectrum of Barium Hydride.

In the last few years our knowledge of the spectra of diatomic hydrides has been greatly increased. This is especially true for the hydrides of the elements in the second column of the periodic table, the spectra of the neutral molecules BeH, MgH, CaH, ZnH, CdH, HgH, and of the ionised molecules BeH^+, MgH^+, ZnH^+, CdH^+, HgH^+ having been analysed. It therefore seemed worth while to complete the available information by studying the spectra of SrH and BaH.

Bands probably due to BaH have already been reported by Eagle,[1] who used an arc in a hydrogen atmosphere between electrodes containing barium chloride. The dispersion of his spectrometer was, however, rather small. I have succeeded now in producing these bands with such intensity that it was possible to photograph them in the first order of a 6 m. concave grating. The source was a vertical arc, the lower negative electrode made of nickel having the shape of a small oblong tub, containing metallic barium, while a nickel rod formed the upper positive electrode. The arc was enclosed in a cylindrical metal case containing hydrogen; the optimum pressure was about 4 cm.

Four distinct band-heads were found at λλ 6634, 6689, 6850, 6923 A. respectively, all shaded towards the violet. The values are in agreement with the measurements of Eagle. An approximate calculation from the perfectly resolved bands furnished a moment of inertia which fits in well with the moments of inertia for elements in the second column of the periodic table, if these bands are ascribed to BaH. The electronic transition is of the type $^2\Pi - {}^2\Sigma$ and probably is analogous to the similar transitions observed in the spectra of the other neutral molecules mentioned above. A full analysis of the spectrum will be published elsewhere.

A. Schaafsma.

Natuurkundig Laboratorium
der Rijks-Universiteit, Groningen,
Nov. 7.

[1] *Astro. Jour.*, **30**, 231; 1909.

Matter: Life: Mind.

In denoting matter, life, and mind as 'events' or 'grades', General Smuts struck a happy medium between the physicists' 'stages' and the metaphysicists' 'planes'. In neither stressing nor denying a causal connexion, he succeeded in steering clear between the dangers of scientific uncertainty and meaningless profundity.

However, Prof. Boycott's letter in Nature of Oct. 24 on this subject calls for some comment.

There will be but few dissentients in answering his query in the affirmative. But where are those 'mechanists' and 'organicists' whom Prof. Boycott saddles with assigning a quantitative relationship between matter and life? Who attributes a quantitative relationship between the combined effect of life-functions and the heterogeneous and variable system of organised matter? I submit that in the present state of our knowledge the connexion between life and living matter is *qualitative*—the former being the find and determined by the complexity and organisation rather than the mass of the latter. As to the functions by which life is perceived, we can resolve them into form, growth, orientation, and reproduction. Our physico-chemical and photoelectric experience enables us to understand and even reproduce the functions of form, growth, and direction,[1] and there is but little doubt that our research in the domain of optically active substances and radioactive isotopes will give us ere long an insight into the problem of reproduction.

As already mentioned, the functions of the living unit are related in general terms to the complexity of its organisation. In the case of viruses these functions are reduced to a minimum, with a correspondingly simplified assemblage of matter essential only to reproduction.

Maurice Copisarow.

145 Alexandra Road,
Manchester, S.W.,
Nov. 23.

[1] Hatschek, *Proc. Roy. Soc*, **95 A**, 303; 1919. Copisarow, *J. Chem. Soc.*, 233; 1927: and *Koll. Zeits.*, **47**, 60; 1929: *ibid.*, **56**, 67, 1931.

Research Items.

Serpent Worship.—Mr. Wilfrid D. Hambly, assistant curator of African ethnology in the Field Museum of Natural History, Chicago, has made a study of serpent worship in Africa which appears as *Publication* 289 (vol. 21, No. 1 Anthropological Series) of the Museum. The study of serpent worship hitherto has been confused, but a classification of the ideas which it embodies is suggested. (1) Python worship, of which there are two unquestionable areas, one in West Africa and a smaller region in Uganda; (2) the serpent in relation to fecundity, transmigration of souls, and totemism; the only one of these with a clear geographical distribution being the reincarnated ancestor concept, which occurs continuously from the Cape to Lake Rudolph; ideas of transformation are spread over the whole continent; (3) the rainbow snake, that is, a number of stories and legends relating to snake monsters of which the basic thought is that the snake is a guardian of water, woods, ruins, or grain; (4) immunity and snake-medicines, dependent on the idea of a human soul being in communion with the snake. Evidence relating to cures of snake-bite show that the treatment is by no means entirely magical. The examination of African python worship in relation to cults and beliefs from other parts of the world provides no evidence that Africa received snake worship from extraneous sources, nor is there more than a superficial resemblance between the snake beliefs of Africa and ancient Egypt. The most fundamental ideas of all kinds of African snake belief are those of reincarnation and fecundity. The idea of the snake ancestor visiting the dwelling has a strong and clearly defined distribution from the Suk to the Zulu. Sometimes the visiting snake ancestor announces a conception. In other cases conception is inferred from the visit of any snake.

Man and the Primates.—In the *Scientific Monthly* for November, Prof. Adolf H. Schultz sets out in detail results of some of the less widely known and quite recent comparative studies on certain features pertaining chiefly to primates and their bodily proportions, which answer such questions as why the gibbon and anthropoid apes must be regarded as man's nearest relatives; whether the gaps between man and the recent anthropoids are relatively large or small when measured by the scale of differences between other primates and the like. Significant features are examined in turn. There is a tendency to increase in bodily size with advance in evolutionary development. Anthropoid apes are the only primates as large as or larger than man. Man's relative hairlessness is not unique, but an extreme manifestation of an evolutionary trend to reduce the coat of the larger primates. The nose supports the recapitulation theory. The human ear resembles most closely that of the gorilla. Man has relatively the largest head, the lower catarrhines the smallest. The high forehead of early stages of life disappears soon after birth in the apes, but is retained in man. The trunk of the higher primates has become relatively shortened by the elimination of vertebræ, allowing the pelvis to shift towards the chest, while it has become relatively short and broad. In this respect man is the missing link between apes and gibbons. In length of arm the apes, other than the mountain gorilla, have specialised to a much greater extent than man, while in length of leg man has specialised to a greater extent than the apes. The hand of man is in every respect the hand of a primate, though in breadth it is conservative when compared with that of a gorilla. The foot of man is nothing but a modification of the foot which has given rise to the foot of modern anthropoids. It is concluded that man and the large anthropoids represent the most advanced expression in all primate evolution. In some respects man is more specialised than the apes, in others the relation is reversed.

Structural Features of the Cruciferous Flower.—Two papers on the anatomical structure of normal and abnormal flowers of Cruciferæ, by Dr. Agnes Arber (*New Phyt.*, vol. 30, 1931), represent a type of investigation that is much needed to elucidate flower structure. So much of the discussion on floral morphology is based on dissections that it is time that the facts were tested with more detail and exactitude. The author is obviously not in agreement with E. R. Saunders' view of the cruciferous gynœcium, and she discusses many of her facts in relation to this argument. The fact that the placentas receive most of their vascular supply from the valve strands appears to support the bicarpellary view, but it is also shown that the lateral sepal bundles are derived from the petal bundles, showing that "vascular bundles may exhibit a complete disregard for morphological boundaries", and this makes the origin of the placental bundles carry less weight than might otherwise be the case. It would be most interesting to know the anatomical facts for the gynœcium of the two species of *Triglochin*, which would appear to be more obvious illustrations of E. R. Saunders' theory. Of less controversial nature, it is satisfactory to have confirmation of Klein's observation that the strands to the lateral sepals pass out before those of the median, thus bringing the cruciferous flower into line with the general rule for the origin of the outermost foliar structures on lateral flower or vegetative buds. The vascular supply to the inner stamens does not support the suggestion of chorisis. The squamules found in relation to young leaves and pedicels (especially in *Nasturtium officinale* R. Br.) are suggested to be "stipules of non-existent bracts". The general absence of stipules in cruciferous leaves makes one sceptical as to the stipular interpretation, though bracts may occasionally be seen subtending the lower flowers in *Cheiranthus* or *Capsella* and probably other genera also.

X-Ray Analysis of Slate.—An application of the X-ray diffraction method to the elucidation of the real nature of slate has been made by H. V. Anderson and K. C. Chesley, and their results and conclusions are presented in the *Amer. Jour. Sci.*, August 1931, pp. 103-112. Seven slates from different localities were examined, and a table is given showing the interplanar spacings in angstrom units, as obtained by the powder method, together with the principal spacings for the minerals found to be present. Evidence is forthcoming which indicates that former analyses reporting kaolin or andalusite in slate are in error, and that the probable aluminium silicate present is kyanite. The preponderance of quartz, corundum, kyanite, and mica in slates is established, and small quantities of other minerals are indicated. An attempt is made to correlate structural differences with grain size, and further work along this line is in progress. X-ray analysis confirms the fact that the cleavage is due to the orientation of the mica during its crystallisation under pressure.

Light Transmission through Fog.—Owing to the increasing importance of commercial aviation, much experimental work is being done on the transmission of visible light through fog. In the *Physical Review* for July 1931, H. G. Houghton gives an interesting account of experiments in this connexion which he has made. He produced a fog by condensing low-pressure steam in a zinc-lined wooden chamber 300 cm. long and 25 cm. square. At one end was located the source of light—an incandescent lamp—and the necessary optical systems and filters for obtaining various bands of wave-lengths in the visible spectrum. The detecting apparatus consisted of a photoelectric cell, a two-stage direct current vacuum tube amplifier, and a sensitive milliammeter. The only difference between the artificial fog and natural fog was the size of the fog droplets. It was found that the artificial fog was composed of smaller particles of more uniform size. After some difficulty, a cell was obtained which was sensitive over the entire visible spectrum. It was found that no type of visible radiation possesses any very marked fog penetrating powers. The coloured beam of wave-length $0{\cdot}490\mu$, however, transmitted a definite maximum percentage of light. The author concludes that the attenuation is probably due more to scattering than to absorption. The shape of the curve showing the transmission at various fog densities indicates that it is largely dependent on the size of the particles of the fog used. Hence any transmission curve is applicable only to the particular fog on which the measurements were made. The author's results apply only to a fog or haze where the particles are small. In the same journal, in conjunction with J. A. Stratton, it is proved mathematically that the particle size of the fog is a controlling factor in the transmission characteristics.

Abnormality of Radio Signals passing through High Latitudes.—Modern developments of short wave wireless communication have brought to light many interesting phenomena, such as the existence of round-the-earth echoes and echoes of long delay. Another peculiarity of such high-frequency transmission has recently been reported to us by S. Namba from the Electrotechnical Laboratory, Ministry of Communications, Tokyo, Japan. It has been noted that the signals from the New York stations received in Japan exhibit certain peculiarities which are probably attributable to the fact that the great circle passing through New York and Tokyo traverses auroral and polar regions. The New York signals are characterised by a continuous fluctuation in carrier wave frequency and a marked blurring in audible morse reception. Since it is known that the frequency emitted by the sending station is kept constant within narrow limits by piezo-electric control, the observed fluctuations in the received signal must be attributed to the influence of the transmission path. The variations in the frequency of the carrier wave are attributed to a pronounced Doppler effect, which has already been noticed to a lesser degree on signals arriving in other directions. As the main ionising agent in the polar regions is considered to be charged corpuscles shot out from the sun and deflected to the magnetic polar region under the influence of the earth's magnetic field, the ionisation in the polar atmosphere may be expected to exhibit greater fluctuations than that in non-polar regions where the main ionising agent is ultra-violet radiation. Both Doppler effect and blurred signals may therefore be abnormally marked for signals passing through high latitudes.

Quantum Theory of Electrolysis.—A new application of the quantum theory has been made by Dr. R. W. Gurney in a paper in the November issue of the *Proceedings of the Royal Society*, entitled "The Quantum Mechanics of Electrolysis". The fundamental idea in this is that the quantum mechanics does not require the same intimate contact between particles for a transfer of charge between them that is pictured on classical theory. This conception has already been employed in several problems, such as those encountered in connexion with the neutralisation of positive ions at the cathode of a discharge tube, and is here applied in particular to the electrode phenomena in solutions to which a potential less than that required to effect decomposition has been applied. Bowden and others have recently made a careful study of the small currents which pass under such conditions, and have embodied the results of their experiments in a number of simple relations. By modifying the theory of neutralisation at a gas-solid interface to allow for the hydration of the ions and other effects peculiar to electrolytes, Dr. Gurney has now been able to obtain all Bowden's results theoretically, and to obtain both qualitative agreement and excellent numerical values for the coefficients in Bowden's expressions. Dr. Gurney has actually developed his theory as if the hydrated ions were molecules in the spectroscopic sense, but this specialisation of the problem is a matter of convenience and not a necessary feature of his work.

Combination of Hydrogen and Oxygen.—When a mixture of hydrogen and oxygen is exposed to a hot quartz surface a reaction occurs which is gentle or explosive according to the conditions of the experiment. W. L. Garstang and H. L. Hinshelwood have given an account of some investigations on the kinetics of the change when it is catalysed in this way in a paper published in the November number of the *Proceedings of the Royal Society*. They have been able to show by a few relatively simple experiments that the active centres on the solid, which are responsible for much of what occurs, are chiefly concerned with the reacting oxygen in the first instance. The centres have, in fact, been shown to absorb oxygen with great rapidity to a kind of saturation state, whereas they remain only sparsely populated with hydrogen. If an aluminium vessel is substituted for one of quartz no low-pressure explosion occurs, but a vigorous reaction still takes place on the surface.

Artificial Rubber.—The production of artificial rubber by the chemists of the E. I. du Pont de Nemours is announced in the November *Journal of the American Chemical Society*, some additional details being given in the news edition of *Industrial and Engineering Chemistry*. The process depends on the addition of hydrochloric acid in aqueous solutions containing cuprous and ammonium chlorides, to monovinylacetylene, with the production of chloro-2-butadiene-1,3 according to the equation :

$$CH{\equiv}C{-}CH{=}CH_2 + HCl = CH_2{=}CCl{-}CH{=}CH_2,$$

the product (which is closely related to isoprene) being called chloroprene. The chlorine atom in the molecule is very firmly bound. By the controlled polymerisation of chloroprene, which takes place very rapidly and easily, a rubber-like material is obtained to which the trade name 'duprene' is applied. This is the synthetic rubber. Although the cost of production of duprene will be many times greater than the present market price of natural rubber, the material is to be manufactured, since it is believed that commercial uses will be found for it because of its unique properties. The material formed by the polymerisation of chloroprene is fully vulcanised without any additions, and the polymerisation can be stopped at an intermediate point with the production of a plastic polymer having the general properties of unvulcanised rubber, which may be mixed with fillers, diluents, etc., and the vulcanisation completed by heating at 110°-130° C. for a short time. An artificial latex was also prepared. Duprene is denser and more resilient than natural rubber, but is not plastic. It resists the action of many liquids which attack rubber. The X-ray structure of stretched duprene, unlike that of polymerisation products of isoprene, resembles that of natural rubber, giving a fully developed fibre diagram showing a number of definite layer lines, the identity period along the fibre axis being 4·8 A., identical with that of β-gutta-percha.

Saccharification of Wood.—In a communication to the Society of Chemical Industry on Nov. 1, Drs. H. A. Auden and W. P. Joshua described a process for the transformation of wood cellulose into fermentable products on an industrial scale. With an improved method they have succeeded in obtaining thirty-five to forty gallons of alcohol per ton of dry sawdust. This makes the process commercially profitable where the cost per ton of dry sawdust is not more than five shillings and a supply of 200 tons per twenty-fours hours is available. The method was worked out in the Research Laboratory of the Distillers' Company, Epsom. It consists in forcing acidulated water (containing two parts per thousand of sulphuric acid), at a temperature of 180° C. and twelve atmospheres pressure, through sawdust packed in lead-lined vessels. Under these conditions 45-50 per cent of the sawdust is changed into fermentable sugars. The molasses thus obtained are fermented with yeast in order to obtain alcohol. A preliminary treatment of the sawdust with superheated steam has been found advantageous, because it removes resins and other undesirable constituents and also helps the hydrolysis.

Extensibility of Protoplasm.—A communication on the effects of salts on the extensibility of protoplasm, by Prof. William Seifriz and Janet Plowe, appears in the *Journal of Rheology*, vol. 11, No. 3 (Easton, Penn.). The elastic properties of protoplasm are important because of their close relation to other properties of living matter, for example, imbibition, contractility, and structure, and to biological processes like cell-division and amœboid movement. By means of the microdissection method Prof. Seifriz has determined the maximum distance to which protoplasm can be stretched. Strips of the upper epidermis of the bulb scales of *Allium cepa* were first placed in aqueous solutions of the nitrates of potassium, sodium, calcium, etc. Afterwards the cells were plasmolised in sugar solution so that the cell-wall could be cut without injuring the protoplasm, and the protoplasm was drawn out by means of the micro-needle. It was found that treatment with calcium, strontium, and magnesium increases the elastic limit of the protoplasm, while potassium, sodium, and lithium decrease it. Their relative action may be expressed by the series $\mathrm{Ca}>\mathrm{Sr}>\mathrm{Mg}>\mathrm{K}>\mathrm{Li}>\mathrm{Na}$.

Astronomical Topics.

Eclipse Observations and the Einstein Shift.—Prof. E. Freundlich gave an account of his observations of the Einstein bending of light by the sun's gravitation at the meeting of the Royal Astronomical Society on Dec. 11. Notes on a similar lecture delivered at Oxford on Dec. 2 appeared in Nature of Dec. 12, p. 993. Prof. Freundlich was probably the very first to attempt observations on the problem; he went to Russia in August 1914 with that end in view, but the outbreak of war caused obstacles to be put in his way, and nothing could be done. Abortive attempts were made at subsequent eclipses; at last he attained full success in Sumatra in the eclipse of 1929. Many precautions, suggested by the experience of others, were taken; in particular, a field of stars at a distance from the sun was photographed during totality, as well as the eclipse field; the two fields were again photographed simultaneously at a later date.

The measures and reductions were made in several different ways, but all agreed in giving a shift at the sun's limb of about 2·25″, which is half a second greater than the Einstein theoretical value. Freundlich also rediscussed the measures made at previous eclipses, and expressed the opinion that they are better satisfied by his value than by the Einstein one, and that the excess is a real phenomenon, though its cause is unknown.

Most of the speakers in the discussion showed unwillingness to depart from the Einstein value; Sir Arthur Eddington, however, admitted that the views of the nature of light that are now held make it more complicated than was formerly supposed, so that it is possible that the Einstein equations may not give a complete account of its behaviour.

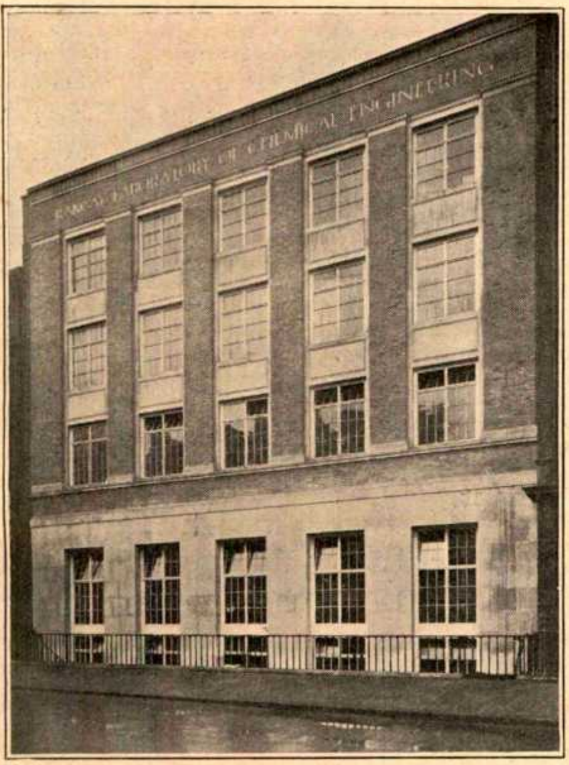
The Origin of Comets of Short Period.—About half a century ago, R. A. Proctor pointed out that the theory of the capture of these comets by the giant planets involved many serious difficulties. There would not be enough close approaches of comets to Jupiter to provide it with such a large family of comets. This is still more the case than Proctor realised, since convincing proofs have been deduced that the life of these comets is short (of the order of a few centuries), so that the supply must be frequently replenished.

Very few astronomers have supported Proctor's view that these comets were erupted by the giant planets, but *Astr. Nach.* 5826 contains a long paper by S. Vsessviatsky which reaches a similar conclusion, and extends the suggestion to include those of the minor planets that have orbits close to that of Jupiter. Many American astronomers favour the suggestion that minor planets are associated with comets in their origin. One of Proctor's arguments was based on the Leonid meteors. Le Verrier had suggested that Tempel's Comet, which formerly contained the meteors, made a near approach to Uranus in A.D. 126, and had its orbit changed from a parabola to an ellipse. Proctor pointed out that an extremely close approach to Uranus would be necessary, and that the cometary mass would need to be condensed to an extent far beyond what we observe in comets; otherwise different portions of it would experience different perturbations, whereas observation shows that the orbits of all the meteors are nearly identical.

Catalogue of Double Stars.—A further instalment of the large catalogue of double stars that is being formed at the Union Observatory, Johannesburg, is published in *Circular* 85 of the observatory. It contains 2017 measures of 488 pairs made in the years 1928–30. The limits of Right Ascension are 13^h to 24^h. As a rule, measures of each star were made on four nights, the separate results and means being given. There are interesting notes on sixty-five pairs; five of them are proved to be merely optical pairs, but the great majority are true binaries. Other notes give comparisons with previous measures, or with ephemerides, where these have been calculated. The pair Innes 600, in south decl. 60°, may have the short period 14 years, or 28 years if the quadrant of the 1913 measure should need reversal. The pair Hussey 298 has described nearly a revolution in thirty years, but apparently its orbit has not been computed yet. A note on α Centauri states that photography gives better results than visual measures; the recent measures give as the correction to Finsen's ephemeris, published in 1926, angle $+0{\cdot}30°$, distance $-0{\cdot}08''$. The great majority of the measures in the catalogue were made with the 26-inch refractor, but a few were made with the 9-inch.

The Ramsay Memorial Laboratory of Chemical Engineering at University College, London.

THE opening of the Ramsay Laboratory of Chemical Engineering by His Royal Highness Prince George, on Nov. 26, marks an important advance in the scientific training of men for industry.



Photo] [Larkin Bros.

FIG. 1.—Ramsay Laboratory of Chemical Engineering.

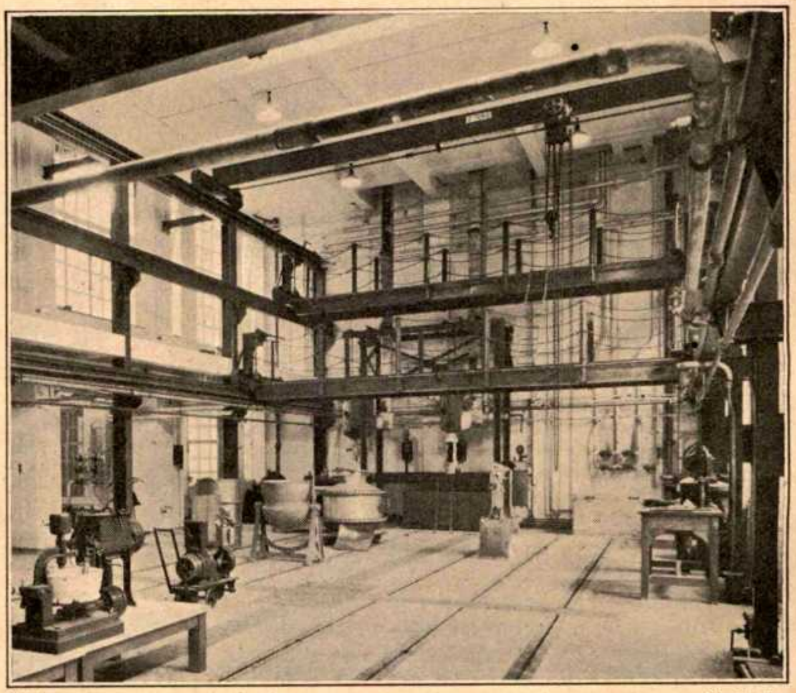
The new laboratory is the first in Great Britain to be designed specifically for chemical engineering training and research. It provides facilities whereby men who have already graduated in chemistry or engineering can obtain a supplementary training, both theoretical and practical, in the principles underlying the design, fabrication, testing, and operation of the different types of plant which are used in the industrial operation of a chemical process.

The course of training normally occupies two years. During the first year, the student receives a systematic training in chemical engineering principles by means of lectures and relevant experimental work. The subjects dealt with include the flow of fluids and the transfer of heat, the physical and chemical characteristics of construction materials and the methods of plant fabrication, the principles of mechanical and structural engineering and the production and distribution of energy in works, the design and operation of unit types of chemical plant, the preparation of flow sheets of materials and energy balances, and the lay-out of plant, factory administration, and industrial economics. The lectures are supplemented by practical training in machine drawing, in plant fabrication, and in the erection, testing and operation of both small and semi-large scale plant units.

During the second year, the student carries out original investigations, either in the laboratory or in a works.

The new laboratory (Fig. 1) has been built as an extension to the old building, which, in addition, has been completely rearranged. The laboratory now occupies a frontage of 60 ft. on Gordon Street, from which it extends for 120 ft. in the direction of the chemistry building. The new building is constructed of steel and reinforced concrete, and is faced with 2-inch Suffolk brick and Portland stone. It consists of five well planned and appointed stories. A noticeable feature of every room is the generous lighting provided by the large and well planned windows.

In its arrangement and equipment, the building presents many new features. In addition to the usual lecture-room, library, and general laboratory facilities, there are a finely equipped machine shop, in which semi-large scale plant can be constructed or repaired, and a large and lofty industrial laboratory (Fig. 2) which is well equipped for the erection, testing and operation of semi-large scale plant. Special laboratories are provided for distillation, for the testing of fuels, and for crushing and grinding operations. The second floor is devoted entirely to the study of fluid flow and heat transfer on a scale which is comparable with that obtaining in works practice. On the top floor are three research laboratories, each of which is capable of accommodating five or six workers.



Photo] FIG. 2.—Industrial laboratory. [Larkin Bros.

At the rear of the building and just outside the machine shop is an unloading bay, served by a two-ton travelling crane, which can deliver heavy goods either into the machine shop or through trapdoors into a wide service corridor which runs through the basement to the industrial laboratory.

Perhaps the most striking feature is the industrial laboratory, which occupies practically the entire basement of the new section. This laboratory is 60 ft. long, 40 ft. wide, and 25 ft. high. It is equipped with a two-ton travelling crane, and is spanned by two portable platforms, respectively at 11 ft. and 17 ft. above the floor-level. The concrete floor is provided with special slots to facilitate the fixing of plant; there are also ample drainage facilities. Staging is provided at one end of the laboratory for liquor stock tanks and feed tanks.

Five thousand gallons of softened water can be stored beneath the basement floor, whence it can be pumped to large service tanks on the roof. From there, it can flow by gravity to two 3-inch ring mains surrounding the industrial laboratory, or to the fluid flow laboratory on the second floor. This water can be used as boiler feed or for cooling or condensing purposes. Other ring mains are provided in the industrial laboratory for mains water, gas, steam and compressed air.

Steam for process working is obtained from a vertical boiler, arranged for oil or coke firing, and capable of evaporating 600 lb. of water per hour at pressures up to 200 lb. per sq. in. Two smaller boilers are provided at different points in the building.

The machine shop measures 45 ft. × 18 ft. × 25 ft. high, and is situated in the basement of the old building. It is fitted with a one-ton travelling crane, and contains the machine tools necessary for turning, milling, slotting, shaping, drilling and sawing. Running along one side of the shop is a gallery equipped with precision lathes and sensitive drilling machines for fine instrument making. There is also equipment for welding and small forging.

The erection and equipment of the new laboratory have been made possible by the far-sighted generosity of a number of leading firms and individuals in the chemical and allied industries, who subscribed a capital sum of more than £26,000 and guaranteed an annual income of £4000 for a number of years. Valuable equipment has been provided by many manufacturers of chemical plant.

The laboratory will accommodate fifty students and research workers. This session, the total number of students in the laboratory is thirty. In its organisation and general atmosphere, the laboratory seeks to resemble the development department of a modern chemical works. Every effort is made, also, to maintain and develop the closest connexion with industry. Each member of the staff has had extensive industrial experience both in Great Britain and abroad. Many of the present students, also, have held important positions in industry.

Psychology and Organised Religion.

THE *Journal of Social Psychology* (vol. 2, No. 4) has an article by Prof. Raymond Pearl discussing some points of psychological interest arising out of the American Census of Religious Bodies, 1926. His aim is to see if any evidence, other than that of general opinion, exists to support the view that there has been for some time past a gradual decay of religious influence in European civilisation. He quotes from an eminent man of science, a Wesleyan minister, a Church of England vicar, and a young American clergyman, all of whom maintain that there is increased indifference to organised religion.

If this is so, then here is a problem of social psychology that ought to be studied. Prof. Pearl makes a beginning by analysing such official returns as are available, namely, those provided by the census of religious bodies in the United States. This is a census of religious organisations and is taken every ten years.

During the period 1916–26 the tables show that while church membership has increased at a rate slightly more than the rate of the growth of the population as a whole, yet the increase is very small. It has always been recognised that religious organisations have played an important part in the social life of their members, being at some periods almost the only means of organised social diversion. Hence it seems pertinent to compare the growth of religious organisations with the growth of other forms of social activity. National banks have increased at rather more than three times the rate of the churches, the consumption of alcoholic liquor increased by 4·5 per cent in one year, the manufacture of playing cards by 80·3 per cent, and cigarettes by 97·4 per cent, and still greater was the development of motion-pictures, automobiles, and radio apparatus. It looks as if several non-religious forms of diversion grew in magnitude and presumably in influence during the decade considered.

Again, organised religion has always realised the importance of training the young, and for this end has evolved the Sunday School. Analysis of the records shows that in the older and more highly developed sections of the country the number of scholars has either decreased or increased by an insignificant percentage, whereas in the newer and less developed sections of the country there have been substantial increases. Comparing the membership of the different denominations, a tendency is shown for those characterised by a narrow and rigid body of doctrine, and therefore appealing to the less intelligent groups of the population, to grow more rapidly than those the more liberal doctrines of which appeal to the more intelligent.

The paper is important, not so much for the generalisations, which are admittedly tentative, as for the method employed and for the interest of the point of view.

In *Human Biology* (September 1931), John R. Miner discusses the relationship between church membership and commitments of prisoners. From data available from the Netherlands and the United States, he concludes that there is little evidence that the churches play any large part in the prevention of crime.

Orbit and Mass of Pluto.

LICK Bulletin 437 contains an exhaustive study by Dr. E. C. Bower, of Pluto, the new planet discovered in 1930. All the prediscovery images have been utilised, except those obtained on Flagstaff plates in 1915. Reference is also made to a possible image on a Franklin-Adams plate taken in 1903. Mr. P. J. Melotte, who detected this image, now considers that it is too ill-defined and doubtful to use, in the absence of any confirming images in neighbouring years. The perturbations have been treated in the manner adopted by Dr. P. H. Cowell for Halley's comet. The centre of gravity of the sun and the four great planets is taken as origin, and the motion calculated by mechanical quadratures. The final residuals of Pluto are all less than 4″, which is not unduly large, as in many cases the images were ill-defined and far from the centre of the plate. The period is 248·43015 years, and the eccentricity 0·2486438 (it is an aid to memory that the first three digits in these two elements are the same); the perihelion passage is on Sept. 30, 1989. There will not be a conjunction with Neptune at minimum distance (3 units) for about eight thousand years.

The determination of Pluto's mass from Neptune depends largely on the two observations made by Lalande in 1795. As he observed the Right Ascensions to the nearest half-second of time only, they are not exact enough to give a precise result; it is shown that a mass of Pluto, 1·3 times the earth's, gives a zero residual in 1795, while a zero mass makes the 1795 residual 9″. It will, however, be possible to derive a fair value of Pluto's mass from its recent approach to Neptune, when the latter has been observed for some eighty more years, as its orbit will then be known independently of Lalande's positions. Dr. Bower suggests that the approach to Uranus in 1968 (distance 13 units) should also be utilised; for this purpose a long series of accurate positions of Uranus, especially from 1940 to 2000, should be obtained. He suggests photography, with the magnitude of Uranus reduced to that of the comparison stars.

The only estimates of Pluto's mass that can be made at present are based on its stellar magnitude and apparent diameter; these both suggest a mass smaller than that of the earth. However, the unexpectedly high value for the mass of Triton, recently found at Mt. Wilson, suggests a similar possibility for Pluto. M. Baldet, as the result of visual observations with the Meudon equatorial, concludes that the diameter does not exceed 0·2″ (Report of the Paris Observatory for 1930).

Dr. Bower's article contains an accurate ephemeris of Pluto from August 1931 to June 1932; this is for the equinox of 1900; Dr. Bower notes that this is the most convenient equinox if one uses positions of the comparison stars derived from the astrographic catalogues; these contain fainter stars than those given in other catalogues. The images of brighter stars on the Pluto plates are too large for accurate measurement.

A New System of Film Projection.

WELL-ATTENDED demonstrations were given at the premises of Messrs. Robinson, King and Co., Ltd., in Stratford, London, of an invention by Dr. R. T. A. Innes, formerly Union Astronomer, Johannesburg, for increasing plasticity and saving space in projection of films. In place of the usual screen a large plane mirror is to be installed, the picture being projected on an ordinary screen so situated that the audience sees it in the mirror. It may be behind them, or on the ceiling. In the demonstration it was behind, the projector being behind and above the mirror.

Regarding the increase in plasticity claimed, we must confess that we failed to perceive it as regards black and white films. It is also claimed that the effects of grain and scratches are masked, but the films shown were not worn; a slight diminution in the sparkle due to grain was perhaps noticeable. An excellent coloured film shown was, however, certainly improved. Colour adds plasticity to films, and Dr. Innes's plan really ‘ varnishes ’ the picture, as it were, and thus adds somewhat to the brilliance and depth of the colour. The effect is similar to the difference between matt and glazed photographs, and would finally, as in this case, be a matter of taste. The lure of devices of this kind for inventors is due to the psychological fact that any change in the tint or texture of a photograph, if it is novel, is at first pleasing, since the photograph is inherently inadequate as a representation of three-dimensional reality. The change is usually imagined to make the picture more real—to fulfil our unconscious wish: this will be remembered when the tinting of films was first introduced, and it accounts for the plastic effect of colour. The unsophisticated are immensely pleased by an extremely brilliant glaze on photographs. But these joys are fleeting: custom soon stales them.

The other advantages claimed are more substantial. Installed in a small room or hall, practically the whole floor space may be filled with seats from which a good view is obtained, since even those close to the mirror see the screen as at a convenient distance. Those at the back have a more distant view than they otherwise would, but can still see well. Thus the available space is much increased. The field for the invention is thus chiefly in small, cramped halls, and in education and advertising.

Difficulties arise from the fact that mirrors exceeding a certain size are expensive to make and handle. Even a small screen would need to be built up of two or three parts, and means would have to be found to make the join unobjectionable. Also, the film is seen reversed if projected upon the screen in the usual way, while serious loss of light occurs with through projection, apart from the fact that the gain in space would no longer be present. With on-projection, therefore, the film has to be turned round in the projector, and few projectors allow of this being done with sound-films, since it brings the sound track on the wrong side. However, one portable equipment at least is available in which this difficulty does not occur, and with such an apparatus and Dr. Innes's mirror a small room could be packed with spectators who would all get a satisfactory view.

University and Educational Intelligence.

CAMBRIDGE.—Dr. F. C. Phillips, of Corpus Christi College, has been appointed University lecturer in petrology.

In a report to the University on forestry in the University curriculum, the General Board states that there is practically no future for graduates trained in forestry except in Government forest services. Only twenty to twenty-five of these posts are available each year, and there are no fewer than five university schools, including that at Cambridge, training candidates for these posts. As a result of investigations, the Committee of the General Board concludes that the University is not justified in maintaining a forestry organisation as a recruiting ground for Government services, partly because the demand is so small, but even more because the Committee considers that University policy in forestry teaching cannot be reconciled with the present official view. It is accordingly recommended that the Department of Forestry be suppressed, examinations in forestry for the ordinary B.A. degree be discontinued after 1934, and examinations for the diploma in forestry cease in October 1935.

SHEFFIELD.—The Council of the University has made the following appointments: Mr. B. H. Bentley, lecturer in botany, to be professor of botany; Dr. R. N. Rudmose Brown, lecturer in geography, to be professor of geography; Mr. L. E. S. Eastham, to be professor of zoology; Dr. J. Florey, to be professor of pathology; and Dr. J. W. Edington, to be professor of bacteriology.

At the Indian Institute of Science, Bangalore, the service of Dr. M. O. Forster as director has been extended until April 1933. Dr. V. Subrahmanyan has been appointed professor of biochemistry.

At the end of the year Dr. R. S. Clay is resigning the principalship of the Northern Polytechnic, London, a post he has occupied for twenty-nine years. The governors, staff, students, and members of clubs and societies who have been associated with him during this long period wish to assist in offering some token of their regard and affection, and a committee has been set up to give effect to this general desire. The honorary treasurer of the committee is Mr. W. M. Macbeth, Northern Polytechnic, Holloway, London, N.7.

The International Federation of University Women has issued a report of its sixteenth council meeting, held at Wellesley College, Massachusetts, last April under the chairmanship of the president of the Federation, Prof. Winifred Cullis, and attended by women graduates of thirty-one countries. Prominent among the activities of the Federation is the establishment of research fellowships to give university women the opportunity of a year's work in a foreign country. The fund for this purpose already exceeds five thousand pounds, exclusive of the collections of the American Association of University Women, which will be allocated partly to national and partly to international fellowships.

Birthdays and Research Centres.

Dec. 20, 1876.—Dr. W. S. Adams, director of Mount Wilson Observatory.

My chief interest for many years has consisted in physical and quantitative studies of stellar spectra. Theoretical astrophysicists have carried on much able research during recent years on problems of stellar constitution and radiation, and the need for observational evidence to aid in discriminating among different theories is pressing. This is especially true of investigations dealing with temperatures and pressures in stellar atmospheres, the opacity coefficient, and the abundance of the elements in different states of excitation and ionisation.

Specific observational studies at Mount Wilson are dealing with the character, intensities, and contours of stellar spectral lines, their differential displacements, and the application of spectral criteria to the determination of the absolute brightness and the distances of stars.

Dec. 22, 1862.—Dr. Vaughan Cornish, past president of Section E (Geography) of the British Association and of the Geographical Association.

The secret of scenic beauty is the enhancement which landscape derives when the grouping happens to be harmonious, whether this be a matter of locality, as when the physical features are harmonious, or of season, as when light or colour are happily blended or contrasted.

During the last six years, I have published a number of original papers in which the principle of harmonious grouping has been applied both to the landscape of the wild and to the scenery of civilisation, and in a chapter, entitled "Watching the Seasons" in a recently published book on "The Poetic Impression of Natural Scenery" I have shown its application to the changes of sunlight and foliage.

Every advance in the systematic study of natural beauty will be a social benefit, since an enhanced appreciation of the countryside will provide the majority of our people with a corrective for the inevitable artificiality of urban life.

Societies and Academies.

London.

Royal Society, Dec. 10.—**Sir Arthur Eddington**: On the mass of the proton. From the theory of the cosmical constant developed in a previous paper, a wave equation for an electron is developed, which, however, is incomplete. The correct equation contains the factors 10 and 136, representing the number of degrees of freedom associated with the respective energy terms. The mass of a particle satisfying this wave equation is given by an equation having two roots, which evidently correspond to electrons and protons, and their ratio is 1847·60. It is verified that the two roots represent charges of opposite sign.—**P. S. H. Henry**: The specific heats of air, oxygen, and nitrogen from 20° C. to 370° C. Further developments of the new constant flow calorimeter for the determination of the specific heats of gases at constant pressure are given. These results, whilst agreeing with those obtained by the sound velocity method at room temperature, show a much higher rate of increase of the specific heats with temperature, and a closer approximation to the curves predicted by means of Boltzmann's hypothesis from the spectroscopic frequencies of vibration of the molecules.—**W. L. Francis**: Studies in membrane behaviour (1). Equilibrium membrane potentials are measured for a buffer concentration gradient of 10 : 1 using $N/40$-$N/400$ and N-$N/10$ solutions. The e.m.f.'s with and without gelatine on the membranes are compared over the pH range 2·35-7·3. The results, more particularly with weaker solutions, appear to support the modified diffusion theory, that is, the anions are retarded in basic solution and the cations in acid solution. Direct evidence, given by determinations of the transport numbers of the sodium and acetate ions across the membrane in $N/2$ solution, vetoes this theory. Assuming that the membrane potentials are made up of the ordinary diffusion potential and an opposed e.m.f. due to the combination or adsorption of ions on the protein, an explanation is suggested which conforms with the known behaviour of gelatine in electrolyte solutions.

Paris.

Academy of Sciences, Nov. 9.—**E. Jouguet**: The secular stability of the rotors of turbines. A discussion of the criteria of stability according to Stoidola's hypotheses, with the additional criterium suggested by Lamb.—**H. Vincent**: A theory of the constitution of antibodies. A comparison of the properties of antitoxins and cryptotoxins (toxin + sodium salicylate). Both form a stable complex with the toxin and both are dissociated when the pH is lowered to 4·7: although the toxin is neutralised, it is not destroyed in either case.—**André Blondel**: The mutual inductances of magnetic leaks in transformers with several secondaries.—**Erik Westzynthius**: The distribution of integers which are not divisible by any one of the n smallest prime numbers.—**A. Marchand**: Various extensions of the idea of a continuum of limited order.—**J. Favard**: A proposition of Minkowski.—**S. Finikoff**: Stratifiable parabolic congruences: transformers of R_0 surfaces.—**J. Herbrand** and **C. Chevalley**: New demonstration of the theorem of existence in the theory of the body of classes.—**H. Parodi**: The method of integration by successive arcs giving, in the calculation of the elementary arc, an approximation as close as desired.—**Georges Giraud**: Problems of values at the boundary in the case of discontinuous data.—**J. A. Lappo-Danilevski**: The construction of the normal integral matrix of a system of linear differential equations in the neighbourhood of a pole of its coefficients.—**A. Markoff**: A general property of Birkhoff's minimal ensembles.—**Jacques Devisme**: Some partial differential equations.—**Arnaud Denjoy**: A theorem of Wiman.—**Bernard Salomon**: Mechanical integrators with holonomial linkages.—**Al. Proca**: The theory of radiation.—**A. Foch** and **J. Bariol**: The motion of a viscous fluid in the neighbourhood of a disc oscillating about its axis.—**Th. Got**: The value of the Dunkerley formula and its analogues for the approximate calculation of the first critical velocity of a rotating axis.—**D. Barbier**: The distribution of the poles of the orbits of double stars.—**Maurice Curie** and **A. Lepape**: The thermal conductivity of the rare gases. A modification of the thermometric cooling method of E. Müller was used. Data are given for the first time for krypton and xenon; the previously published results for helium, neon, and argon are confirmed.—**G. Bruhat** and **J. Thouvenin**: The double refraction produced by the compression of amorphous silica and crystallised quartz and its dispersion in the ultra-violet. Two specimens of fused silica show comparable double refractions on compression, the differences between them being only 5-6 per cent. This double refraction is about 40 per cent higher than that of crystalline quartz. Havelock's formula for the variation of the double refraction with the wave-length is considered to be only a first approximation.—**Mlle. M. Quintin**: The activity coefficient of the bivalent copper ion in solutions of its sulphate. In the range of concentration studied, including some relatively high concentrations, the Debye theory applies to solutions of copper sulphate, if a correction factor for the dimensions of the ions is included.—**S. Rosenblum**: The long path α-rays emitted by $ThC + C'$ and some determinations of the velocities of the α-rays. The direct measurement of the velocity of the α-rays has been determined with the aid of the large electromagnet of the Academy of Sciences by the method of magnetic focalisation.—**Paul Woog, Mlles. Emilie Ganster** and **Fanny Coulon**: The variation of the point of thawing out of mineral oils accompanying changes in their state.—**P. Bary** and **E. Fleurent**: The degradation of india-rubber solutions of various concentrations. The changes were followed by the alterations in the viscosity of the solutions.—**L. Riéty** and **G. Salager**: An electromotive force of filtration of abnormal value. Solutions of mercuric cyanide, flowing through a capillary tube, set up abnormal electromotive forces, ranging from 0·65 to 3·025 volts with varying concentration.—**J. Sambussy**: The action of a continued difference of potential on acetone and ether.—**Maurice Lambrey**: A method of studying the decomposition of gun-cottons at the ordinary temperature. The method is based on the increase of the γ absorption bands of nitric oxide in presence of an inert gas (hydrogen). Clear evidence has been obtained by this method that various specimens of carefully purified gun-cotton evolve traces of nitric oxide at 30° C.—**André Kling** and **Daniel Florentin**: The mode of action of dehydrating catalysts in the hydrogenating cracking of phenols. Contrary to expectations, the activity of certain catalysts (alumina, blue oxide of molybdenum) is increased by a preliminary heating to 750° C.—**Frèrejacque**: The autoxidation of uric acid in the presence of amines.—**E. Aubert de La Rüe**: The extension of the granular eruptive rocks in the Kerguelen Archipelago.—**Yang Kieh**: The prolongation towards the west of the dislocated zone situated to the north of the Marche chain.—**Henri Besaire**: The stratigraphy of the sedimentary formations of the province of Analalava, north-west Madagascar.—**V. Frolow**: The fall of the Oronto in 1929–30.—**E. Diénert**: The condensation of water vapour in the soil.—**Mlle. Lucie Ricard**: The vascular insertion of rootlets.—**A. Kopp** and **D. d'Emmerez de Charmoy**: New results on the diseases of sugar cane and maize.—**Polack**: Which colours do all colour-blind people fail to distinguish? A modified test for colour-blindness is suggested, stress being laid on the separation of blue, violet, purple, and greenish blue. Separation of the red and green is possible in certain colour-blind people.—**Raymond-Hamet**: The indirect vaso-dilatory action of the ergot alkaloids.—**Fernand Mercier**: The influence of dextrorotatory pseudo-cocaine on the hypertensive action of adrenaline. The two optically isomeric cocaines have a different physiological action as regards the hypertensive effect produced by adrenaline.—**Mme. M. L. Le Roux**: The experimental removal of the ovaries of *Gammarus* and its effect on the evolution of the oostegites.—**A. Vandel**: The existence of males of parthenogenetic origin and the genotypical constitution of the parthenogenetic females of *Trichoniscus* (*Spiloniscus*) *Elisabethæ*.—**J. Parrod** and **Mlle. Y. Garreau**: The oxidation products of *d*-mannose by ammoniacal copper oxide in the presence of air, at the ordinary temperature. The oxidation products, oxalic acid, imidazol, and *d*-arabino-tetroxy-butyl-4-imidazol, were the same as those previously isolated from the oxidation of *d*-glucose under similar conditions.—**H. Belval**: The lævorotatory glucides of the bulbs of *Lycoris*.—**F. Vlès, A. de Coulon**, and **A. Ugo**: The factors of the evolution of tar cancer in mice.

ROME.

Royal National Academy of the Lincei, May 17.—**T. Levi-Civita**: Concerning the notes of Hatzidakis and Sakellariou on central motions.—**C. Miranda**: Extension of the theorems of Hilbert-Schmidt and Picard to singular linear integral equations.—**C. Rimini**: The flexion of surfaces.—**T. Viola**: Noteworthy properties of continuous functions.—**Pia Nalli**: Rigid transports of vectors on surfaces. The results previously deduced for varieties with any number of dimensions are applied to surfaces.—**W. Fenchel**: Channel waves of permanent type.—**N. Hatzidakis**: Observations on a paper by M. Sakellariou on "A Class of Central Motions".—**A. Belluigi**: The gravimetric depression of Carpaneto.—**M. Lombardini**: Geometric considerations for periodal analysis. The properties of the extremes, zeros, and flexes of the sum of two sine curves, previously considered, are now utilised for deducing the necessary simple conditions to be satisfied by the distribution of the zeros, extremes, and flexes in order that a curve may be regarded as the sum of two sine curves.—**Orazio Specchia**: Raman spectrum of the ion SO_4.—**R. Zoja**: The distribution of the tensions in a solid with rectilinear axis and with rectangular transverse section of variable dimensions (3).—**R. Einaudi**: The relations existing between Euler's variational equations and the canonical equations of mechanics.—**Goffredo Vitali**: The calculation of a lens. Pacella's method of calculating a plano-convex lens leads to very simple results when the plane face is replaced by a spherical surface with its centre at the focus of the lens.—**Paolo Straneo**: The unitary theory of gravitation and electricity (3). Further consequences of the unitary equations. Certain considerations, mainly qualitative, bearing on the author's unitary theory are discussed, with some of the more immediate and simpler consequences, and the general scope of the theory.—**L. Malossi**: Double sulphates of bismuth with alkali metals (2). Double sulphates of bismuth and lithium. The system $Bi_2(SO_4)_3$-Li_2SO_4-H_2O forms the two compounds, $Li_3Bi(SO_4)_3, 2H_2O$ and $Li(BiO)SO_4, H_2O$.—**P. Pratesi**: Reactions of addition to unsaturated organic compounds. Application of the electronic theory of valency to unsaturated molecules of various types results in verification of all the regularities with regard to the formation of additive compounds established by Markownikow and Ipatiew for particular classes of compounds.—G. B. Bonino and P. Cella: Raman spectrum of hydrogenated derivatives of naphthalene. The Raman spectra of deca- and tetra-hydronaphthalene are compared with those of naphthalene and cyclohexane.—G. B. Bonino and L. Brull: Raman spectrum of dichlorobromomethane. Whereas the Raman spectra of chloroform and bromoform exhibit six frequencies, five of them intense, dichlorobromomethane displays one more, owing to the possibility of oscillations Cl-Br, this not occurring with the other two compounds. The ratio between the values of $\cos^2\beta$ for chloroform and bromoform equals the inverse ratio between the permanent electric moments for the two compounds. If this relationship holds also for dichlorobromomethane, the electric moment for this compound should be $1{\cdot}25 \times 10^{-18}$.

Diary of Societies.

FRIDAY, DECEMBER 18.

SOCIETY FOR EXPERIMENTAL BIOLOGY (in Department of Zoology, University College), at 10.30 A.M., at 2.15, at 4, and at 5.30.

ROYAL SOCIETY OF MEDICINE (Physical Medicine Section), at 5.30.—Prof. A. V. Hill: The Liberation of Energy by Muscle (Samuel Hyde Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.

SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at George Hotel, Glasgow), at 7.15.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Royal Technical College, Glasgow), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff), at 7.30.—Christmas Lecture.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (jointly with Leicester Association of Engineers) (at College of Technology, Leicester), at 7.30.

SOUTH LONDON BOTANICAL INSTITUTE (at 323 Norwood Road, S.E.24), at 8.

INSTITUTE OF CHEMISTRY, at 8.—Sir Frank E. Smith: The Chemist and the Community (S. M. Gluckstein Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Rev. Dr. C. Alington: The Education of the Average Man.

SATURDAY, DECEMBER 19.

SOCIETY FOR EXPERIMENTAL BIOLOGY (in Department of Physiology, University College), at 10.30 A.M., and at 2.15.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at 55 Russell Square, W.C.1), at 2.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Roger Fry: Great French Painters (3).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Tees-Side Branch—Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

MONDAY, DECEMBER 21.

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with South Wales Section of Institute of Chemistry) (at Cardiff Technical College), at 7.30.—Christmas Lecture.

TUESDAY, DECEMBER 22.

LONDON NATURAL HISTORY SOCIETY (at London School of Hygiene and Tropical Medicine) (Plant Galls Section), at 6.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Segrave Club, Wolverhampton), at 7.30.

Discussion.

TUESDAY, DECEMBER 22.

CONWAY HALL (Red Lion Square), at 7.—Dr. F. H. Hayward and the Celebration Fellowship: Celebration of Science (Geology).

Official Publications Received.

BRITISH.

Report of British Delegates of the Meeting of the International Council for the Exploration of the Sea, held at Copenhagen, March 23rd-28th, 1931. Pp. 9. (London: Ministry of Agriculture and Fisheries.)

India: Meteorological Department: Scientific Notes. Vol. 3, No. 30: The Structure of the Sea-Breeze at Poona. By Dr. K. R. Ramanathan. Pp. 131-134+9 plates. 1 rupee; 1*s.* 9*d.* Vol. 4, No. 31: The Lunar Atmospheric Tide at Kodaikanal and Periyakulam. By Dr. S. K. Pramanik, S. C. Chatterjee and P. P. Joshi. Pp. 5. 4 annas; 5*d.* (Calcutta: Government of India Central Publication Branch.)

The Parliament of the Commonwealth of Australia. Report on Tour of Inspection of the Oil-Fields of the United States of America and Argentina, and on Oil Prospects in Australia. By Dr. W. G. Woolnough. Pp. 118. (Canberra: H. J. Green.) 5*s.*

Mysore Geological Department. Records, Vol. 29, 1930. Pp. iv+38+2 plates. (Bangalore: Government Press.) 2 rupees.

The North Staffordshire Field Club. Transactions and Annual Report, 1930-31. Edited by the Rev. E. Deacon. (Vol. 65.) Pp. 169+A25-A50+7 plates. (Stoke-on-Trent.) 7*s.* 6*d.*

The Indian Forest Records. Vol. 15, Part 3: Standard, Commercial and Heartwood Volume Tables (Factory Working) for Khair (*Acacia catechu*, Willd.) in North India. By H. G. Champion and Ishwar Das Mahendru. Pp. iii+16. 5 annas: 6*d.* Vol. 16, Part 5: Investigations on the Seed and Seedlings of *Shorea robusta* Gaertn. F. By H. G. Champion and B. D. Pant. Pp. v+33+6 plates. 1.6 rupees; 2*s.* 3*d.* (Calcutta: Government of India Central Publication Branch.)

Journal of the Chemical Society. October. Pp. v+2509-2831+x. (London.)

The Zoological Survey of India. Memorandum on the Proposals for Retrenchment. By Sir C. V. Raman. Pp. 19. (Calcutta: The Author, 92 Upper Circular Road.)

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 6, No. 4, October. Pp. 345-482. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

Proceedings of the Royal Society. Series A, Vol. 134, No. A823, November 3. Pp. 356. (London: Harrison and Sons, Ltd.) 18*s.*

Canada: Department of Mines. Mines Branch. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1928-1929. (No. 722.) Pp. ii+143+3 plates. (Ottawa: F. A. Acland.)

Department of Agriculture: New South Wales. Veterinary Research Report No. 6, Parts 1 and 2. By Dr. H. R. Seddon. Pp. 91+6 plates. (Sydney, N.S.W.: Alfred James Kent.)

Bulletin of the Department of Zoology, Panjab University. Vol. 1: Fauna of Lahore. 2: Entomostraca (Water-Fleas) of Lahore. By G. L. Arora. Pp. 62-100+plates 5-8. (Lahore.) 3 rupees.

British Cast Iron Research Association. Tenth Annual Report for the Year ending June 30th, 1931. Pp. 16. (Birmingham.)

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 17, No. 3, October. Pp. 617-1048. (Plymouth.) 15*s.* net.

Royal Society of New South Wales, Sydney. Presidential Address by Prof. O. U. Vonwiller delivered on May 6, 1931. Pp. 36. (Sydney.)

Department of Scientific and Industrial Research. Report of the Springs Research Committee. Pp. iv+75. (London: H.M. Stationery Office.) 1*s.* 3*d.* net.

Empire Marketing Board. Dairy Research: a Report to the Empire Marketing Board. By Sir William Dampier. (E.M.B. 44.) Pp. 60. (London: H.M. Stationery Office.) 1*s.* net.

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 1, No. 5: Abnormalities in the Blood Vascular System of the Anura. By Dr. Charles H. O'Donoghue. Pp. 179-224. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 5*s.* 6*d.*

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1403 (Ae. 524—Spin 61): Measured Spins on Aeroplane H. By S. B. Gates. Pp. 5+2 plates. 6*d.* net. No. 1408 (Ae 529—T. 3060): Relation between Heat Transfer and Surface Friction for Laminar Flow. By A. Fage and V. M. Falkner. Pp. 30+12 plates. 1*s* 6*d.* net. (London: H.M. Stationery Office.)

Proceedings of the Malacological Society of London. Edited by R. Winckworth. Vol. 19, Part 6, November. Pp. 259-297+plates 30-33. (London: Dulau and Co., Ltd.) 10*s.* net.

Malacological Society of London. Library Catalogue (Radley Bequest) 1927. Pp. 28. (London: Dulau and Co., Ltd.) 1*s.* 6*d.* net.

The Victorian Bush Nursing Association. Report and Statement of Accounts to 30th June 1931. Pp. 266. (Melbourne.)

The Geological Survey of India. Memorandum on the Proposed Retrenchment. By Sir C. V. Raman. Pp. 12. (Calcutta: The Author, 92 Upper Circular Road.)

Proceedings of the Institution of Chemists (India). Vol. 3, Part 1, October. Pp 90. (Calcutta.) 4 rupees.

Catalogue of Indian Insects. Part 21: Lycidae. By Richard Kleine. Pp. iii+52. 1.2 rupees; 2*s.* Part 22: Phalonidae and Chlidanotidae. By T. Bainbridge Fletcher. Pp. iii+15. 6 annas; 8*d.* (Calcutta: Government of India Central Publication Branch.)

Publications of the Dominion Astrophysical Observatory. Vol. 4, No. 15: Luminosity of Planetary Nebulae and Stellar Temperatures. By H. Zanstra. Pp. 205-260. 40 cents. Vol. 6, No. 1: Two Binary Orbits. By W. E. Harper. Pp 10. Vol. 6, No. 2: The Orbit of H.D. 185936. By S. N. Hill. Pp. 11-16. Vol. 6, No. 3: Measurements of the Wave Lengths of Strong Oxygen and Nitrogen Lines in the Region λ3880-4705. By C. S. Beals. Pp. 17-24. Vol. 6, No. 4: Solar Motion Graph. By J. A. Pearce and S. N. Hill. Pp. 2. 25 cents. (Ottawa: F. A. Acland.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), Part 4. By Dr. L. F. Spath. Pp. iv+279-550+plates 48-102. (Calcutta: Government of India Central Publication Branch.) 34.12 rupees; 53*s.* 6*d.*

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 69, No. 419, November. Pp. 1829-1890+xxvi. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

Imperial Agricultural Bureaux. Second Annual Report of the Executive Council, 1930–1931. Pp. 12. (London: H.M. Stationery Office.) 1*s.* net.

Union of South Africa: Department of Agriculture. Seventeenth Report of the Director of Veterinary Services and Animal Industry, Onderstepoort, Pretoria. Part 1. Pp. v+429. 10*s.* Part 2. Pp. vii+431-878. 10*s.* (Pretoria: Government Printing Office.)

Papers from the Geological Department, Glasgow University Vol 14 (Quarto Papers of 1927–1931). (Glasgow University Publications 21.) 5 papers. (Glasgow: Jackson, Wylie and Co.)

Ministry of Agriculture and Fisheries. Report on Salmon and Freshwater Fisheries for the Year 1930. Pp. 68. (London: H.M. Stationery Office.) 1*s.* 6*d.* net.

Record of the Royal Institution of Great Britain, 1931. Pp. 164. (London: Wm Clowes and Sons, Ltd.) 5*s.*

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 15, No. 59, September. Pp. ix+59-82+211-352+xxvi. (Sheffield.) 10*s.* 6*d.*

Department of Scientific and Industrial Research. First Report of the Steel Structures Research Committee. Pp. xii+276+11 plates. (London: H.M. Stationery Office.) 5*s.* net.

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 10, October. Abstracts Nos. 1783-2009. (London: H.M. Stationery Office.) 9*d* net.

The British Science Guild. Biology and Civilization: being the Seventh Annual Norman Lockyer Lecture, delivered on November 24th, 1931, at 4 30 P.M., in the Hall of the Goldsmiths' Company, London. By Dr. H. H. Dale. Pp. 24. (London: British Science Guild.) 1*s.*

Transactions of the Optical Society. Vol. 32, No. 1. Pp. 44+vi. (London.) 10*s.*

Tide Tables for the Pacific Coast of Canada for the Year 1932: including Juan de Fuca Strait, the Strait of Georgia and the Northern Coast, with Data for Slack Water in the Navigable Passes and Narrows and Information on Currents; also Tide Tables for the U.S. Ports of Seattle and Port Townsend. (Thirty-second Year of Issue.) Pp. 80. (Ottawa: F. A. Acland.)

Journal of the Indian Institute of Science. Vol. 14A, Part 6: Studies in Electro-Culture. Part 1: Introduction, by K. Venkata Giri, T. J. Mirchandani and V. Subrahmanyan; Part 2: Influence of Electrical Treatment on the Germination of Barley and the Diastatic Activity of Malt, by K. Venkata Giri and V. Subrahmanyan. Pp. 67-97. (Bangalore.) 2 rupees.

Indian Institute of Science. Investigations on the Spike-Disease of Sandal. 1: Resumé of Observations made to Date; 2: Report of Progress made during the Quarter ending 30th June 1931. Contributors: N. C. Chatterjee, C. Dover, H. A. H. G. Hicks, J. E. M. Mitchell, M. Sreenivasaya, A. V. Varadaraja Iyengar. Edited by Dr. V. Subrahmanyan. Pp. 16. (Bangalore.)

Foreign.

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 9, Part 3, September. Pp. 225-386+plates 30-43. (Tokyo: Iwanami Shoten.) 1.76 yen.

Smithsonian Institution: Bureau of American Ethnology. Bulletin 98: Tales of the Cochiti Indians. By Ruth Benedict. Pp. x+256. (Washington, D.C.: Government Printing Office.) 40 cents.

Obras completas y correspondencia científica de Florentino Ameghino. Vol. 8: Los mamíferos fósiles de la República Argentina. Parte 3: Homalodontes. Edición oficial ordenada por el Gobierno de la Provincia de Buenos Aires. Dirigida por Alfredo J. Torcelli. Pp 595. (La Plata: Ministerio de Gobierno de la Provincia de Buenos Aires.)

Royal Agricultural Society, Egypt: Technical Section. Bulletin No. 18: Natural Crossing in Cotton. By Dr. M. A. Fikry. Pp. 23+3 plates. (Cairo.)

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 9. Pp. iv+206. (Paris: Les Presses universitaires de France.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'annee 1930. Par Ernest Esclangon. Pp. 39. (Paris.)

Comité International des Poids et Mesures. Procès-verbaux des séances. Deuxième série, Tome 14, Session de 1931. Pp. vii+243. (Paris: Gauthier-Villiars et Cie.)

U.S. Department of Agriculture. Technical Bulletin No. 253: Petroleum Oils and Oil Emulsions as Insecticides, and their Use against the San Jose Scale on Peach Trees in the South. By H. S. Swingle and Oliver I. Snapp. Pp. 48. 10 cents. Circular No. 185: New Fertilizer Materials. By Albert R. Merz. Pp. 15. 5 cents. (Washington, D.C.: Government Printing Office.)

Bell Telephone System: Technical Publications. Mathematical Physics, Monograph B-584: Fourier Integrals for Practical Applications. By George A. Campbell and Ronald M. Foster. Pp. 177. (New York: Bell Telephone Laboratories.)

U.S. Department of the Interior: Office of Education. Bulletin, 1931, No. 20: Biennial Survey of Education in the United States, 1928–1930. Chapter 17: Education of certain Racial Groups in the United States and its Territories. Prepared by Katherine M. Cook, with the collaboration of John H. McBride, Jr., W. Carson Ryan, Jr, William Hamilton and Ambrose Caliver. Pp. 56. 10 cents. Bulletin, 1931, No. 20: Biennial Survey of Education in the United States, 1928–1930. Chapter 18: Radio and Education. By Armstrong Percy. Pp. 23. 5 cents. (Washington, D.C.: Government Printing Office.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 12, No. 2A. Pp. 141-194+plates 24-29. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Cornell University Agricultural Experiment Station. Bulletin 522: The Family Finances of 195 Farm Families in Tompkins County, New York, 1927–28. By Helen Canon. Pp. 84. Bulletin 524: The Communities of Schuyler County, New York, 1927. By Ray E. Wakeley. Pp. 74. (Ithaca, N.Y.)

U.S. Department of Commerce: National Bureau of Standards. Research Paper No. 339: A New Apparatus for preparing Ra B+C Sources. By L. F Curtiss. Pp 215 218. 5 cents. Bureau of Standards Journal of Research. Vol. 7, No. 4, October. Research Papers Nos. 361-371. Pp. 617-764. (Washington, D.C.: Government Printing Office.)

Verhandlungen des I. Internationalen Kaninchenzuchter-Kongresses Leipzig 1930. Herausgegeben von Prof. Dr. Hans Nachtsheim. (Zeitschrift fur Pelztier- und Rauchwarenkunde, Band 3.) Pp. ix+283+7 Tafeln. (Leipzig: Reichs-Zentrale fur Pelztier- und Rauchwaren-Forschung.)

Iktisat Vekâleti Meteoroloji Enstitusii. 1927, 1928, 1929, 1930 senelerinde. Turkiyede yağmur vaziyeti Bulteni. Pp. 36. (Ankara.)

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University. Vol. 2, Art. 4: Scientific Results of the second Oceanographic Expedition of the *Pawnee*, 1926. Deepsea Fishes from off the Western Coast of North and Central America, with Keys to the Genera Stomias, Diplophos, Melamphaes and Bregmaceros, and a Revision of the Macropterus Group of the Genus Lampanyctus. By Albert Eide Parr. Pp. 53. Vol. 4, Art. 1: A Practical Revision of the Western Atlantic Species of the Genus Citharichthys (including Etropus), with Observations on the Pacific *Citharichthys crossotus* and *C. spilopterus* By Albert Eide Parr. Pp. 24. (New Haven, Conn.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 30, Part 3. Beitrag zur Kenntnis der Cryptinenfauna Formosas. Von Toichi Uchida. Pp 163-194. (Tokyo: Maruzen Co, Ltd.)

The Rockefeller Foundation. Annual Report, 1930. Pp. viii+380 (33 plates). (New York City.)

Proceedings of the United States National Museum. Vol. 79, Art. 21: Some Tertiary Mollusks from Southern Florida. By W. C. Mansfield. (No. 2887.) Pp. 12+4 plates Vol. 79, Art. 23: Anodontites, a Genus of South and Central American and Mexican Pearly Fresh-water Mussels. By William B. Marshall. (No 2889) Pp 16+2 plates. (Washington, D.C.: Government Printing Office.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 14, No. 4, July. Pp. 131-193. (Tokyo and Kyoto: Maruzen Co., Ltd.) 1.30 yen.

Sveriges Geologiska Undersökning. Ser. C, No. 364: A Seismological Map of Northern Europe. By K. E. Sahlstrom. Pp. 8+1 plate. 0.50 kr. Ser. C, No. 365: Granitindustrien i Forenta staterna. Reseberattelse av Hjalmar Nordquist. Pp. 162+2 tavlor. 5.00 kr. Ser. C, No. 366: Berggrunden inom malmtrakten Kiruna–Gallivare–Pajala. Av Per Geijer. English Summary: Pre-Cambrian Geology of the Iron-bearing Region Kiruna–Gallivare–Pajala. Pp. 225+1 karta. 4.00 kr. Ser. C, No. 367: The Iron Ores of the Kiruna Type; Geographical Distribution, Geological Characters and Origin. By Per Geijer. Pp. 39. 1.00 kr. Ser. C, No. 368: Kungshamnsmossens utvecklingshistoria jamte pollenanalytiska åldersbestammingar i Uppland. Av Erik Granlund. Pp. 51. 1.00 kr. Ser. C, No. 369: Praktisky-geologiska undersökningar inom Jokkmokks socken sommaren 1930. Av Alvar Hogbom. English Summary: Practical Geological Investigations in the Parish of Jokkmokk in the Summer 1930. Pp. 57+3 tavlor. 2.00 kr. Ser. C, No. 370: Jordskalv i Sverige 1926–1930. Av K. E. Sahlstrom. Resumee: Erdbeben in Schweden 1926–1930. Pp. 52+1 karta. 1.00 kr. Ser. C, No. 371: Kulturtechnische Grundwasserforschungen. Von Herman Flodkuist. Pp. 317. 5.00 kr. (Stockholm: P. A. Norstedt and Soner.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 10, Octobre. Pp. 465-516. (Prague: Regia Societas Scientiarum Bohemica.)

University of California Publications. Bulletin of the Department of Geological Sciences, Vol. 20, No. 3: An Auklet from the Eocene of Oregon. By Alden H. Miller. Pp. 23-26. 25 cents. University of California Publications in Zoology. Vol. 38, No. 2: Systematic Revision and Natural History of the American Shrikes (Lanius). By Alden H. Miller. Pp. 11-242. 3 dollars. (Berkeley, Calif.: University of California Press.)

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SATURDAY, DECEMBER 26, 1931.

CONTENTS.

PAGE
National Needs (II.). By H. E. A. 1053
Science and Philosophy of Life. By Prof. James Ritchie 1056
Second Thoughts on Radiotelegraphy . . . 1057
Forest Travel in the Tropics 1059
Short Reviews 1060
The Passivity of Iron. By U. R. Evans . . . 1062
The Voyage of the *Beagle*, 1831–1836 . . . 1065
Obituary :
  Prof. Carveth Read 1067
News and Views 1068
Letters to the Editor :
  Constitution of the Keratin Molecule.—J. B. Speakman and Mercia C. Hirst . . . 1073
  Chinese Alchemy.—Prof. J. R. Partington, M.B.E. 1074
  New Yields from the Oldoway Bone Beds, Tanganyika Territory.—Dr. L. S. B. Leakey, Arthur T. Hopwood, and Prof. Hans Reck . . 1075
  Latency of Seedlings in some Grasses.—H. G. Chippindale 1075
  Zeeman Effect of a Forbidden Line.—E. Segrè and Dr. C. J. Bakker 1076
  Neon-Helium Bands.—Dr. M. J. Druyvesteyn . 1076
  The Study of Specific Combination in Immunity Reactions.—J. R. Marrack and F. Campbell Smith 1077
  Structure of the Azides.—Dr. Ernst Bergmann and W. Schütz 1077
  A Two-Dimensional Space Lattice ?—W. Baker 1078
  The Tertiary Wall of Wood Fibres.—S. H. Clarke 1078
  Turbulence in a River.—Dr. Harold Jeffreys, F.R.S. 1078
Research Items 1079
Astronomical Topics 1081
Constitution of the Alloys of Silver and Mercury. By F. C. T. 1082
International Standards of Lighting . . . 1083
Research in Wood Preservation 1083
University and Educational Intelligence . . . 1084
Birthdays and Research Centres 1085
Societies and Academies 1086
Diary of Societies 1087
Official Publications Received 1088
Recent Scientific and Technical Books . . Supp. v

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National Needs (II.).

> “Son, I am wearied of that Madrissah (school) where they take the best years of a man to teach him what he can only learn upon the road.”—*The Mahbub to Kim.*
>
> “*Sciencia vinces*—whether it be on the field of battle, on the waves of the ocean, amid the din and smoke of the workshop or on the broad acres under the light of heaven ; assuredly, in the future, even more than in the past, not only the prosperity but even the existence of the Empire will be found to depend upon the ‘improvement of Natural Knowledge’—that is upon the more complete application of scientific knowledge and methods to every department of industrial and national activity.”—*Sir Wm. Huggins* (1905).

WHAT, precisely, are we to do ? Mr. Louis Anderson Fenn asks (NATURE, Nov. 28, p. 909) in commenting upon my article on “National Needs”. He summarises my contentions in saying, that due appreciation of the *method of science* should be part of the cultural equipment of the citizen, adding : this can only be brought about through *a new kind of scientific education*, differing from the current type in having a definite social and political reference. I agree—but it is a little late to ask me to create and sustain such a movement. My article was a trumpet-call to this end ; my whole life, since 1870, has been consciously devoted to such purpose, I am obliged to confess, with little constructive success, except that I have learnt how all but insuperable are the difficulties to be overcome ; how every advance that we would make is subject to reduction by an overwhelming indeterminate factor—human nature.

The fundamental difficulty is to secure agreement as to the meaning of the label *scientific.* A science is a body of knowledge ; to be scientific is something very different from having knowledge : it means knowing how to make complete use of knowledge. The pioneer workers, in whatever field, are necessarily scientific ; yet among these, only a small minority are consciously scientific ; very few know how priceless a gift they have in their possession or seek to use it outside their specific work ; the majority act intuitively. I well know how long it was before I was clearly conscious of a guiding purpose behind my own efforts. The fact is, as I have often said, original inquiry is artistry pure and simple and the artist, we know, is rare. Artists are not noted for their common sense. Even in the narrow field of experimental inquiry, we have still to learn to exercise *proportionate judgement*, for which see Faraday's lecture on “Mental Education”, delivered before

Prince Albert in 1854. The doctrine Faraday professed should be our profession of faith: read frequently, as a lesson, in every church and in every school, in every laboratory before beginning work—if it be in us to rise so high and to have and hold a scientific faith. I agree with Mr. Fenn that our present-day 'science' is as ambiguous as the Christian faith. I would say not only politically but in all respects.

The Bishop of Birmingham said recently "that on this earth life would flicker out when the solar heat passed away but, in some other realms, he was forced to assume all that was of value in his personality would endure". Even mitred heads can asseverate, "I know it's true but I won't believe it". Why assume anything of an inconceivable situation? Our textbooks are full of similar proof of the prevalence of dogma. This is our difficulty—we do not hold to the truth even in teaching so-called science. In short, we have to cure ourselves before operating upon the public confidence. Few, probably, are educable to a scientific faith; most of us are inescapably credulous. Yet I believe much might be done with the multitude, if only a few of us could rise to the height of the opportunity before the teacher; could see how great is the peril in which we now stand and the call for the supreme effort calculated to raise our mental and moral standards; could combine in such crusade.

There must be a focus point. There is but one: the *Royal Society*. No collegiate body is likely to undertake the task—the literary mind being definitely incapable of understanding and using the experimental method. At the head of this article I have quoted words used full five and twenty years ago by the president of the Society, the late Sir William Huggins, a man to be ranked with Faraday as a lover of truth and a master of philosophical method. In justification of the claim he made, he added the statement:

> "It is obvious that it must be so, for it is only through an increased understanding of what are called the laws of Nature—the sequence and the interaction of natural phenomena—that we can hope to bring Nature into complete subjection and to make use of her illimitable forces to work out our own ends."

In the interval, the growth of 'natural knowledge' has been marvellous. Unfortunately, the control man has secured over Nature in no way extends to himself. We are faced with the fact that he is incapable of managing his ordinary affairs. Chaos now prevails throughout the world: we seem to be unable to do more than await events; we have no considered policy; no men competent to evolve one in any considered way. The astounding revelation has come upon us that the commercial community has no method of business—the banking fraternity, perhaps least of any, in view of the magnitude of its business and the trust imposed in it by the public. We have lived, it seems, upon the 'confidence trick': confidence being lost, the game cannot go on. The world is like Hans Andersen's 'King that had no clothes': at the mercy of pretending weavers. Money-making, as the aim and end of life, the American religion, is being made impossible by over-running the machinery which has made such doctrine possible. This is why I say that "a wise socialism is foreshadowed". Man is necessarily and by nature selfish but scientific advance will only be possible if he learn to subordinate his individual desires and be rational. This is our difficulty—to overcome our human nature.

To quote Sir William Huggins:

> "Clearly, it is only by such a widening of the general education common to all who go up to the Universities, before specialisation is allowed, that the present 'gap between scientific students of literary form, and classical students ignorant of scientific method' can be filled up, and the young men who will in the future take an active part in public affairs, as statesmen and leaders of thought, can be suitably prepared to introduce and encourage in the country that fuller knowledge and appreciation of science which are needed for the complete change of the national attitude on all science [scientific] questions, which is absolutely necessary if we are to maintain our high position and fulfil our destiny as a great nation."

The Society had memorialised the universities in the previous year (1904), begging them to take steps to ensure that *a knowledge of science* should be recognised in schools and elsewhere as an essential part of general education. The schools and universities may answer that this has been done. Those of us who are alive to facts, however, know that the object aimed at by Sir William Huggins has in no way been accomplished. Examinations have more and more prevailed to prevent the desired change; now even the teachers hug the chains that have been hung around them. Thereby hang coaching fees, examiners' fees, bold advertisement of schools and fond parents' worship of Tommy and Jane's successes. All very human—but bad business. A certain number of expert scientific workers has been brought into being under the system but the public mind, the business mind, the administrative mind, is untouched, in no way *disciplined* to grasp the complexities of our modern life.

Sir William Huggins—I knew him intimately—knew well what he wanted: a more complete application of *scientific knowledge and method* to every department of national and industrial activity. He had no desire that the stars should be understood: yet every desire that the method which had enabled him to understand them should be clear to all—the experimental method, the method of exercising sound scientific thought—thought replete with knowledge and action based upon such thought.

The Royal Society has done nothing, during the twenty-five years' interval, to carry out its former president's behest and support its own action. We are more and more developing bureaucratic habits and academic impotence, making natural science a close corporation; worse still, an inordinate vanity is growing upon us, through excessive publication and prize-giving. No other class, let us confess, gets itself so much talked about and rewarded for so little real service. Courage of opinion is gone; there is no evidence among us of any clear sense of responsibility, let alone of patriotism. Yet in our hands rests a terrific power, if we would but use it—as there must ever be in real knowledge. Present-day engineering achievement, patent to the public on every side, the outcome of considered thought and exact work, is sufficient evidence not merely of what is but of what might be, if we combined our forces to useful public ends. The engineer is not actuated solely by thought of gain; a greater end, the glory of achievement, counts for much. The late Sir Charles Parsons's concern was to make the turbine a perfect machine; whether it paid was a secondary consideration—far more his friends' consideration than his own.

Man is a far finer machine than any turbine or, indeed, any engineering achievement—yet we give no real thought to his improvement. We seek to administer remedies when he falls into ill-health but do little, if anything, to render him proof against disease. In seeking to gain mastery over Nature, we neglect our own souls. The schools for our young gentlemen are in the hands of most respectable governing bodies who unconcernedly continue to support the grand old fortifying, classical curriculum, with its religious accompaniments; they rarely elect a 'head' who is not its advocate. Not a single school stands out as engaged in the conscious and calculated practice of real scientific method. The condition of our schools is heart-rending to some of us who know—considering what they might be. It is true—Rome was not built in a day; still, I have watched school building operations during sixty-five years and can record little progress. Lytton Strachey tells us that Dr. Arnold elected not to teach physical science at Rugby (1828):

> "Obviously only two alternatives were possible, it must either take the chief place in the curriculum or it must be left out altogether. Before such a choice, Dr. Arnold did not hesitate for a moment. 'Rather than have physical science the principal thing in my son's mind,' he exclaimed in a letter to a friend, 'I would gladly have him think that the sun went round the earth and that the stars were so many spangles set in the bright blue firmament. Surely the one thing needful for a Christian and an Englishman to study is Christian and moral and political philosophy.' "

Even to-day, men of my school make no demand for physical science. We ask only that the underlying method, which has made modern, post-Arnoldian progress possible, be taught with interest and full honesty of purpose; as a philosophy but through practice and with reference to life. In my own case, interest was first awakened through the study of words—and the sight of butterflies—not through 'stinks'; but possession came only through engaging in experimental inquiry.

Organise our scientific forces we must. The Royal Society alone can take the lead. It should forthwith constitute its fellows a parliament of scientific opinion, sub-dividing it into sections, according to subjects, if desirable; also co-opting a limited number of specially competent persons from outside the Society. Our first act would be to learn to take counsel together for the common good—a hitherto unknown art unpractised by scientific workers: this would be the prelude to the establishment of a limited scientific democracy, the beginning of my scientific socialism.

Constantly complaint is made that scientific workers are not used by Government or in the public services. Why should we be, when we do not set the example of using ourselves? "Physician, heal thyself", after all, is an expression of worldly wisdom; "Charity begins at home" is another. It rests with the Society to show openly that there is an intellectual method behind all its activities and, by example, to encourage the development of the scientific temper of mind in the community. Need I say more by way of giving the lead that is asked of me? Personally I pursue one hope:

"To the solid ground of Nature trusts the mind that builds for aye." H. E. A.

Science and Philosophy of Life.

Life: Outlines of General Biology. By Sir J. Arthur Thomson and Prof. Patrick Geddes. Vol. 1. Pp. xix + 714. Vol. 2. Pp. xi + 715-1515. (London: Williams and Norgate, Ltd., 1931.) 63*s*. net.

WHEN two men of science, with the ripe experience of Sir J. Arthur Thomson and Prof. Patrick Geddes, combine to give the world their finished thoughts about life, the result is likely to be unusual and instructive. These volumes are both. They contain no ordinary exposition of general biology, for, instead of the formal treatment of themes which incline to become stereotyped, they embrace less ceremonious discussions of the facts generally classed as biological, and pass beyond these, aided and abetted by the authors' long intimacy with teaching and with civic endeavour. So that their net, wide-mouthed and fine-meshed, seems to catch almost everything that floats in the ocean of life.

The treatment of the themes in general cannot fail to remind one of the works of the older naturalists, where anecdotes formed the supporting skeleton upon which the body of generalities was built; only here the uncritical anecdotes of the early field naturalist are replaced by authenticated observations and by records of experiments drawn from a wide knowledge of recent biological investigation. The method has this great advantage for the general reader, that at almost any page he may dip into these two great volumes and find himself interested in an example or a theme, carefully labelled and complete in itself, but in reality an item in a massed argument for some particular generality. For the student or the teacher of biological subjects the advantage of the method lies in the wealth of facts which have been marshalled here for his conviction, to give body to the argument, and which secondarily form a gold-mine of information from which he may extract nuggets at his leisure.

Another impression made by the design of the work is that the authors are conscious, as every follower of the science must be, of the unwieldy masses of evidence which have accumulated, and that by a *tour de force* they have compelled the multifarious evidences, differing in quality and degree, to fall into line and play a part in support of their biological theses.

A fourfold purpose animates the book. Its first aim is to state and illustrate the outlines of biology as generally understood—the characteristics of organisms, their ways of acting in relation to their own organisation and in relation to their inanimate and animate environment, their development as living units, and their evolution as items in the complete tale of life's progress. Characteristic of this great section (of more than 900 pages) is the successful endeavour to import into the discussions a real flavour of livingness and of the wonder and drama of life. A second purpose is focused upon an examination of the science of biology, first as to its constituent branches, and second as to its place in the field of knowledge, its relation to the sciences and the arts; and here we are faced with subtle schemes of inter-relationships, as intricate as the web of life itself, which culminate in the mystical end papers of the volumes and their necessary but illuminating interpretation.

In the third place, throughout the whole work, which is marked by a philosophic synthesis of the factual groundwork, there runs the continuous thread of the neo-vitalistic outlook; but the treatment is cautious, and full weight is given to the discoveries of the biochemist and biophysicist, though insistence is made upon the need still for concepts characteristic of and peculiar to the life sciences.

Finally, the authors very properly bring together again for the consideration of their fellow-workers the special contributions to biological interpretations which their earlier writings have made familiar—the metabolic theory of sex, the inclined plane of animal behaviour, the concept of the cell-cycle with its morphological and physiological counterparts, the restatement of the concepts of reversion and parasitism, and so on.

No part of the "large and crowded volumes", however, so reveals the reactions of these skilled teachers to their long experience of education and of life as the final chapters and appendices. There, in discussing man and the wider aspects of biology, they let themselves go, and from a series of talks about many things they reach forward to a theory of life, "evolutionary throughout, from organisms at simplest to humanity at highest", in which due place is found "for each and all the contributory sciences, for the occupations and the arts, and for literatures and philosophies as well". Since the biological outlook lies at the foundation of this evolutionary integration, a strong plea is made for the further teaching in school and college of biology, "the general science of organisms—the study of the nature, persistence, continuance, development, and evolution of life". Of first-class zoology and first-class botany there is abundance, but "our frank reproach is that the Universities, within and beyond the British Empire, fall short of their just ambition as regards Biological Education". The cultural course for 'arts' students might well be oriented, on a sound basis of correlated structure and function, towards the old-fashioned natural history, which would stimulate dormant interest and fill the mind with concepts later to be applied subconsciously and automatically in any walk of life. As a basis for medical studies, what could be more telling than the driving home, by practical exercises and observations, of the great biological concepts of growth, development, correlation, variability, heredity, evolution, and so forth, with excursions, where need be, into issues of special significance to medicine? It is a strong plea for 'biology for life'.

In places this is a wayward work, occasionally discursive and diffuse, occasionally unnecessarily repetitive, mostly clear and easy in style, sometimes tantalisingly involved, but it has an atmosphere of its own, which, with its wealth of facts and its ideals, will well serve its purpose of furthering an interest in the science of life and in life itself.

James Ritchie.

Second Thoughts on Radiotelegraphy.

(1) *Modern Radio Communication: a Manual of Modern Theory and Practice, covering the Syllabus of the City and Guilds Examination and suitable for Candidates for the P.M.G. Certificate.* By J. H. Reyner. Third edition. Pp. xi + 259. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 5*s.* net.

(2) *The Cable and Wireless Communications of the World: a Survey of Present Day Means of International Communication by Cable and Wireless; containing Chapters on Cable and Wireless Finance.* By F. J. Brown. Second edition, revised. Pp. xi + 153. (London: Sir Isaac Pitman and Sons, Ltd., 1930.) 7*s.* 6*d.* net.

(3) *The Theory and Practice of Radio Frequency Measurements: a Handbook for the Laboratory and a Textbook for Advanced Students.* By E. B. Moullin. Second edition, entirely re-set and greatly enlarged. Pp. xii + 487. (London: Charles Griffin and Co., Ltd., 1931.) 34*s.* net.

THE new edition of a technical work presents acute problems to the author, the publisher, the librarian, the reader, the editor, and the reviewer. A rapidly advancing art and a widely distributed literature demand frequent revisions of these 'zusammenfassenden Berichte' on which the harassed worker must increasingly depend. But the author and his publisher must find it difficult to determine the appropriate moment at which to revise, and the conditions in which revision should be embodied in a new work rather than in a new edition. The librarian and the reader have to face the problems of expending money in purchasing and time in reading the revised or enlarged works; on the editor and reviewer devolves the special responsibility for guiding them on the degree of novelty or value embodied in the new edition, without dereliction of their primary duties towards entirely new works.

(1) Mr. Reyner's book, first published in 1923, is designed "to cover the City and Guilds examination in the subject". It is of the essence of a plan thus restricted that there should be some superficiality of treatment, and a judicious superficiality is not a defect. But there is evidence that the revision work of the 1925 and 1931 editions has not been sufficiently thorough, with the result that in places the allocation of space is disproportionate, in others the treatment is actually erroneous. If, indeed, a completely fresh work is not here called for, pruning of the sections on obsolescent apparatus like the arc transmitter, the high-frequency alternator, and the frequency changer, expansion of the apparently hasty additions dealing with screen-grid valves, and a complete re-writing of the sections on atmospherics and on the Heaviside layer, neither of which represents the position even of 1928, may be recommended.

(2) Mr. Brown's book was, in its original form, unique as a guide to the difficult economic technical and administrative problems of world communications by cable and by wireless. His rare combination of experience in State and private enterprise admirably fits him for his task, and the fresh information embodied in the present volume is characteristic of the appropriate treatment of new editions. The book may be unhesitatingly recommended to all who are interested in the vital problems of close linking of the Empire and the world by electrical communications.

(3) Mr. Moullin's "Handbook for the Laboratory and a Textbook for Advanced Students" attained a deservedly high reputation in its first edition of some 270 pages. That the preface to the first edition was written from the Engineering Laboratory, Cambridge, while that to the second edition comes from a corresponding address in Oxford, is perhaps not the least significant change in this story of radio frequency measurements, which now occupies nearly double the space to which it was formerly confined. Even though it

belongs to the first edition, a cautionary statement in the 'Cambridge' preface is of such importance to the worker from other fields on his entry into radio-frequency measurement that we quote it without apology:

> "In high-frequency work we are again and again forced to remember that inductance, capacity and resistance are attributes possessed simultaneously by all apparatus, and we cannot say this is an inductance or that a capacity with the easy non-chalance of the power engineer. Therefore the chapter headings in this book are bound to be a little fictitious."

The greatest innovation in the new edition is the introduction of a new chapter (i.), "Developing the Electromagnetic Equations and Calculating the Field near Circuits and Aerials". "This chapter forms a focus for the book, but is not meant to be a full exposition of the equations of the electromagnetic field." So long as this limitation is fully recognised, the heroic effort of compression into forty pages may be commended, but the chapter is certainly not in itself a sufficient introduction to the equations; it should be used only for re-proportioning knowledge acquired from other sources.

For an account of the main plan of the work the reader must be referred to the review of the first edition (NATURE, Jan. 29, 1927, p. 155). The chapter which has attained the greatest expansion is that on the valve generator, now nearly three times its former length. The treatment is satisfactory within the limits adopted, but the crucial question of frequency stability is too lightly dismissed, and might well be given more weight in the next edition. The problem of the acoustic-frequency generator also merits fuller handling; in particular, the diagram for a beat-frequency generator might readily have been made very much more useful by the addition of a schedule of circuital element values, since it represents a generator which is only "very perfect" if certain stringent but sufficiently familiar conditions, not detailed in the text, are satisfied.

The chapters on measurement of potential difference and current, and on measurement of capacity, deal with fields in which the author has himself made especially valuable contributions, and contain discussions of the thermionic voltmeter, the dynamometer ammeter, and the tubular variable condenser, the two latter instruments having been devised by him since the publication of the first edition. There is now available a not inconsiderable literature of thermionic voltmeters, in which the departures from the author's original patterns are of great practical significance; fuller reference to these contributions would have been useful. The dynamometer ammeter and the Moullin condenser are instruments of great elegance and importance; it is very satisfactory to have an adequate discussion of them in the handbook.

The chapter on the intensity of radiated fields has been very little expanded, and it must be confessed that this is symptomatic of the not entirely healthy state of the subject. It may be hoped that the recent decision of the International Union for Scientific Radiotelegraphy to undertake a comparative study of the methods of field measurement will lead to the resolution of present doubts and difficulties.

One of the most surprising features of the book is that it contains no description or illustration of the normal equipment of the radio laboratory. The sub-standard wavemeter, the standard signal generator, the attenuation box, the Campbell capacitance bridge are in hourly use in the technical laboratory, but they would come almost as novelties to the reader of this work. The range and flexibility of the filter circuits of everyday practice are, too, much in excess of anything that might be inferred from the four pages which the author devotes to them. It may be added that a section on filter circuits which does not refer to Campbell, Zobel, Johnson, or Shea is an unexpected phenomenon. There are, perhaps, other evidences of insularity in the name index, but even this does not explain the absence of a reference to Bartlett on filters.

On the merely editorial side it may be suggested that the footnote which economises for the publisher by the use of "loc. cit." and "id.", where multiple references to many works of a few authors are in question, makes extravagant demands on the patience and perspicuity of the reader, who merits the greater consideration.

These notes are critical, and that they have been set down in detail must be taken as a token of the high regard in which the book as a whole is held. It is alone of its kind, it is extremely good, it should be in every high-frequency laboratory, and possession of the first edition does not excuse failure to acquire the second. But we venture to suggest that while the second edition is probably as good as any one author can make it, Mr. Moullin would increase the already heavy debt we owe him if, in proceeding to a third edition, or to an equivalent new work, he would take to himself one or more collaborators in the herculean task of preparing the ideal and monumental "Handbook of Radio Frequency Measurements".

Forest Travel in the Tropics.

Tropical Forests of the Caribbean. By Tom Gill. (Published by the Tropical Plant Research Foundation in co-operation with the Charles Lathrop Pack Forestry Trust.) Pp. xix + 318 + 81 plates. (Yonkers, N.Y.: Tropical Plant Research Foundation, 1931.)

THE Spaniard Cortez is known as a brave man, with an indomitable spirit and an almost inhuman quality of endurance. The American Tom Gill, more than four hundred years later, in adventuring the survey of the tropical forests of the Caribbean, required a very different kind of courage, and found a very different world, which was traversed in a very different manner. After reading Mr. Gill's book, the reader will reflect upon what the condition may be when another four hundred years have passed, but at present Mr. Gill, in association with the Charles Lathrop Pack Forestry Trust, has presented us with an interesting and informative up-to-date account of these forests.

Cortez, and those other bold adventurers who followed him in rapid succession, spoke of the marvellous forests of rare and unknown timbers. Mr. Gill says: "Cuba, seen through the eyes of Columbus, was a place of lovely verdure to be described only by the most glowing words in his vocabulary. It was a place of cool and fragrant woodlands, made up of trees of strange varieties, displaying leaves, flowers, and fruits of kinds he had never seen", and he refers to "the infinite number of fine, large, green trees", and "the verdure of the place, tempted me to fix there for ever". He also quotes Henry Hawks, writing in 1572, who said: "There are marvellous great woods, and as faire trees as may be seene of divers sorts, and especially firre trees that may mast any shippe that goeth upon the sea".

From the opening pages throughout to the end there is a mournful story of the way in which successive generations visiting the Caribbean have destroyed these forests. It seems as though the march of civilisation has proclaimed everywhere the destruction of trees over the wide surface of the globe.

The book is divided into sixteen chapters, among the titles of which are "Effects of Human Occupancy", "British Forestry in Tropical America", and "Tropical Forests and To-morrow", with others divided into the different countries—Porto Rico and Haiti; Central America and the West Indies; Mexico; Venezuela and Colombia—giving full information regarding each country; and it is enlivened by no less than eighty excellent pictures taken on the spot.

With the text supplemented by the pictures, the reader is enabled to visualise the existing conditions; the forester to gain necessary information; and all of us to learn a lesson to-day to plant beforehand, and so to lay up for those who follow us a rich heritage in the place of a vast deforested country.

No light feat of hardihood and endurance was required to accomplish this work, necessitating three winter visits—two by Mr. Gill and one by Mr. Barbour, Mr. Gill paying a special tribute to the value of aeroplane survey.

The writer combines the qualities of the scientific worker with the mature knowledge of a lumberman, so that the fortunate blending of both points of view increases the value of his catalogued information. It is consoling for us to read:

> "one has to confess that British forestry has gone further in the American tropics than United States forestry", and for the American an alarming note when he says, "Nor does there seem to have been at any time, including *the present*, a real adequate effort on the part of Government and individuals to place the United States on a self-supporting timber basis. The American lumberman has cut his way across the Continent; and now is hacking out the *last great* stand of virgin timber within the Continental United States, the Douglas Fir region of the Pacific North-West."

There is an arresting thought expressed in the following words:

> "Throughout the world there is a very fundamental relationship between man and trees, and in the tropics one sees it on every hand—a delicately balanced relationship, dangerous to destroy."

This pronouncement is illustrated and emphasised by the pictures of the deforested hill-top in Haiti in contrast to the year-old plantation in Trinidad and the mahogany forest in British Honduras, and other pictures. The author continually refers to, and stresses, the destructive effect on the climate and health of the people as the result of deforestation. He specially refers to the altered climate in the valley of Mexico. He says:

> "Not more than twenty-five years ago it was extremely rare that high winds would raise even small clouds of dust over the City of Mexico. To-day from December to April the wind blows with great force, bearing large quantities of fine dust that hover like clouds over the city and settle there. . . . All these conditions conspired to convert regions once forest-covered into desert, and created a serious menace through soil erosion. More than one Mexican forester has pointed out that the effect of forest destruction on climate, soil, and water flow

has brought about the abandonment of many flourishing towns.

"In old documents are still preserved requests for permission to cut trees necessary to be removed in grading for new cities and making highways in regions which to-day are desert and desolate of all trees. One finds, for example, permission granted many years ago to cut oak and pine about Saltillo, showing that in those days the region was at least partially covered with some kind of forest vegetation. To-day it is desolate." The author then pays a special tribute to Miguel A. de Quevedo, whom he calls the "Father of Mexican Forestry".

Appended to the book is a list of the better known broad-leaved species of the Caribbean region.

There is perhaps too much repetition and occasionally an absence of information which the expert in fine woods would have valued, but on the whole the book adds greatly to the world's knowledge of this wonderful tract of forest country, which includes a considerable area of yet unexplored forests, and provides a lesson to the whole world on the urgent importance of vigorous reafforestation based on scientific principles.

Short Reviews.

Maize in South Africa. By A. R. Saunders. (South African Agricultural Series, Vol. 7.) Pp. 284 + 72 plates. (Johannesburg: Central News Agency, Ltd., 1930.) 20*s.* net.

THIS book will naturally be of most interest to those vitally concerned with the cultivation and disposal of maize in South Africa, but students of the problems which arise when an economic crop undergoes rapid development in a new region will also find it of value.

Maize viewed as a world crop occupies first place in respect of tonnage. Of the 131 million tons produced, the Union of South Africa is responsible for about 2½ million, so that it is as yet one of the minor producing countries. None the less, 40 per cent of the cultivated land of the Union is occupied by maize, and nearly four-fifths of the crop is exported. Compared with other countries, the yield of maize in the Union is low, being less than one-half of that of the United States, and the future of the industry rests more on the possibility of increasing the yield per acre than in the extension of the existing area. In this, the position has some similarity to that of sugar beet cultivation in England.

The author discusses in detail the factors affecting the yield of maize in South Africa. Climate, soils, fertiliser treatment, and systems of cultivation are all dealt with in an interesting way. As in many relatively undeveloped countries, superphosphate plays a great part in crop production and is by far the most important fertiliser in the maize-growing areas, where it gives quite striking results. A further factor in improving yield is inter-cultivation with the object of checking weeds, and some interesting experimental data are given on this point. The most direct method of crop improvement is the choice of suitable varieties and a chapter is devoted to practical notes on the more important varieties in cultivation. The remainder of the book deals with the diseases of the crop, and this section, like the rest of the book, is excellently illustrated. The disposal of the crop and its position in commerce are also discussed. Many references to the literature are given and the book is well indexed. H. V. G.

(1) *Worsted Open Drawing: a Simply Written Explanation of the Process; for Managers, Foremen and Students in the Industry.* By S. Kershaw. Pp. vii + 131. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 5*s.* net.
(2) *Leather Crafts Manual.* By Ivy Evelyn Norman and Paul I. Smith. (Lockwood's Manuals.) Pp. vii + 88. (London: Crosby Lockwood and Son, 1930.) 2*s.* 6*d.* net.
(3) *Practical Dry Cleaner, Scourer and Garment Dyer.* Edited by William T. Brannt and J. B. Gray. Sixth corrected edition. Pp. xviii + 378. (London: Crosby Lockwood and Son, 1930.) 12*s.* net.

IT is always matter of conjecture as to the kind of reader to whom technical works will hold an appeal. Class students will use the textbooks recommended by their teachers; the majority of craftsmen may well carry on without such books (Does not Mr. Kershaw write, in (1), p. 75, "Intelligent working is better than a guide book"?), whilst the general reader will mostly ignore technical works; (3) is an exception to test the rule, for it seems to interest the public and is now in a sixth edition. Truly, the essential merits of these three books are independent of general favour, however such limitation might be disapproved by the publishers. Once again, as so very often, are we confronted with the view ("Worsted Open Drawing", p. 85): "Even experts disagree". Mr. Kershaw's work is commendably practical and has many useful diagrams. "The Leather Crafts Manual" is brief and to the point; it may, however, be remarked, regarding the historical survey, that assumptions are not proofs. The text is full of interest and the illustrations are attractive, but the index is very poor. (3) is far too diffuse in treatment, and however accurate the text, yet the impression conveyed is as of a *catalogue raisonnée* of recipes, with not infrequent repetition of information. Sufficiently pruned, there would be enough left to satisfy requirements; but the treatment is due probably to the book being a compilation by various writers.

P. L. M.

Index of Spectra. By the late Dr. W. Marshall Watts. Appendix Z: *Iron and Iron Oxide.* Pp. 116. (Westcliff-on-Sea: T. M. F. Tamblyn-Watts, 1931.) 18*s.*

WATTS'S "Index of Spectra" was a household name among the last generation of spectroscopists, and few books have in their day fulfilled more adequately an important purpose. Mr. F. Tamblyn-Watts, who was Dr. Watts's assistant for more than thirty years, and to whom have been left the papers which were to have formed the basis of a continuation of the "Index", has decided to publish these papers as they stand, as additional appendices. They contain material up to 1918 relating to some twenty elements and certain of their compounds, and the volume before us is one of the posthumous publications. Those familiar with Watts's "Index"—that is to say, all the older spectroscopists—will need no description of the character of the work.

We cannot but regret that Mr. Watts has ventured to continue the publication of this work. Invaluable as the "Index of Spectra" has been in the past, its work is done. Modern spectroscopy requires something different, and this is being adequately supplied in the seventh volume of Kayser's "Handbuch der Spektroscopie", which is now appearing part by part. The new appendix dealing with the iron spectrum is particularly inopportune, since iron provides the secondary and tertiary standards of wave-length and has accordingly received special attention during the last decade. At the time when the measurements here published were made the importance of 'pole effect' was unknown! Mr. Watts would be well advised to abandon his project, which must inevitably fail to achieve the purpose he has in view.

Handbuch der Spektroscopie. Von Prof. H. Kayser und Prof. H. Konen. Band 7, Lieferung 2. Pp. 499-750. (Leipzig: S. Hirzel, 1931.) 28 goldmarks.

THE seventh volume of Kayser's standard "Handbuch der Spektroscopie" is devoted to bringing up to date the collection of data which vols. 5 and 6 provided for an earlier period. In this great task Prof. Kayser has the collaboration of Prof. Konen, and the first part of the new volume appeared in 1923. It contained data for the elements A to Fe (in alphabetical order of chemical symbols) complete up to 1922. The long interval which has elapsed before the publication of the second part of the volume is due to the magnitude of the task and pressure of other work. The second part now before us treats of the elements Ga to Ir, but includes only data up to 1928. In order so far as possible to preserve homogeneity of the whole volume with respect to the period covered, it is proposed in the third part, which is now nearly ready, to summarise subsequent work on the elements A to Hf up to the time of publication. The remaining parts will then appear as quickly as possible and will be complete to date of issue.

The new part, in which 250 pages are necessary to present the work on ten elements, has the well-known characteristics of this invaluable book, and no description will be necessary. The deep debt of gratitude which spectroscopists have for long owed to Prof. Kayser (and for the present volume to Prof. Konen also) will be increased by this new publication, and the forthcoming parts will be eagerly awaited.

A School Algebra: as far as the Advanced Course in the School Certificate Stage. By A. M. Bozman. Pp. viii + 427 + lxii. (London and Toronto: J. M. Dent and Sons, Ltd., 1931.) 4*s*. 6*d*.

THIS textbook is designed to cover a school course in algebra up to the stage of the advanced papers in school certificate examinations. It is divided into two parts, the first comprising twelve good chapters on the fundamentals, and the second an additional thirteen chapters on the progressions, surds, logarithms, theory of quadratics, graphical solutions, permutations, combinations, and the binomial theorem.

The general plan of the course is well laid out, though the chapter on generalised arithmetic might have come a little earlier. Very commendable features are the changing of the subject of a formula and the graphical treatment of equations. The former is too often inadequately dealt with in many existing textbooks in spite of the fact that a knowledge of the fundamental processes of algebra is demanded, whilst the latter is frequently vitiated by piecemeal treatment, which tends to obscure the real significance of graphical representation. In the present volume these defects have been skilfully remedied; the chapter on graphical solutions being particularly clear and thoroughly sound.

Each chapter contains a good assortment of interesting and well-graded examples, though a few seem rather difficult, for example, Nos. 11 and 13 on p. 251. There are also five sets of excellent revision exercises, the last of which, beginning on p. 413, should be announced in the list of contents on p. vi.

The volume may be favourably commended to all who need a good book on the subject.

Die Schlämmanalyse. Von Dr. Hermann Gessner. (Kolloidforschung in Einzeldarstellungen, herausgegeben von Herbert Freundlich, Band 10.) Pp. x + 244. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 18 gold marks.

MECHANICAL methods of analysis by elutriation, originally applied almost exclusively to soil analysis, are finding increasing value in the examination of many technical products. This book deals with particles ranging from 1 mm. to 0·001 mm. diameter, and is mainly concerned with sedimentation methods, although sieving and air separation are touched upon. The first third of the letterpress treats of the theory of the falling particle; the next third describes the apparatus used, and more than sixty types of sedimentation vessels are figured; the last third shows the practical applications of the methods. With such a host of different types of apparatus, all designed for the same purpose and differing only in detail, it is not easy to appreciate the various advantages and disadvantages. A greater measure of criticism might have been given, and comparison of results obtained with different types would have been instructive. The question of sieves receives rather scant treatment, and standard sieves other than German are not mentioned. Nevertheless, the book forms a worthy addition to the monographs on colloidal subjects of which it is the tenth volume. J. R. NICHOLLS.

The Passivity of Iron.

By U. R. Evans.

IN 1790, James Keir[1] discovered that treatment of iron with nitric acid produces a peculiar condition in which the metal loses its power of precipitating silver from silver nitrate, although retaining its 'metallic splendour'. The behaviour of iron towards nitric acid was further examined by Schönbein[2] and Faraday;[3] Schönbein described the peculiar condition as 'passivity'. Later work has shown that many other oxidising agents render iron passive towards reagents which attack the metal in its ordinary or 'active' condition; reducing agents tend to restore 'activity'. Similarly, anodic treatment may produce passivity, but cathodic treatment usually renders the metal active again. Low temperatures favour continuation of passivity, and high temperatures a return to activity; alkalis are favourable to passivity, and non-oxidising acids to activity. These facts cannot fail to suggest that passivity is due to a protective oxide film.

The objection has been raised that passivity can be produced under conditions where an oxide film would be dissolved. Recent work, however, has shown such statements to be untrue. Furthermore, the oxide films responsible for the principal types of passivity have now been stripped from the metal and studied; although invisible when in optical contact with the bright metal, the films are perfectly visible when lifted from it. Finally, optical methods have been worked out which enable the invisible film to be detected whilst still upon the metal; such methods depend on the manner in which a film affects the character of polarised light reflected at a metallic surface—a subject examined mathematically by Drude.[4] The cause of passivity is therefore no longer in doubt, and the time is appropriate to review the subject.

Passivity due to Nitric Acid.

Dilute nitric acid consumes iron far more rapidly than dilute sulphuric acid; but the concentrated acid produces only a feeble reaction, and even this soon dies away, the iron becoming passive; the iron may then be brought into acid sufficiently dilute to attack active iron, and yet will remain unchanged. It has been alleged that this type of passivity cannot be due to a layer of oxide, which, it is argued, would be destroyed by the acid. In 1928, however, Hedges[5] studied the action of nitric acid on ferric oxide (free from hydroxide), and found that there was practically no dissolution at low temperatures; when the acid was heated, dissolution set in at about 75° C., and this is roughly the temperature at which the passivity of iron, placed in nitric acid, breaks down. Thus, Hedges not only removed the objections to the oxide film view, but also produced new evidence in its favour. I have found it possible to keep flaky ferric oxide in nitric acid for six days without destruction of the flakes.[6] The film formed on iron by concentrated nitric acid is invisible, but, in 1900, Michéli[7] obtained optical evidence of its existence. Moreover, Benedicks and Sederholm[8] have shown that iron placed in dilute nitric acid containing alcohol develops a film which displays a network of cracks on drying; in this special case, therefore, the film becomes visible even when it is still attached to the metal. There is no reason to doubt that the passivity produced by nitric acid is due to an obstructive film of ferric oxide.

Passivity produced by Exposure to Air.

Pilling and Bedworth[9] have divided metals into two classes, according to the relation between the densities of the elements and their oxides. In the first class, the natural volume of the oxide is less than the volume of the metal needed to produce it; here any superficial oxidation will necessarily produce an oxide layer pierced by voids through which oxygen can pass unobstructed to attack the metal below. This class includes most of the lighter metals, such as magnesium and calcium, and it is not surprising to find that those metals 'burn' readily in air. Iron and most other heavy metals belong to the second class. Here, the oxide, when unstressed, occupies a greater volume than the metal contained in it. Consequently, conversion of the surface into oxide will produce a layer free from voids, which is actually in a state of lateral compression.

At ordinary temperatures, such a film, even when very thin, should exclude oxygen from the metal below, and thus the film on iron exposed to dry cold air never attains 'visible thickness'. At slightly elevated temperatures, diffusion of oxygen through the solid film becomes possible, and the film may reach a thickness comparable to the wavelength of light, so that interference tints appear on the metal; at still higher temperatures, a thick greyish scale is produced, which often tends to crack and peel off.

This cracking and peeling is very characteristic of relatively thick films. It is partly attributable to differences in the coefficients of expansion of iron and its oxide; but probably even if produced and held at constant temperature, a thick film would tend to crack more than a thin film. All films formed on heavy metals must possess potential energy due to the state of compression, which energy will be released when the film becomes detached. Thus, the work needed to detach area a of an ideal film of thickness θ will not be less than $aW_A - a\theta P_C$, where W_A is the adhesional work per unit area and P_C the compressional energy per unit volume (work against cohesional forces is neglected, being small for a thin film). When, therefore, the thickness θ is less than W_A/P_C, energy must be expended in stripping the film; but if the thickness is greater than that value, spontaneous peeling is at least not impossible. In the case of scale produced at a red heat, this spontaneous detachment can often be observed microscopically, whilst the ultra-microscopic cracking of films of the interference colour range is inferred from the fact that these films have a far smaller protective action than 'invisible' films, which are too thin to give colours. Electrolytic iron, if freshly abraded, quickly precipitates copper when a drop of dilute copper nitrate solution is placed on the surface. If the iron is exposed to air at ordinary temperatures for some time before the copper nitrate is applied, the deposition of copper does not occur; the time needed for the formation of a film sufficiently continuous for protection is much greater after coarse abrasion than after fine abrasion, doubtless owing to the internal stresses and ultra-microscopic fissures left in the metal in the first case. If the iron is gently warmed in air and cooled again, the passivity towards copper nitrate is produced more quickly than at ordinary temperatures; but if the warming has been conducted at temperatures where interference tints appear, deposition of copper commences, starting at points representing cracks in the film. Thus, if a strip of freshly abraded iron is gently heated for a few seconds at one end (the other end being unheated), cooled and tested with copper nitrate, the iron will usually be found active at the unheated end, where the film is incomplete, and also at the heated end, where it is cracked; but there will generally be a passive region in the gently warmed part in the middle.

There is little doubt that the nitrate itself has some film-repairing action, since copper sulphate usually produces some deposition of copper under analogous conditions. Copper chloride invariably produces instantaneous growth of copper; chlorine ions can penetrate through imperfections which the larger ions cannot pass.[10] Even in copper nitrate the passivity of iron often tends to break down at jagged places. This failure is to be expected; geometrical considerations indicate that, at points of high convex curvature, the metallic atoms will, on oxidation, move outwards to a circle of greater radius, so that the lateral compression already referred to will be abnormally low at these points.

Steel or commercial iron does not attain reliable passivity on exposure to air alone; the junction between dissimilar phases constitutes a place where a protective film is liable to break down. But if steel is treated in a solution of chromic acid or potassium chromate the weak places are brought into repair, and a drop of copper nitrate afterwards produces no action.

In recent papers which I have published,[11] with J. Stockdale, L. C. Bannister, S. C. Britton, and other collaborators, methods are described for isolating oxide films from a metallic basis. All methods depend on an operation, such as immersion in iodine, or anodic treatment in a chloride or sulphate solution, which dissolves the metal just below the oxide film; this allows the oxide film to peel off or to be transferred to glass or cellophane. In the case of some metals, particularly nickel, the films responsible for heat-tints themselves show bright colours after removal. The protective films on iron made passive by exposure to air at low temperatures, being too thin to give colours, are invisible whilst on the bright metallic surface; but they are found to be plainly visible when removed from it. Being thinner than the films from heat-tinted iron, they are, as a whole, more transparent; but since there is more interlocking with the metal when the film is thin, the 'passivity films' show frequent opaque spots due to residual metal. A comparative study of films above and below the limiting thickness needed to produce colour (about 400 A.) has indicated that no sharp change of properties occurs at the limiting thickness, the position of which is merely fixed by the accident that the human eye is insensitive to waves below a certain wave-length.

The thinner (invisible) films have been detected optically whilst still on the metal by Freundlich, Patscheke, and Zocher,[12] whose conclusions agree with the results of the Cambridge experiments in indicating that combination of iron with oxygen occurs rapidly even at room temperature, although the films cease to grow before they reach visible thickness.* A pure iron mirror free from oxide was obtained by heating iron carbonyl vapour in a closed vessel. When air was admitted and quickly pumped out again, an oxide film was left on the metal which could be detected by the polarised light method; simultaneously the mirror became inert to nitric acid of specific gravity 1·4, although similar mirrors not exposed to air were attacked by the acid under identical conditions. The optical change corresponded to a mean film-thickness of about 10 A. The films produced on abraded surfaces at Cambridge are very much thicker, since the abrasion produces a zone of disorganised metal, and the oxygen can penetrate more deeply. These thicker films are actually less protective than the very thin ones; but to the experimenter the thickness is useful, since it allows the film to be removed from the metal.

PASSIVITY PRODUCED BY ANODIC TREATMENT.

The fact that an iron anode becomes passive in an alkaline solution is easily understood on the oxide film view. But anodic passivity can also be produced in a neutral salt solution, or even (if the current density is high enough) in dilute acid. When iron is made the anode in dilute sulphuric acid at a low current density, it passes smoothly into solution as ferrous sulphate. When the initial current density is high, dissolution also occurs normally at first; but later passivity sets in, the dissolution slows down, and the current sinks to a lower value The current, which continues to flow in the passive state (providing the e.m.f. is high enough), is mainly devoted to the production of oxygen gas; the dissolution of iron, although still measurable, becomes very slow.[13]

W. J. Müller [14] has shown that the time needed to produce passivity becomes shorter as the initial current density is increased; he has also demonstrated that passivity never sets in until the liquid layer next to the metal has become saturated with some iron compound; indeed, at this stage the polarising microscope has revealed some solid substance, apparently $FeSO_4,7H_2O$, upon the metallic surface.[15] It is unlikely, however, that a layer of ferrous sulphate is directly responsible for the passivity;[16] for all visible material present on the iron surface peels off or disappears when complete passivity sets in, a circumstance noticed by Hedges.[17] When once oxygen evolution has begun, the metal is clean and bright, and the passivity is certainly due to an invisible oxide film on the surface. This film has recently been detected and measured optically in an important research by Tronstad,[18] who has followed the increase of film thickness under anodic treatment, as well as the diminution under cathodic treatment, in acid, neutral, and alkaline solutions.

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* Some evidence of the very rapid oxidation of iron in air at low temperatures was provided by Faraday in his "Experimental Researches in Electricity", Series XVII. § 2049 (1840). I am indebted to Mr. A. Marshall for directing my attention to this work.

Probably authorities would still differ regarding the details of the anodic reactions. When the iron is active, the discharge of sulphate ions to give ferrous sulphate may conveniently be written thus:

$$SO_4'' + Fe = 2e + FeSO_4.$$

The ferrous sulphate will at first dissolve in the liquid, regenerating SO_4'' ions; but at high-current densities the liquid layer will soon become supersaturated, and solid matter will separate out, covering up most of the surface, and raising the true current density on the small part still uncovered. This may permit the local potential to rise high enough for the inception of alternative reactions, which absorb greater amounts of energy. For example, the discharge of hydroxyl ions, according to the equation

$$2OH' = 2e + H_2O + O$$

becomes quite possible at this stage, since the hydrogen ion concentration of the layer next the anode is now greatly decreased. The oxygen may convert the iron superficially into oxide, which will interfere with further conversion of iron to sulphate; but the major part of the oxygen will stream off as oxygen bubbles, which will dissipate the visible crust of ferrous sulphate or basic salt, and leave only the invisible oxide to protect the metallic surface.

I have investigated the objection that sulphuric acid would dissolve a ferric oxide film,[19] commencing by studying iron covered with a visible ferric oxide film. Iron heated in air to give an early interference tint (caused by a film of 500-800 A. thickness) was cooled and introduced into $M/10$ sulphuric acid; within a second, the film was dissolved away and the colour vanished. The experiment was repeated with iron heated to give thicker films (greater than 2000 A.); here there was some slight attack at first, but the films soon peeled off, and, as soon as the oxide was out of contact with the metal, the dissolution practically ceased; the film flakes could then be collected, washed, and photographed. This shows that sulphuric acid has practically no *direct* action on ferric oxide; the rapid destruction of the film in contact with metal is due to the cell

Iron | Sulphuric Acid | Ferric Oxide

set up at discontinuities; the ferric oxide is the cathode of this short-circuited cell, and becomes reduced to ferrous oxide, which at once dissolves in the acid; it seems that oxides of the type MO are usually much more quickly attacked by acid than those of the type M_2O_3. This explanation is supported by the fact that if chromic acid, a strong oxidising agent, which would prevent the reduction, is added to the dilute sulphuric acid, heat-tinted iron can be kept in the acid mixture for many hours without loss of colour.

Heat-tinted iron was then subjected to anodic treatment in $M/10$ sulphuric acid (the e.m.f. and resistance being such as to provide a current density of 6 amp./dm.^{2} when the iron was active, or 3 amp./dm.^{2} when it was passive). It was found that if the tinted iron was introduced into the acid before the circuit was completed, the colour film was destroyed, and when the current commenced to flow, the iron behaved as an active electrode, passing into solution as ferrous sulphate. But if the circuit was completed before the introduction of the anode, so that the current flowed from the instant of immersion, then the iron was passive from the first moment, and oxygen was evolved, the colour due to the film remaining undestroyed. It was then possible to interrupt the current for a few seconds without destruction of the film; during the interruption a few oxygen bubbles continued to rise from the metal, indicating a residual charge of excess oxygen, which doubtless prevented the local reduction to the quickly soluble ferrous compound. If the circuit was restored before this supercharge of oxygen was exhausted, the iron was still found to be passive, oxygen was again evolved freely, and the colour remained undestroyed. But if the interruption was continued after the bubbles representing the supercharge had ceased to appear, then the oxide film was destroyed by the mechanism already indicated, the colour vanished, and, on restoring the circuit, the iron was active, and dissolved freely without any appearance of oxygen. If the circuit was restored at the precise moment when the film had suffered destruction at some points but not at others, dissolution of the iron commenced at the film-free points, thence extending under the skin, which peeled off in curling flakes. When once these oxide flakes had passed out of contact with the metal, their dissolution ceased.

Experiments conducted on iron which had been exposed, after abrasion, to air at ordinary temperatures showed remarkable analogies with the results obtained on heat-tinted specimens; evidently, the thin invisible films behaved in much the same way as the thicker colour-films. When the current was turned on after the anode entered the acid, the iron was dissolved freely, whereas if the circuit was completed before the introduction of the anode, the iron was usually passive from the moment of immersion, oxygen being evolved from the surface. The current could then be interrupted for a few seconds without destroying the passivity, but if the interruption was prolonged beyond the short period during which the slow stream of oxygen bubbles (representing the supercharge) rose from the metal, then, on restoring the current, the iron behaved as an active anode, and iron passed freely into solution without evolution of oxygen. Special experiments,[20] in which the circuit was restored at a chosen moment when the film was destroyed at certain points but not at others, indicated that it was possible to undermine the invisible film formed during the previous passive period; it peeled off in curling microscopic flakes, which, although mechanically flimsy, were chemically stable in the acid, when once out of contact with metallic iron. Thus the films responsible for anodic passivity, like those responsible for air-passivity, have been stripped from the reflecting basis and rendered visible.

Space does not permit the discussion of several other aspects of anodic passivity, particularly the periodic alternations between the active and passive states which often occur at a range of current densities intermediate between the activity and passivity ranges. For this matter, the reader is referred to the work of Hedges,[21] who has made the subject particularly his own.

CONCLUSIONS.

It is not suggested that all inert metals owe their lack of reactivity to oxide films; metals like gold will react very slowly even when quite free from films. But the important types of passivity in iron are almost certainly due to films of ferric oxide. The facts as known to-day confirm in many respects the porous oxide film theory put forward twenty-five years ago by Haber and Goldschmidt.[22] All iron which has been exposed to air is covered with an oxide film; the essential difference between active iron and passive iron is that on the former the film is in bad repair and on the latter it is in good repair; the degree of initial repair needed to cause a sample of iron to display passivity will vary with the presence or absence of film repairers or penetrating ions in the solution into which it is to be introduced. A ferric oxide film will only resist the action of a non-oxidising acid, for example, dilute sulphuric acid, if a supercharge of oxygen is present to prevent local reduction to the rapidly dissolving lower oxide, or alternatively if an oxidising agent, for example, chromic acid, is also present; where the main acid is itself an oxidising agent, for example, nitric acid, this reduction does not occur.

I am indebted to Dr. L. Tronstad for much information embodied in this article.

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The Voyage of the *Beagle*, 1831–1836.

ON Dec. 27, 1831, H.M.S. *Beagle*, a ten-gun brig, under the command of Capt. FitzRoy, R.N., sailed from Devonport. "The object of the expedition was to complete the survey of Patagonia and Tierra del Fuego, commenced under Capt. King in 1826 to 1830—to survey the shores of Chile, Peru, and of some islands in the Pacific—and to carry a chain of chronometrical measurements round the world." It is well known how FitzRoy proposed to the Hydrographer that "some well-educated and scientific person" should be invited to join the expedition, how Capt. Beaufort wrote to Prof. Peacock, that he in turn consulted Prof. Henslow, who, as FitzRoy writes, "named Mr. Charles Darwin, grandson of Dr. Darwin the poet, as a young man of promising ability, extremely fond of geology, and indeed of all branches of natural history".

The voyage lasted about three months short of five years. The first land touched was St. Jago, one of the Cape de Verd Islands. In the three weeks spent there, Darwin's observations had two most useful results. They showed him "the superiority of Lyell's manner of treating geology" in the first volume of the "Principles", in spite of Henslow's well-meant warning "on no account to accept the views therein advocated". It was there, too, that it "first dawned on me that I might perhaps write a book on the geology of the various countries visited, and this made me thrill with delight. That was a memorable hour to me."

From St. Jago the *Beagle* crossed the Atlantic, by way of the St. Paul's Rocks and Fernando Noronha, to Bahia in Brazil. Nearly three and a half years, from March 1832 to July or August 1835, were spent at various ports on the South American coasts from Bahia southwards to the Falkland Islands and Tierra del Fuego, and then up the west coast to Valparaiso and Callao. From the latter port the *Beagle* sailed westwards, with long stops in the Galapagos Islands, Tahiti, New Zealand, and Australia, then by Keeling Island, with its coral reefs, Mauritius, Cape Town, St. Helena and Ascension, and once more to Bahia, returning to England in the autumn of 1836.

During the long pauses at the various South American ports, Darwin made many an excursion inland. From Bahia Blanca he crossed the Pampas and dug out the remains of "great fossil animals covered with armour like that on the existing armadillos ", a discovery that he notes as one of the beginnings of his views on the origin of species. At Valdivia he felt the great Concepcion earthquake of Feb. 20, 1835, and his accounts of the earthquake in his " Journal " and in his important memoir on the volcanic phenomena of South America read before the Geological Society are among our chief authorities on this great disturbance.* On the west coast of South America, from lat. 45½° to 12° S., he found traces of shelves uplifted at various times to a height, as near Valparaiso, of 1300 feet. It was here also that the whole theory of the origin of coral reefs was thought out before he had seen a single true reef. The intermittent elevation of the South American coast led him to reflect on the effects of subsidence, replacing " in imagination the continued deposition of sediment by the upward growth of corals ".

No part of the voyage had so much effect on his subsequent work, however, as the five weeks spent in the Galapagos archipelago. The chapter on these islands was almost rewritten in the later editions. But there are a few sentences in the first edition, omitted from the others, that are worth reprinting, if only for what was evidently in his mind, though then left unexpressed. " It would be impossible for any one accustomed to the birds of Chile and La Plata to be placed on these islands, and not to feel convinced that he was, as far as the organic world was concerned, on American ground. This similarity in type, between distant islands and continents, while the species are distinct, has scarcely been sufficiently noticed. The circumstance would be explained, according to the views of some authors, by saying that the creative power had acted according to the same law over a wide area " (p. 474). He afterwards reflected " with high satisfaction " on the discovery of these relations; for it was evident, even in those early days, that such facts " could only be explained on the supposition that species gradually become modified ".

The *Beagle* reached Falmouth on Oct. 2, 1836, and, in the following December, Darwin was in Cambridge arranging his collections. At the same time he began writing his " Journal of Travels "; not hard work, he notes, for his MS. journal had been written with care. His chief labour was to make an abstract of his more interesting scientific results. In March 1837 he moved to Great Marlborough Street in London, and the " Journal " seems to have been finished by July, for in August he was unable to leave London as he was busily engaged in correcting the proofs. Possibly it was to celebrate the completion of the MS. that, in July 1837, he opened his " first notebook for facts in relation to the Origin of Species ", a subject on which even then he " had long reflected ".

Even so late as December of the same year there was evidently some idea of mixing the journal up with FitzRoy's, for his future wife then wrote that his sister " wants it to be put altogether by itself in an Appendix " (" Emma Darwin ", vol. 1, p. 274). This was the plan afterwards followed, and it appeared as the third volume of FitzRoy's " Narrative " under the title " Journal and Results ".

The " Journal " was one of the longest of Darwin's books, and it was begun and finished within seven months. This meant that he must usually have written nearly three pages a day. Copies of the proofs were circulated among various friends, for Hooker read Lyell's set before he left on his southern voyage and slept with them underneath his pillow. On the other hand, Dr. Holland thought they were not worth publishing, though " I don't believe ", wrote Darwin's future wife, " he is any judge as to what is amusing or interesting ".

When it did appear there was little doubt as to its reception. The copy that Lyell gave to Hooker became " a well-thumbed copy ", for all the officers in the *Erebus* were borrowing it. The second master of the *Terror* wrote that Darwin had " accomplished what Old Johnson said of Goldsmith when he heard he was going to write a Natural History, ' he will make it as interesting as a Persian tale ' ". Even the historian Sismondi was " found in an ecstasy over the book ". " Notwithstanding his ignorance of natural history he found the greatest interest in it, that it was written with so much feeling, so good, so right a heart."

The " Journal and Results " is in one way unique among Darwin's works. It is the only book of his that was written before he became a permanent invalid. It has all the charm of the health and vigour of youth; on nearly every page it reveals his delightful personality, his humour and never-ending courtesy. It is written in a style that is always fresh and interesting. It has inspired many similar works, and yet it remains, far and away beyond all others, the greatest of our books on scientific travel.

It owes this place no doubt to Darwin's habit of writing up his MS. journal day by day, taking pains to describe carefully and vividly all that he had seen. In after years Darwin often lamented his inability to write a simple sentence. There is no trace of this difficulty in the " Journal ", and page after page might be quoted as models of good clear English. There is one passage at least—the description of Brazilian forest scenery—that seems not altogether unworthy of a master of English prose. " I have said that the plants in a hothouse fail to communicate a just idea of the vegetation, yet I must recur to it. The land is one great wild, untidy, luxuriant hothouse, which nature made for her menagerie, but man has taken possession of it, and has studded it with gay houses and formal gardens. . . . In my last walk, I stopped again and again to gaze on these beauties, and endeavoured to fix for ever in my mind an impression, which at the time I knew, sooner or later must fail. The form of the orange-tree, the cocoa-nut, the palm, the mango, the tree-fern, the banana, will remain clear and separate; but the thousand beauties which unite these into one perfect scene must fade away; yet they will leave, like a tale heard in childhood, a picture full of indistinct, but most beautiful figures " (p. 390).

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* On next April 19 it will be fifty years since Darwin's death, and we are still wanting : (i) a volume reprinting his memoirs (such as that mentioned above) and his other papers not directly reproduced in his books, and (ii) an index to all his works, like that compiled by Cook and Wedderburn for Ruskin's complete works.

The " Journal and Remarks " long survived the two volumes with which it was once connected. In the first three years 1337 copies were sold. A second edition appeared by itself in 1845 as one of the " Home and Colonial Library ". It was then called " Journal of Researches into the Natural History and Geology of the countries visited during the Voyage of H.M.S. 'Beagle', etc." The third edition, with the same title inside, but on the cover " Naturalist's Voyage round the World ", was published by Murray in 1860.* They were thus prepared in the years following the writing of the " Sketch " of 1844 and the appearance of the " Origin ", and they naturally contain more distinct references to his views on the modification of species. It is unnecessary to quote the changes made, for they are fully given in the " Life and Letters " (vol. 2, pp. 1-5). Of these two editions, many thousands of copies were sold—the imprint of 1879 is labelled " fourteenth thousand "—and translations have appeared in French, German, and other languages. In addition to the " Journal ", " The Structure and Distribution of Coral Reefs ", a book that he said " no human being will ever read ", was published in 1842, and a second edition in 1874. " Geological Observations on the Volcanic Islands, etc.", appeared in 1844, and " Geological Observations on South America " in 1846, and a second edition of both in one volume in 1876.

If it were only for these four books—and it was for the work contained in them and the Cirripede volumes that the Copley medal of the Royal Society was awarded to Darwin in 1864—we should be justified in recalling the departure of the *Beagle* a hundred years ago. But a still stronger claim lies in the observations that Darwin made on the Pampas, in the Galapagos Islands, and elsewhere in South America, the discoveries that were the foundation of the long course of reflection and experiment that ended in the " Origin of Species ".

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* In 1901 a new edition was brought out with 15 plates and other illustrations

Obituary.

PROF. CARVETH READ.

PROF. CARVETH READ, whose death occurred on Dec. 6 at Solihull, was born at Falmouth on March 16, 1848. He counted among the contemporary philosophers who have been most influenced by science and scientific ideas. His early logical studies, which found their expression in an essay " On the Theory of Logic " (1878), are marked by what has been considered the Cambridge spirit, which insists on sound method, and is not satisfied with mere divination, even if it turns out to be true. His later well-known treatise, " Logic, Deductive and Inductive " (1898), of which the fourth edition (1914) is definitive, brought to a term his studies on that side.

A more speculative work was " The Metaphysics of Nature " (1905), where Prof. Read anticipates the later phase of thought that brings science and metaphysics into close contact. This phase, as has been pointed out sometimes in our columns, has made the old jokes about the futility of the pursuits of metaphysicians obsolete. To give science itself a firm standing-ground, as Prof. Read showed by setting himself to the task, metaphysical as well as logical distinctions are necessary.

Still, Prof. Read felt the influence of the prejudice, and owned that, " amidst the contempt into which ontology has now fallen it is lonely, wearisome, and depressing to write about it ". With an ironic humour for which he had a gift, he therefore turns in a self-deprecating manner on his own conclusions. These do, however, constitute a real construction, to which, as he has himself noted, Spinoza and Hume have in their different ways especially contributed.

In " Natural and Social Morals " (1909) Prof. Read went on to apply the conclusions arrived at, so far as they are applicable to human life. He had found that in a certain sense, with careful definitions, the world can be called a conscious being; though he also held that the interpretation of Nature, or of history, by final causes seems to lie beyond our power. But while we cannot say that consciousness, as it exists in the human mind, is the end of the universe, yet philosophy, or, to use a more generalised term, culture, is, in the old phrase of the schools, for man the Chief Good.

Evidently, however, theoretical knowledge as an end, whether in philosophy or in any other mode of activity, cannot be so predominant as to exclude all others. " To philosophise is not every man's ruling passion ", though thinkers like Aristotle and Spinoza placed it at the summit. The idealistic conclusion that " consciousness appertains universally to the unconditioned and perdurable Being ", Prof. Read regards as merely " orectic "; it is an effort to conceive rather than a definite conception. No use can be made of it in relation to the knowledge of phenomena. To those the thinker has to come back with only the guidance of scientific method.

Rather in the spirit of Hume, who, after all his subtle inquiries into ultimate questions, turned to something so tangible as history, Prof. Read took up finally as his special subject comparative psychology and the physical and mental evolution of man. The results are partly on record in " The Origin of Man and of his Superstitions " (1920; second edition in two separate volumes, 1925). With such positive scientific studies the years of Prof. Read's retirement from his successive chairs of philosophy and of comparative psychology in the University of London were occupied to the last.

News and Views.

ON Dec. 29 occurs the bicentenary of the death of Brook Taylor, who in his day was considered the most notable British mathematician after Newton, and who counted among his contemporaries Halley, Cotes, Saunderson, Colson and Maclaurin. Born on Aug. 18, 1685, at Edmonton, Middlesex, Taylor entered St. John's College, Cambridge, and in 1701, while there, began a correspondence with Keill of Oxford. He was elected a fellow of the Royal Society in 1712 and from that time onwards he contributed papers to the *Philosophical Transactions*, discussing the motion of projectiles, the centre of oscillation, and the forms taken by liquids when raised by capillarity. In 1715 he published his important work "Methodus Incrementorum Directa et Inversa", the first treatise dealing with the calculus of finite differences. It contained the famous 'Taylor's theorem', the importance of which was, however, not fully realised until pointed out by Lagrange. Taylor also published, in 1715 and 1719 respectively, two works on linear perspective which contained the earliest general enunciation of the principle of vanishing points. In 1714, he became one of the secretaries of the Royal Society, but resigned this post in 1718 and soon afterwards abandoned the study of mathematics. He long suffered from consumption, and he died at Somerset House on Dec. 29, 1731, at the age of forty-six years, two years after succeeding to his father's estate in Kent. He was twice married, his second wife dying in 1730, leaving him a daughter who married Sir William Young. Taylor was buried in the churchyard of St. Anne's, Soho.

AMONG the many vessels of the British Navy connected with the history of scientific exploration, H.M.S. *Beagle* will always be remembered on account of the work of her commanding officer, Capt. Robert FitzRoy, and of his famous guest, Charles Darwin, who, through Prof. Henslow, became FitzRoy's companion during five years. An account of the famous voyage which began on Dec. 27, 1831, appears elsewhere in this issue (p. 1065). FitzRoy had been appointed to the *Beagle* in 1828 at the age of twenty-three years, and already had made surveys of the coasts of Patagonia and Terra del Fuego. Though deeply interested in science himself, FitzRoy could not have foreseen what were to be the fruits of Darwin's studies. Darwin was invariably a sufferer from sea-sickness, the effects of which were felt all his life, yet he remained in the *Beagle* to the end of her voyage. From South America the ship crossed the Pacific, visited New Zealand, Australia, and the Cape, and arrived at Falmouth on Oct. 2, 1836. From the first there was a complete understanding between the commanding officer and his guest, and to FitzRoy is due the geographical names Mount Darwin, Darwin Sound, and Port Darwin. FitzRoy afterwards became governor of New Zealand, but he is also remembered for his work as chief of the Meteorological Office of the Board of Trade, and as a pioneer in the publication of weather forecasts. FitzRoy died in 1865, six years after Darwin's publication of his "Origin of Species", a work which was the direct outcome of Darwin's observations begun on the *Beagle*.

A TABLET has been placed on the house in Egerton Road, Bristol, where he lived for the last twenty-six years of his life, in memory of the late Mr. W. F. Denning, the veteran amateur astronomer and observer of meteors, who died on June 9. The tablet was unveiled on Dec. 18 by Dr. H. Knox-Shaw, president of the Royal Astronomical Society, in the presence of a number of Mr. Denning's relatives and friends. Prof. Lennard-Jones, who was present as the representative of the University of Bristol, referred to the fact that the University had conferred on Mr. Denning the honorary degree of M.Sc., and stated that he was a citizen of whom Bristol might well be proud. Dr. Knox-Shaw, in a short address, bore testimony to the high value set on Mr. Denning's work by his fellow-astronomers, and directed attention to the fact that the observation and study of meteors has of recent years come to be regarded as of much greater importance than in former days, partly owing to the information they afford as to the conditions at great heights in the earth's atmosphere.

DENNING'S catalogue of meteor radiants, published in 1899 in the *Memoirs of the Royal Astronomical Society*, still remains unique of its kind. In the later years of his life he calculated a large number of true meteor paths from observations made by himself and other people, many of whom were induced to cooperate with him by his evident devotion to his subject. He has left in manuscript a book on meteors which it is hoped will soon be published. An indication of the high standard of Denning's work is afforded by a letter which he wrote in the early 'seventies to the Rev. Robert Main, Radcliffe Observer at that time, requesting that the observations of meteors then being carried out at Oxford might be made with greater accuracy. His activities were by no means confined to meteors—he also made a series of valuable observations of the surface markings of the planet Jupiter—but it is because of his work on meteors that Denning's name will live in the foremost rank of English amateur astronomers. Mr. Denning was of an extremely retiring nature, and although he frequently wrote articles for the scientific journals and corresponded with a number of astronomers, he was personally known to only a very few. The inscription on the tablet runs as follows: "William Frederick Denning, F.R.A.S., Hon. M.Sc., Bristol University, and gold medallist of the Royal Astronomical Society, lived here from 1905 till his death on June 9th, 1931, aged 83 years. He discovered five comets and, in 1920, the new star in Cygnus, and was specially distinguished for his lifelong devotion to the observation and study of meteors."

ON Dec. 16 the new ore-dressing laboratory of the Mining Department of the University of Birmingham was opened by Sir Robert Horne. The Department already has a coal-treatment laboratory and a mining-machine laboratory (in which demonstrations of the use of coal-cutting and other machinery used in mines are given to students). This new extension therefore brings the state of equipment of the mining department to a standard probably unequalled in the world. At a luncheon which followed the opening ceremony, Sir Robert Horne insisted that "research, research, and research is the only policy upon which a thriving business can be founded". He believes that our coal industry is so far from being played out that in its future we shall find the renewal of prosperity of our country. There are great opportunities in low temperature carbonisation of coal on one hand and in hydrogenation on the other, and Sir Robert feels certain that scientific research to-day is on the edge of great discoveries. In both of these processes we have come very near to practicable results, and if the experiments which are being fruitfully made by an association of coalmasters in the Birmingham district are not misleading, "we may look forward with confidence to what the future of the coal industry is going to be". Sir Robert also believes that while large liners will keep to the use of oil fuel, a large part of the mercantile fleet will in future be run on pulverised coal.

AT the degree congregation which followed the luncheon, the honorary degree of LL.D. was conferred on Sir Robert Horne and Mr. Evan Williams. In introducing the former, the vice-principal (Prof. E. de Selincourt) said: "A University which believes in knowledge not only as worthy to be pursued for its own sake, but also as the one sure foundation for successful achievement in all branches of human activity, delights to honour those men who, prominent in the larger world of practical affairs, pay willing tribute to the intrinsic value of higher education and the vital importance of scientific research". In introducing Mr. Evan Williams, the vice-principal referred to the special effort which Mr. Williams has made to attract into the coal industry men of a high type: "We at this University hold him in special honour because he has always recognised that the success of the industry he controls depends ultimately on its power to draw into its ranks men of brains and character, who bring to their work no mere smattering of technical knowledge but a wide outlook and a scientifically trained intelligence; and because he has given a timely and practical encouragement to those researches which can only be conducted in the laboratory of the expert investigator".

SIR DANIEL HALL's thoughtful and moving article on "The Faith of a Man of Science" in the December number of the *Nineteenth Century* is a welcome sign of the times. Short as it is, it touches on a number of the deepest questions which are exercising all thinking men, and does it in a sincere and simple way which is the most effective for the purpose. It has often been remarked that the modern conferences of men of science have taken the place for us of the medieval conferences which discussed theology. But, with all their faults, the medieval conferences did go to the root of the matter; they discussed the subjects which at that time men thought the most fundamental. With us the scientific conference tends to be more and more specialist and technical, and we have to look to the individual to tell us what he thinks about first principles. More of them are coming to do this, and we may now add Sir Daniel Hall to the list on which Sir Oliver Lodge, Sir Arthur Eddington, and Prof. Julian Huxley are conspicuous names.

SIR DANIEL is alone among those mentioned in deriving his religion from the study of Berkeley, but in this he agrees with a large number of philosophical thinkers who are returning to Berkeley with added interest and pleasure. He is the fountain of the belief in modern times that the one reality is mind, and it is well known that recent extensions of our view of the universe, so far from dwarfing the mind of the thinker, have given a fresh range to the Berkeleian conception. The side on which one would have wished Sir Daniel Hall to have developed his thought is that of the collective mind, especially as exhibited in the history of science. No individual thinker, least of all the man of science, can expect to evolve a religion, or a coherent view of the whole, from his single consciousness. He needs to keep widening it to embrace the whole thinking process, back to the beginning of thought, and infinite, as it seems to us, in both directions. But it is a process in time, of which, for our own small part, the events are becoming more and more distinctly known.

"ACADEMIC Research and National Dividends" was the very topical alternative title given by Sir Frank Smith, secretary of the Department of Scientific and Industrial Research, to his Gluckstein Memorial Lecture entitled "Chemistry and the Community", delivered at the Institute of Chemistry on Dec. 18. Pure research, he said, has played a large part in the birth and development of most modern industries. Aluminium was exhibited in 1885 as a laboratory curiosity, but now a quarter of a million tons are produced yearly, chiefly by electrolysis, while the rare metals are the basis of many important engineering developments. Physical research on atomic structure and the nature of radiation, perhaps the most outstanding work of the present day, may seem far removed from practical affairs, but already it has given us the wireless valve, which has revolutionised communications, and the gas-filled tungsten lamp, with an efficiency four times that of the old carbon filament lamp. Sir Frank stated that such pure research in the past twenty-five years has led to a saving of not less than a thousand million pounds, and no one can foresee its further possibilities. As an indication of directions in which pure research can render further aid to industry, he mentioned lubrication, distillation of coal, alloys of iron and steel, and vulcanisation of rubber, all familiar subjects industrially but none of them fully understood. Tremendous advances would result from complete knowledge of the mechanism of these processes. The least depressed industries of the present time are those which maintain efficient research services. Work of this kind pays industry handsomely, and pays the community even better.

SOME important facts on the distribution of urban population in Great Britain were noted by Prof. C. B. Fawcett in a lecture to the Royal Geographical Society on Dec. 7. Using the term conurbation for the large urban areas, Prof. Fawcett showed that there are seven of these with a population of more than a million each, and that during the intercensal period 1921–31 the combined population of these areas has increased by 6·5 per cent, while that of the total population of Great Britain has increased by only 4·7 per cent. The population of the thirty next largest urban areas increased by 4·4 per cent, and that of the next thirty-eight towns by only 2·6 per cent. Thus the great conurbations have absorbed a considerable share of the total increase in population during the last decade. Of the total increase, greater London has absorbed about one half and greater Birmingham more than a sixth. Other interesting facts emerged from the county figures. These show that the gain in population is almost entirely confined to the English lowland. The 'highland areas' and the Isles of Man and Wight show actual decrease. The metropolitan area of London and its satellite towns has now a population of about twelve millions.

IN *Mechanical Engineering* for November is a biographical sketch by Mr. and Mrs. H. P. Vowles of Jacob Perkins, who was undoubtedly the pioneer in the use of very high pressure steam. His experiments extended over many years, and between 1820 and 1830 he constructed boilers and engines working at pressures of 800-1400 lb. per sq. in. One of his inventions was the precursor of what to-day is known as the uniflow engine. Perkins was born in Newburyport, Mass., on July 9, 1766, and was apprenticed to a goldsmith. He then turned his attention to the making of dies for copper coinage, machinery for nail making and for bank-note engraving. It was this last which brought him to England. The Bank of England would have nothing to do with Perkins' inventions, but he was successful in other directions and, in his later years, the firm he founded printed the first penny postage stamps. Ventilating and heating, steam-guns, paddle wheels, and other things all engaged Perkins' attention, and in 1826 he read a paper before the Royal Society describing his experiments on the compressibility of water, in which he used pressures up to 2000 atmospheres. As an American, he was regarded with a certain amount of jealousy, and by some was looked upon as a charlatan, but the present paper should remove any doubt as to the value of his work. He died in London on July 30, 1849, at the age of eighty-three years. His second son, Angier March Perkins (1799?–1881), and his grandson, Loftus Perkins (1834–1891), were both well known for their work with high pressure steam and hot water, and the latter was responsible for the machinery of the yacht *Anthracite* which in 1881 crossed the Atlantic fitted with a water-tube boiler with 500-lb. steam pressure. A great grandson, Ludlow Patton Perkins, who died in 1928, carried on the traditions of the family, while the firm of bank-note and stamp engravers, Messrs. Perkins, Bacon and Co., of Southwark Bridge Road, recalls the name of Jacob Perkins himself and of Joshua Bacon, a printer who married his daughter.

MANY engineers ten years ago deprecated the use of aluminium for overhead conductors on the grounds of its comparatively small tensile strength and that its weather-resisting qualities had not yet withstood the test of time. Since then the use of steel-cored aluminium has become almost universal. In this cable, the inner core generally consists of seven strands of galvanised steel wire twisted together, surrounded by a layer of aluminium wires twisted together, which forms a water-tight covering for the core. In this way a mechanically strong and electrically good conducting cable is obtained. The steel core provides the necessary tensile strength, and the aluminium carries most of the current. In the *Electrician* for Nov. 27, E. T. Painton points out the great demand there is for this kind of cable. The five chief factories in Great Britain are manufacturing it at the rate of 150,000 miles of cable per year. A large fraction of this cable is used for the national grid, but much of it is exported. In France the extensions of railway electrification and the development of water-power resources have led to great extensions of the overhead system, the bulk of which is carried out by steel-cored aluminium. In the United States, in Canada, and in Australia many new lines are being erected and the old lines duplicated by this kind of cable. Until its advent, span lengths of 1000 feet were only used in crossing rivers and ravines. It is now quite customary to use 1000-feet span lengths. The distance apart of the lattice towers in the Grampian Supply System varies from 900 ft. to 1300 ft. One of the greatest difficulties the engineer has to overcome is the obtaining of wayleaves, and the fewer towers required the easier it is to get them.

IN the annual report of the North-East Coast Institution of Engineers and Shipbuilders it is stated that the standard and volume of the discussion of papers have been well maintained, and the average attendance has been appreciably higher than for a number of sessions past. The membership roll now stands at 1201; but the Institution has to deplore the loss by death of twenty-four members, among whom are Sir Charles Parsons, Mr. Andrew Laing, Sir Hugh Bell, and Sir Archibald Ross. One interesting note in the report states that, as a result of the efforts of the Institution, the Newcastle-upon-Tyne City Council decided on May 20, 1931, to establish an engineering museum. The president of the Institution for 1931 is Mr. J. McGovern, now holding office for a second year, who delivered his presidential address on October 16. Dealing with the importance of technical knowledge and research, he asked the question whether a central research station controlled by the shipbuilding industries and free from direct government control would not be to the interests of the industries. He would include in the programme not only problems of resistance in air and water, propulsion, stability and rolling, but also investigations on vibration, stresses and deflections at sea, the impartial recording of trials and other problems, the solution of which demand resources not at the service of the majority of private firms. Regarding the best interests of the industry as a whole, "and further, as a general truth, we gain more by conference than by competition". In referring to the use of heavy oil engines in ships, Mr. McGovern spoke of the pioneer work of Akroyd—this, of course, should read 'Akroyd Stuart', 'Akroyd' being Stuart's Christian name.

THE Empire Marketing Board has issued a report, compiled by Sir William Dampier, on "Dairy Research" (E.M.B. No. 44. London: H.M. Stationery Office. 1*s*. net). The subject is dealt with under three headings: (1) What is dairy research, and what is the dividing line between a dairy research institute and other research institutions in the sphere of animal nutrition and diseases, and low temperature research? (2) What is being done in this field? and (3) What extensions are desirable, and to what problems should research be directed? A new system of payment for milk is advocated, on a basis of quality instead of volume. A further study of the detection of adulteration by freezing-point methods is recommended. As the consumption of milk per head of population in Great Britain is low, a publicity scheme for milk would, it is suggested, greatly benefit the industry. Attention is directed to some of the important practical results that have emerged from research work, such as Major Dunkin's test for the detection of Johne's disease; and further problems needing investigation are suggested—for example, the influence of pasteurisation on the vitamins in milk, the keeping and ripening of dairy products, the utilisation of by-products, inheritance of high milk yield, and many others.

Two developmental tendencies in connexion with the bird sanctuaries in the Royal Parks of England are noticeable in the Report for 1930, issued by H.M. Stationery Office. The first and most natural and proper tendency is towards the encouragement of native British birds, for nesting or for shelter and food. This has been brought about through the thinning of undergrowth, the planting of bushes suitable for cover and for their yield of berries, and by the suppression of vermin, amongst which the introduced grey squirrel is reckoned one of the greatest menaces. The most striking natural visitor of the year was a white stork which paid a spring-time call at Richmond Park. The second tendency is making the Royal Park sanctuaries something quite different from a bird sanctuary as generally understood. It is marked by the introduction of various sorts of foreign birds, with the intention that they should establish themslves and multiply. There have been added to the waters of the sanctuaries mandarin ducks, black-billed tree ducks, Baikal teal, Japanese spotbills, and Magellan geese, and in the shrubberies Indian doves, Amherst pheasants, and others—interesting birds all of them, and many beautiful, but a little suggestive of a zoological garden rather than a sanctuary for the encouragement of native birds and bird visitors.

THE sixteenth annual report (1931) of the Experimental and Research Station at Cheshunt, under the direction of Dr. W. F. Bewley, is a record of very varied activities, many of which have considerable general interest. Manurial trials and soil sterilisation trials are reported upon, steam sterilisation proving more successful than formaldehyde in practice, whilst P. H. Williams has continued the determination of the numbers of bacteria in the soil at weekly intervals. The presence of organic nitrogen seems to be the main factor determining the large and rapid fluctuations of bacterial content noted during the season. T. Small has continued the study of the tomato leaf mould, *Cladosporium fulvum*; the freeing from infection of empty greenhouses seems possible by fumigation under certain ideal conditions, but the incidence of the disease in practice obviously provides numerous puzzles, and considerable difficulties seem to stand in the way of its control by fungicide sprays or fumigants under commercial conditions. Interesting experimental results with several virus diseases are described. Attention may perhaps be directed to the frequent isolation of a bacterial organism from necrotic tissues by Bewley and Corbett, and to the simple and very effective methods of experimental inoculation of mosaic disease employed by B. D. Bolas. An ingenious experimental device for the study of soil ventilation described by the latter worker may also prove to have wide applicability, whilst the attempt to use electric light to rear hardy tomato seedlings during the winter months will be of special interest to northern readers.

NORTH country naturalist activity is shown in a very favourable light by the November issue of the *Vasculum* (vol. 17, No. 4). The news of societies reported in its pages shows local societies with an active membership, and with both field and indoor meetings able to supply reports of genuine interest, whilst some of the contributors' notes show how inquiries of very general interest are raised by such meetings. Thus the Darlington and Teesdale Naturalists' Field Club held its fungus foray this year at Dryderdale, and Mr. F. A. Mason, of Leeds, who undertook the task of identification, had as a result a list of 138 species and varieties. This autumn it has been a very general experience in the British Isles that the larger agarics are relatively scarce, but at Dryderdale they were found relatively in abundance. J. B. Nicholson contributes a suggestion based upon the abundance of toadstools in this locality compared with their poor appearance this season in the Darlington district. Usually their relative scarcity this autumn is put down to the poor growth of the mycelium during the inclement summer. Dryderdale is at a higher altitude than Darlington, and is not likely to be appreciably warmer. Mr. Nicholson suggests that a more important factor may have been the good drainage in this locality, and that a reason for the scarcity of such fungi may be, in some cases, the high water-table during the wet summer.

SIMILARLY, the editor of the *Vasculum*, the Rev. J. E. Hull, has a very interesting note, as the result of his collection of spiders during this wet summer, upon a possible association between melanism and humidity. The other articles, beside including valuable new records, as of the mosses, liverworts, and sphagna of South Northumberland, by E. M. Lobley, and upon a new genus and species of feather-mite (*Hirstia chelidonis*, J. E. Hull), also include two papers of considerable general interest. W. K. Richmond discusses the overland migration of wading birds in England, whilst J. E. Hull discusses a very interesting recent French paper by Jacques Denis, upon the spiders found in the coal mines of the north of France. The editor discusses, in charming but critical fashion, and with a recollection of earlier English records, the puzzles of distribution provided by the presence of some of these spiders living and breeding in the depths of the mine. Most of them have probably been introduced in the bark of the timber carried down the mine, but how does a species of *Theridion* arrive and flourish there when its normal habitat is the greenhouse, and it has never been taken in the open air in the north or centre of France ?

WE learn from Science Service, Washington, D.C., that attention is being given to the problem as to whether the yellow fever mosquito and other kinds of similar insects are likely to be carried to the United States through the agency of long-distance aeroplanes. Members of the United States Public Health Service have found that certain types of aeroplanes do carry mosquitoes. Stained examples of the insects were liberated into planes leaving Porto Rico and a certain number were recovered when the machines arrived at Miami, 1250 miles away. Heavy infestation of planes at airports is not considered likely, but even one infected mosquito, of the yellow fever kind, might be the means of starting an epidemic. Considering the small number of these insects that find their way into aircraft, and the facility with which the latter may be freed, it is concluded that while the danger does exist, aeroplanes can be efficiently treated so as to destroy mosquitoes. Air traffic development need not therefore be delayed on this account.

AN interesting institution, known as "La Clinique-Manufacture Internationale", at Leysin, Switzerland, is described by Dr. Rollier, the director of heliotherapy there, in *Bull. Soc. d'Encouragement pour l'Industrie Nat.*, Nos. 7, 8, 9; 1931. This Institute is devoted to sun treatment of cases of surgical tuberculosis, the patients while under treatment being engaged in regular and remunerative work. This is accomplished, for example, by the use of trolleys provided with electric motors and such tools as may be required, which are wheeled to the bed and adjusted to the needs of the particular person. We see depicted in the illustrations, patients in bed, but fully exposed to the sun's rays—basket-maker, sculptor, needle-woman, lace-maker, and mechanics—at work at their crafts ; spinal cases lying in the prone position. The Institute, a fine building looking out to the Dents du Midi, was opened in February last year and has 120 beds.

WE have received from the Ministry of Agriculture and Fisheries a copy of an illustrated Bulletin, No. 29, entitled "Insect Pests and Fungus Diseases of Basket Willows", 1931. Few plants are more subject to insect attacks than are willows and osiers, while fungus diseases are, on the whole, less numerous. This Bulletin describes the principal pests involved, whether they be insect or fungus, and the control measures that are appropriate in each case. It is a publication of definite practical utility, and growers should make use of the information that it brings together. The heaviness of insect infestation is often a serious drawback to osier cultivation, but with the present Bulletin in his hands, the grower should be able to surmount such difficulties. It is priced at 6*d.* net, and is obtainable from His Majesty's Stationery Office, or through any bookseller.

THE Lord President of the Council has appointed Dr. F. S. Sinnatt, M.B.E., to be director of fuel research under the Department of Scientific and Industrial Research.

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1931 to the Institution of Electrical Engineers, has been made by the Council to Dr. M. G. Say, for his paper on "High-Voltage Underground Cables".

THE Council of the Institution of Electrical Engineers has appointed a special technical committee, representative of electrical engineers, medical men, and radiographers, to obtain papers on radiological and electromedical subjects, and to deal with such other matters as may be referred to it by the Council. The aim is to stimulate and foster interest in the electrical engineering aspect of radiology.

IN the autumn issue of the *Fight against Disease*, the quarterly journal of the Research Defence Society, tributes are paid to the late Lord Knutsford, who was chairman of the Society from 1908 until his death. There is also an excellent portrait. Comment is also made upon litigation concerning the Grove-Grady will, under which a sum of approximately £200,000 was to be devoted to the founding of a new antivivisection organisation ; the Court of Appeal held, however, that it was not a valid charitable gift.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A bacteriologist at the Royal Free Hospital and a lecturer in bacteriology at the School of Medicine for Women—The Warden and Secretary, School of Medicine for Women, 8 Hunter Street, W.C.1 (Jan. 8). A Massey scientific research fellow at University College, Nottingham, for research on cancer by physical and chemical methods—The Registrar, University College, Nottingham (Jan. 8). A principal of the Woolwich Polytechnic—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, S.E.18 (Jan. 23). A dean of the British Post-graduate Medical School—The Chairman of the Governing Body, British Post-graduate Medical School, New Public Offices, Whitehall, S.W.1 (Feb. 15). A professor of physics and a professor of botany at University College, Cork—The Secretary, University College, Cork. An assistant to the Editor and Secretary of the Society of Chemical Industry—The President, Society of Chemical Industry, 46 Finsbury Square, E.C.2.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Constitution of the Keratin Molecule.

As a result of a study of the action of acids on wool, it has been possible to identify one of the most important linkages in the keratin molecule. The following is an outline of the argument.

Wool fibres are easier to stretch in acid solution than in water at the isoelectric point, but when they are washed free from acid in running water, they show an almost perfect recovery of the original elastic properties.[1] Nitrous acid is similar to other acids in causing a reduction in the resistance to extension, but its effect on the fibre is incapable of being reversed by prolonged washing in running water. This peculiarity is clearly due to the irreversible conversion of amino groups into hydroxyl groups,[2] and the otherwise similar action of nitrous and other acids on wool suggests that *all* acids react primarily with the free amino groups present.

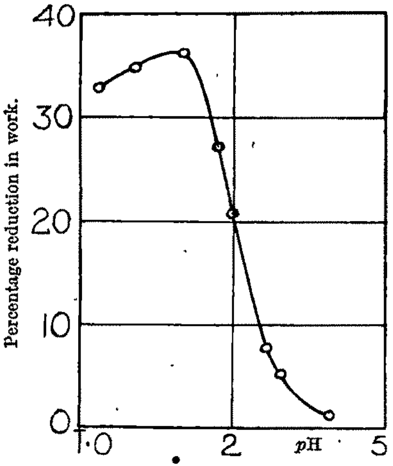

FIG. 1.

The preceding deduction may be substantiated as follows. The reduction in the work required to stretch fibres in hydrochloric acid solutions of varying *p*H has been determined in a manner precisely similar to that described in an earlier communication on sulphuric acid solutions.[3] It is clear from the results, which are reproduced in Fig. 1, that reaction between wool and hydrochloric acid is complete at about *p*H 1, just as in the case of sulphuric acid. Similarly, the removal of hydrochloric acid from solution by wool reaches completion at the same *p*H, as shown by the data of Fig. 2.* If, however, the action of acids on wool is concerned primarily with its free amino groups, then the acid adsorbed by wool at *p*H 1 should be chemically equivalent to its content of free amino nitrogen. From the curve of Fig. 2, it will be seen that 100 gm. of dry wool adsorb about 80 c.c. of *N* hydrochloric acid at *p*H 1, and the percentage of free amino nitrogen in wool must therefore be 14 × 80/1000 = 1·12 per cent. Direct determination of the amount of free amino nitrogen in the Cotswold wool used in these experiments has already given values which range from 0·94 to 1·11 per cent.[4]

The removal of hydrochloric acid from solution by wool must therefore be due to simple chemical combination with free amino groups. If further support for this view should be necessary, it is afforded by the fact that a linear relationship holds between the reduction in the work required to stretch fibres in acid solution and the corresponding amount of acid adsorbed, as shown in Fig. 3. Each molecule of hydrochloric acid combined with wool contributes a definite quantum to the total reduction in the resistance to extension observed in strongly acid solutions. It must, however, be clearly understood that precise relations of this type are not to be expected in the case of acids weaker than hydrochloric, for reasons to be discussed elsewhere.

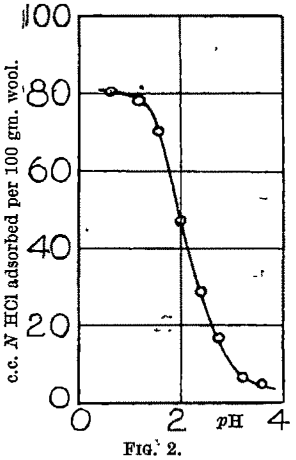

FIG. 2.

So far, it has been shown that acids react with amino groups in wool and, in so doing, make it easier to stretch. It is obvious that stretching could not be facilitated by acid were it not that the amino groups are already combined in some way to form a link which opposes extension. The most probable mode of combination is with a carboxylic acid giving a link of the type: R_1–COO–NH_3–R_2. When wool is immersed in acid solution, the carboxyl group is displaced by the external acid, the link is opened and extension of the fibre facilitated. Assuming such a link as the above to exist in wool, its position with regard to the fibre structure may be deduced as follows.

Studies of the structure of the wool fibre by the methods of physical chemistry [5, 1] and X-ray analysis [6, 7, 8] have shown conclusively that the fibre is constructed from long-chain protein molecules arranged parallel to its length. X-ray analysis indicates that these chains are simply peptide chains folded into a series of hexagons, but the precise nature of the side linkages between them has remained undetermined.[7] The suggested linkage of the type: R_1–COO–NH_3–R_2 must be one of these linkages, because wool fibres, on treatment with acid, show only a negligible change in length (which may be a contraction), whereas the increase in cross-sectional area is always considerable and may, with acids like formic acid, attain a value as high as 125 per cent.[1] Thus the linkage opened by acid must lie between the long-chain protein molecules from which the fibre is constructed.

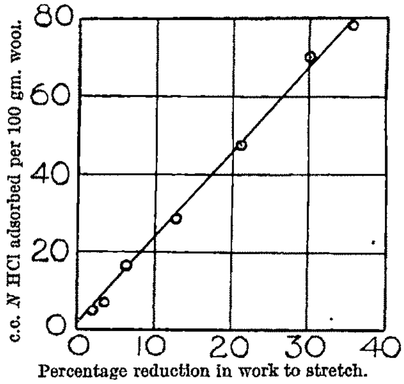

FIG. 3.

Proof that the suggested linkage really occurs in wool, and more exact details of its nature, may be obtained as follows. Such a linkage can be formed only from diamino and dicarboxylic acids. The diamino acids available for the purpose are arginine and lysine, which, according to Marston,[9] are present in wool to the extent of 10·2 per cent and 2·8 per cent respectively. If, as must be the case, one of the two amino groups of each acid forms an integral part of the long peptide chains, the arginine and lysine would together account for 1·09 per cent by weight of free amino nitrogen in wool. Thus the whole of the arginine and lysine present must be involved in the linkage under discussion. The dicarboxylic acids available for combination with arginine and lysine are glutamic and aspartic acids. In each case, one carboxyl group would form an integral part of the long peptide chains, the other being combined in the side link with the amino group of arginine or lysine.

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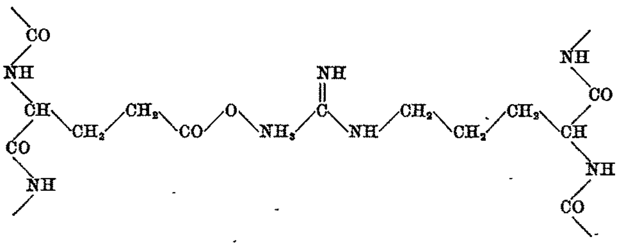
* These figures are taken from a hitherto unpublished investigation carried out in conjunction with Mr. A. E. Battye in 1925. Recent research has provided an explanation of the anomalies then observed in the adsorption of different acids by wool.

Using Marston's data, the arginine and lysine are together equivalent to an amount of glutamic acid equal to 11·4 per cent by weight of the wool, and the amount present is 12·9 per cent.[10] The aspartic acid content of wool is small and of the order of 2·3 per cent. In view of the varying difficulty of estimating the different products of protein hydrolysis, the equivalence between the arginine and lysine content of wool and its glutamic and aspartic acid content is surprisingly precise. Thus the main link between the long-chain peptide molecules of wool will be a salt of glutamic acid and arginine, with the occasional replacement of glutamic acid by aspartic acid and of arginine by lysine. The precise nature of the link is given in the following formula, glutamic acid and arginine being taken as typical units :



According to this formula, the distance between the long peptide chains will be of the order of 14 × 1·25 = 17·5 A., whereas when aspartic acid and lysine form the link, the distance will be about 12 × 1·25 = 15·0 A. The corresponding spacing in the X-ray photograph of wool must therefore be of the same order as these values, or a multiple of them, but precise agreement should not be expected, because the side link may not be at right angles to the peptide chains. One of the two chief side spacings observed by Astbury[6] is, however, of the order of 27 A., almost double the calculated value. Further, according to Astbury, the reflections characterising this spacing are of the very diffuse type required by the occasional replacement of glutamic acid by aspartic acid and of arginine by lysine.

Evidence in favour of the suggested linkage is, however, not limited to calculations and coincidences of this kind. When a wool fibre is stretched, Astbury has shown that the reflections typical of the 27 A. spacing disappear, and from his model of the 'keratin complex' it is clear that the side link under discussion must rotate through an angle of at least 109° 28′.[8] Such rotation is clearly impossible unless the side linkage is opened at the $-COO-NH_3-$ group. In other words, when a wool fibre is stretched in water, work has to be done in opening the $-COO-NH_3-$ groups, the smaller resistance to extension in acid solution being due to the fact that these groups are already opened by acid before extension commences. Thus the difference between the work required to stretch fibres in, say, $N/10$ hydrochloric acid and in distilled water is a measure of the heat of formation of the $-COO-NH_3-$ linkage from free acid and base. The actual value for the reduction in the work required to stretch fibres 30 per cent of their length in $N/10$ hydrochloric acid, compared with that required in water at the isoelectric point, is $3·86 \times 10^7$ ergs, or 0·923 calorie per gram of wool. But 100 gm. of wool combine with 80 c.c. of N hydrochloric acid at pH 1, so that the reduction in the work to stretch fibres, corresponding with the adsorption of one gram molecule of hydrochloric acid, is $92·3 \times 1000/80 = 1·15 \times 10^3$ calories. This value is in close agreement with that for the neutralisation of the weak acid hydrogen cyanide by the weak base ammonia, namely, $1·3 \times 10^3$ calories per gram molecule of base.[11]

The cumulative evidence presented in this note is such as to leave no doubt that one of the linkages between the long peptide chains in the keratin molecule is a salt of glutamic acid and arginine, qualified by the fact that glutamic acid may occasionally be replaced by aspartic acid and arginine by lysine.

In conclusion, we wish to express our indebtedness to the Government Grant Committee of the Royal Society and to the Clothworkers' Company of London, for grants in aid of the present investigation.

J. B. SPEAKMAN.
MERCIA C. HIRST.
Textile Chemistry Laboratory,
The University, Leeds,
Oct. 19.

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[1] Speakman, *Proc. Roy. Soc*, A, 132, 167 ; 1931.
[2] Meunier and Rey, *Compt. rend.*, 184, 285 ; 1927.
[3] Speakman and Hirst, NATURE, 127, 665, May 2, 1931.
[4] Speakman, *Jour. Soc. Chem. Ind.*, 50, 17 T ; 1931.
[5] Speakman, *Jour. Soc. Chem. Ind*, 49, 209 T ; 1930.
[6] Astbury, *Phil. Trans.*, 230, 75 ; 1930.
[7] Astbury and Woods, NATURE, 126, 913, Dec. 13, 1930.
[8] Astbury, *Jour. Text. Science*, 4, 1 ; 1931 : *Jour. Text. Inst.*, 22, 1931 ; in the press.
[9] Marston, Council of Sci. and Ind. Res., Commonwealth of Australia, *Bulletin* 38 ; 1928.
[10] Barker, "Wool : A Study of the Fibre", p. 36 : H.M.S.O., 1929.
[11] Berthelot, *Ann. der Chim. et der Phys.* ; 1878.

Chinese Alchemy.

IN the supplementary volume of his "Entstehung und Ausbreitung der Alchemie" (1931, p. 17), Prof. E. O. von Lippmann refers to my note on Chinese alchemy,[1] and since he appears to assume that in these matters silence gives consent (see his work, p. 40), it seems necessary to make some reply to his statements. He had adopted in the first volume of his book (1919, 449 ff.) the thesis of Berthelot that alchemy in China was transmitted through the Arabs, and this view, which is not held, so far as I am aware, by any competent authority at present, he maintains in the new volume. The sources of his information in both volumes are considerably removed from the originals, and for this reason he has probably not noticed that they are almost entirely based on the important paper by Edkins, which he refers to as 'old'. He directs attention to a review by Laufer[2] of Johnson's "Study of Chinese Alchemy" (also largely based on Edkins's paper) as in some way representing 'modern' opinion on the matter. In this review Laufer makes no contribution to the subject, merely referring to Maspero's 'critical work' on China.[3] Maspero, however, does not mention alchemy beyond a vague remark that it probably reached China from India in the third century A.D., a thesis which is not at all in agreement with Prof. Lippmann's. An Arabic origin of Chinese alchemy seems to me improbable on several grounds. In addition to those already given, I may refer to the statement of Al Nadim in the "Fihrist",[4] which shows that, even in the early period (A.D. X cent.) of the study of Arabic alchemy, an Indian or Chinese origin was considered possible. Another fact which seems to speak against an Arabic origin of Chinese alchemy is that its study was almost entirely confined to Buddhist circles, both in India and China.

A further statement made by Prof. Lippmann, to the effect that Stapleton, Husain, and Azo support an Arabic origin of Chinese alchemy, is incorrect, as will be seen by referring to the publication of these authors, or to my summary of it.[5] A similar inversion of the views of these authors appears in Prof. Lippmann's account of Indian alchemy,[6] and many such examples of lack of care in quoting authorities could be given from both his volumes. That an unfamiliarity with a foreign language might be the cause does not seem to be a satisfactory explanation, since the same course is taken with publications in German (see, for example, the reference to Hammer-Jensen's work on p. 9, and the very serious error with respect to Roger Bacon on p. 53, ref. 2).

The difficulty about quoting 'authorities' in the way adopted by Prof. Lippmann is that almost any view may be supported by a suitable choice of authority. An example in my own experience may serve to illustrate this, since an eminent authority on China referred me to a recent paper on Chinese alchemy in which it was asserted that alchemy began in China in 1100 B.C., that the Chinese had a theory of phlogiston several centuries before Becher and Stahl, and that glass was made in China in prehistoric times. Most of the publications on Chinese alchemy merely repeat what was collected by Edkins; although Wieger's great treatise on Taoism[7] gives a list of more than a hundred and fifty Chinese treatises on alchemy, not one of these has been critically examined or translated. A beginning in this study, the necessity of which was pointed out in my original notes,[1] has been made by Prof. T. L. Davis with the assistance of a native scholar, and since he has been fortunate enough to enlist sympathy in a region where I personally found none, we may expect some real additions to knowledge. The purpose of this note is mainly to indicate the doubtful value of a source of information which may be quoted as authoritative, and to the necessity of preserving a perfectly open mind on the question. J. R. PARTINGTON.

81 Barn Hill,
Wembley, Middlesex.

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[1] NATURE, **119**, 11; 1927: see also *ibid.*, **120**, 158, 878; 1928—which are not mentioned by Lippmann.
[2] *Isis*, **12**, 330; 1929.
[3] "La Chine antique", Paris, 1927.
[4] Berthelot, "Chimie au moyen âge", vol. 3, p. 40.
[5] NATURE, **120**, 158, 242; 1927.
[6] *Alchemie*, **2**, 23.
[7] Vol. 1, 1911.

New Yields from the Oldoway Bone Beds, Tanganyika Territory.

IN NATURE for Oct. 24, 1931, a letter from us was published giving the first results of our work at Oldoway in Tanganyika Territory; we should be grateful if the following additional results could be recorded:

(1) Bed No. 1, the lowest bed in the Oldoway series, has now yielded an extensive fauna which includes *Deinotherium* sp., *Hipparion* sp., and also *Elephas* (*antiqus recki* ?). The *Deinotherium* cannot be regarded as a derived fossil, since five complete teeth were found amongst a partially articulated skeleton. In Bed 1, at two different sites, we have found artefacts of a Pre-Chellean type actually with *Deinotherium*.

(2) Bed No. 2, at its base, contains tools of an early Chellean type of large size, and in its upper part, at the same horizon as the human skeleton found by Reck in 1913, tools of a more advanced Chellean type. Thus *Homo sapiens* is shown to be the contemporary, and presumably the maker, of an advanced Chellean type of culture. The fauna includes *Hipparion* and *Elephas antiqus recki*.

(3) Bed No. 3 has yielded a series of tools which may be regarded as transitional from the Chellean to the Acheulean stage of culture development.

(4) Bed No. 4, in its lower part, has yielded a big series of tools of an early Acheulean type, whilst in its higher levels we have found an old open station site which has yielded more than 500 perfect advanced Acheulean type tools. Even Bed No. 4 includes in its fauna *Elephas antiqus recki*, *Hipparion*, *Pelorovis*, *Hippopotamus gorgops*, and *Equus* sp., and we know, from the results of the material obtained by Reck in 1913, that more than fifty per cent of the species are extinct.

(5) Bed No. 5 overlies the other four beds unconformably and is separated from them by a long period of earth movement and erosion. At two sites in bed No. 5 we have found tools of an upper Kenya Aurignacian type.

(6) In view of the evidence of the fauna, and also in view of the fact that we have in beds Nos. 1 to 4 the gradual evolution from a Pre-Chellean type of culture to a developed Acheulean, we incline to the view that this part of the Oldoway series represents the lower and middle Pleistocene, a period which Leakey and Solomon have shown to be represented in Kenya by Gregory's Kamasian series.

L. S. B. LEAKEY.
ARTHUR T. HOPWOOD.
HANS RECK.

East African Archæological Expedition,
Nov. 30, 1931.

Latency of Seedlings in some Grasses.

EXPERIMENTS at this Station have shown that when seeds of *Lolium italicum* are sown in the field together with those of certain other grasses (notably *Festuca pratensis*, *Phleum pratense*, and *Poa trivialis*), the early establishment of the latter may be considerably diminished as compared with that occurring in the absence of the rye-grass. Some months after sowing, an increase in the establishment of the same grasses is often shown. In seeking an explanation of this behaviour, a peculiar property of grass seedlings has been revealed.

Under certain conditions, when seeds of *F. pratensis*, *P. pratense*, and *P. trivialis* are sown between plants of *L. italicum*, the seedlings which result develop with extreme slowness, and after several months are no larger in size than is normally the case two weeks after germination. Such seedlings, growing in the open under conditions of low mineral nutrition and poor illumination, have been found to be remarkably persistent. The mortality in seedlings of *F. pratensis* has been after 10 months 29 per cent; in seedlings of *P. pratense*, 3 per cent after 4 months; and in those of *P. trivialis*, 4 per cent after 3 months; a high proportion of the seedlings of each species has remained alive for much longer periods.

In each case, the seedlings proved capable of normal development when transferred to a favourable environment.

There is no reason to suppose that this behaviour is peculiar to these species only of grasses, and its importance to agricultural practice is obvious. It would also seem probable that the ability of seedlings to persist for long periods in an environment unfavourable to growth and to develop normally afterwards must be an important factor in competition under feral conditions. In the colonisation of denuded areas, for example, its effect would be to increase the chances of establishment of species the seeds of which germinate slowly, and in the invasion by alien species of areas already occupied by other plants (especially when this is a consequence of the grazing, and other activities, of animals) the value to any species of this behaviour in the seedling stage would also seem clear. In this connexion it would be extremely interesting to know if a similar phenomenon is shown by the seedlings of any dicotyledonous plants.

H. G. CHIPPINDALE.

Welsh Plant Breeding Station,
Aberystwyth, Dec. 7.

Zeeman Effect of a Forbidden Line.

THE Zeeman effect is one of the most powerful methods of finding the causes of the occurrence of forbidden lines. The selection rules which govern it are quite different for ordinary lines, for quadripole lines, and for lines the appearance of which is due to external electric fields.

Quite recently the Zeeman effect of quadripole lines has been experimentally investigated. We have now been able to obtain the Zeeman effect of a line which shows the characteristic features of a line due to the random electric fields of the discharge, for example, the components with $\Delta m = 0$ are observable in the transverse direction as σ- and π-components.

The mercury line $6\,{}^3P_2 - 7\,{}^3P_2$ $\lambda = 3680$ A., which is forbidden by the selection rule for the azimuthal quantum number, was investigated in a magnetic field of about 12,000 gauss. As light source an arc in vacuum was used.

If this line was due to quadripole radiation, its Zeeman pattern would have been of the type $\frac{(3)\ 6}{2}$, with all the components of equal intensity as shown in Fig. 1. Assuming an electric field distributed at random, the type can be calculated by means of the Schrödinger perturbation theory (we are indebted to Dr. E. Majorana for this calculation), and one obtains the pattern of Fig. 2 of the type $\frac{(0)\ (3)\ 0\ 3\ 6}{2}$. (The numbers in the figure denote the calculated intensities of the components.)

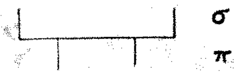


FIG. 1.

Moreover, we should expect that the line would be rather diffuse owing to the rapid variability of the electric fields, due to the ions which are present in the discharge and to the Stark effect shift.

What we actually observed without field was a rather diffuse line. In the magnetic field the line showed little alteration, but became a little broader, especially in π-polarisation.

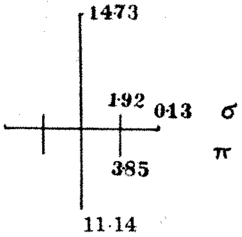


FIG. 2.

The diffusion was real because the Zeeman pattern of other lines on the same plate, for example, $\lambda = 3662{\cdot}88$ $6\,{}^3P_2 - 6\,{}^3D_1$ of mercury, Zeeman pattern $\frac{(0)\ (2)\ 1\ 3\ 5}{2}$, were resolved. Anyhow, from our photographs we conclude that the Zeeman pattern was a centred one both in π- and σ-polarisation. If the Zeeman type had been as in Fig. 1, corresponding to quadripole radiation, we should undoubtedly have seen a non-centred type and probably should have resolved components separated by 3 and 6 normal units, even with a line originally so diffuse, if they had occurred.

Moreover, the broadening of the π-components is a confirmation of our interpretation, because, as shown in Fig. 2, the lateral components in π-polarisation are in the same position as, but double the intensity of, those in σ-polarisation.

We hope to repeat the experiment with a stronger magnetic field.

We are indebted to Prof. P. Zeeman for his interest and advice in connexion with this investigation.

E. SEGRÈ.
C. J. BAKKER.

Laboratory "Physica" of the
University, Amsterdam.

Neon-Helium Bands.

IN the course of some experiments on the spectrum of the negative glow, some bands near 4000 A. were observed in the negative glow of neon-helium mixtures. The definite experiments were carried out in the following way.

Two glow lamps (nickel plate cathode, ring anode) were joined by a glass tube; in the tube was a small glass bulb which separated the gases from another, and the bulb could be shattered by a small iron ball. One glow lamp was filled (after degassing) with neon and the other with helium, both at a pressure of 6 mm. of mercury. Spectrograms were taken of the two negative glows with a small glass spectrograph, Fig. 1.

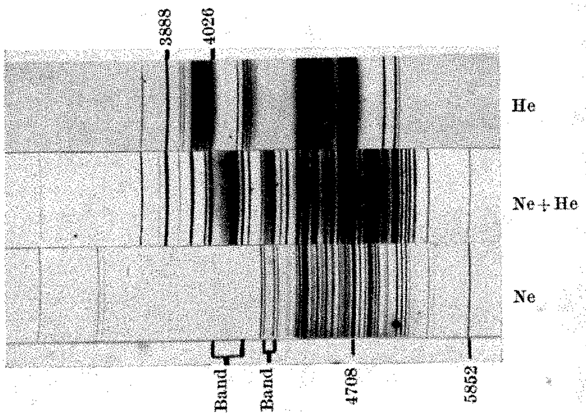


FIG. 1.

In the neon glow the neon arc- and spark-lines were observed, in the helium glow the helium lines and the He_2-bands were present. Then the small glass bulb was shattered, so that the gases were mixed and a new spectrogram was taken. The He_2-bands had now disappeared, but besides the neon and helium lines two bands were observed, the stronger one between the helium lines 4026 and 4121, the other one between 4219 and 4276. Although the bands could not be resolved, it seems very improbable that they would coincide with He_2-bands. The most probable explanation seems that the bands are to be attributed to a compound of neon and helium, such as Ne-He.

Prof. Coster in Groningen was so kind as to take some spectrograms of these bands with a grating; on some plates the bands were partly resolved, but the intensity was too low to photograph the lines with greater dispersion. To obtain a greater intensity I looked for these bands in a direct current positive column in a neon-helium mixture, but I did not obtain the bands.[1] Maybe this can be attributed to the fact that in the negative glow a great velocity range of electrons is present, while in the positive column studied the electronic velocity was too low. In the negative glow the bands disappeared when 10 per cent argon was added to the neon-helium mixture. The bands did not change when the lamp was cooled with liquid air.

M. J. DRUYVESTEYN.

Natuurkundig Laboratorium der
N. V. Philips' Gloeilampenfabrieken,
Eindhoven, Holland.

[1] W. Weizel, *Zeit. für Phys.*, **51**, 328; 1929.

The Study of Specific Combination in Immunity Reactions.

IT can scarcely be denied that up to the present the study of immunity reactions has been especially difficult owing to current theories being most vague and conflicting. As a result much of the work done has shown a lack of method and definite line of attack. It seemed to us that if a reaction, in which at any rate one of the reacting substances was a definite chemical compound, could be studied, this would form a sound basis for further investigation. This we have attempted to do.

The work of Landsteiner and others [1] affords strong evidence that in certain precipitin reactions the first stage of the reaction is the combination of antibody with definite chemical groups in the antigen. This work has shown (1) that the sera of rabbits immunised with a protein to which one of various chemical groups has been attached will give a precipitate with any protein to which this group has been attached, and (2) the simple substances (haptenes) containing the active chemical group, although they do not give a precipitate with the serum, when added in excess inhibit the formation of a precipitate by serum and protein containing the active group. Presumably there are two stages in such a precipitin reaction: first a specific combination of chemical groups with antibody, and second a molecular rearrangement, leading to precipitation, which does not take place unless these groups are attached to protein. This suggests a method of simplifying the study of immunity reactions by confining the investigation to the first stage and using as one of the reacting substances a haptene, that is, a chemical compound of known composition.

Since the haptenes will pass through a collodion membrane and the antibodies will not, it is possible to measure the concentration of free haptene in a mixture of haptene and antibody by dialysis. Non-static methods such as the ultracentrifuge and ultrafilter would not be sound, as the amount of haptene bound by antibody may vary with the antibody concentration, and water probably passes through a membrane faster than the haptenes. Using a small dialysing apparatus so designed that the concentration of haptene in the antibody-free fluid could be measured photometrically without its removal, we have been able to demonstrate the specific combination of antibody with haptene. We used *p*-aminobenzene arsinic acid (atoxyl) as the active group; this was diazotised and coupled with horse serum-pseudoglobulin to form the antigen, and with tyrosin to form the haptene.

Using a solution of haptene approximately $M/25,000$, the ratio of haptene bound by globulin prepared from immune sera to that remaining free was approximately 2/1. We used, as control, globulin from normal rabbit serum and globulin from immune serum from which the antibody had been removed by precipitation with excess of antigen; with these the ratio of bound to free haptene was approximately 1/6. We were not dealing simply with an increased power of adsorbing azo-dyes, since *o*-carboxybenzene-azo-dimethylaniline (methyl red) was not adsorbed any more by immune serum globulins than by normal globulin. On the other hand, atoxyl diazotised and coupled with *p*-cresol behaved in the same way as the tyrosin compound. This direct method therefore confirmed Landsteiner's supposition that haptenes combine specifically with antibodies.

We hope so to improve this method as to obtain accurate measurements of the amount combined under varying conditions. Such specific combinations may be involved in many biological processes and certainly are essential to enzyme action. Hitherto the methods of their study have been limited. In the case of enzymes direct methods have not been suitable for quantitative work and kinetic methods involve considerable assumptions.

Evidence has accumulated of recent years that antibodies are modified serum globulins. It may be hoped that, with increasing knowledge of the nature of the combination between haptenes and antibodies, it will be possible to correlate this process and the further stages of immunity reactions with theories of protein structure such as have been outlined in recent letters to NATURE.[2]

J. R. MARRACK.
F. CAMPBELL SMITH.

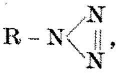
Hale Clinical Laboratory,
London Hospital,
E.1.

[1] K. Landsteiner and H. Lampl, *Biochem. Z.*, **86**, 343; 1918. K. Landsteiner, *Biochem. Z.*, **104**, 280; 1920.

[2] C. Rimington, NATURE, **127**, 440; 1931. W. T. Astbury and H. J. Woods, NATURE, **127**, 665; 1931.

Structure of the Azides.

WE have just seen Dr. Sutton's communication on the "Structure of the Azides, from their Electric Dipole Moments".[1] We also have measured the dipole moments of phenylazide, *p*-chlorphenylazide, and *p*-bromphenylazide and found the values 1·55, 0·47, and 0·64 × 10^{-18} e.s.u., respectively, in good agreement with Dr. Sutton's data. We believe that the moments for the two halogeno-compounds are really zero or very small, because we must neglect their atomic polarisation. The moment of the molecule is, therefore, the vectorial sum of the moments of the substituents.

Dr. Sutton considers his measurements as evidence in favour of the cyclic structure of the azide-group , because in that formula the moment-vector coincides with the R – N linking, and, indeed, the parachor measurements of Lindemann and Thiele [2] are in harmony with his conclusion. But we cannot agree with this. A short time ago, L. Pauling [3] determined exactly the crystal structure of potassium azide. The data given by him show that the three nitrogen atoms lie on a straight line.

It seems, therefore, possible that any 'open-chained' formula for the azide-group may hold true. We can accept that the argument of Dr. Sutton in terms of the octet theory for ruling out the classical formula $R - N = N \equiv N$—the central nitrogen atom would have a shared decet—is not decisive, because the octet rule of valency electrons seems not to be a comprehensive law (compare the existence of sulphur hexafluoride, etc.). Probably also the formula $R - N = N \xrightarrow{} N$ is valid because the angles between the links in an azide molecule are very uncertain. The dipole measurements by no means contradict the assumption that the three nitrogen atoms lie on a straight line; the data given by Pauling seem to prove it.

With regard to the very interesting work of Lindemann and Thiele, it seems that the parachor measurements do not give a definitive structural proof,[4] because in the series of the aliphatic diazo-compounds very closely related to the azides there is a discrepancy between the parachor measurements and the chemical evidence. The former evidence [5] is in favour of the cyclic structure, but such a structure is unable to account for the existence of optically active diazo-compounds.[6] Also, the assumption of an equilibrium between the cyclic and the open-chained molecules is not in harmony with the observed optical properties of the compounds cited.[7]

ERNST BERGMANN.
W. SCHÜTZ.

Chemical Institute of the University,
Berlin, Nov. 15.

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[1] NATURE, **128**, 639, Oct. 10, 1931.

[2] *Ber.*, **61**, 1529; 1928.

[3] *Zeit. physik. Chem.* (B) **8**, 326; 1930. *Jour. Am. Chem. Soc.*, **47**, 2904; 1925.

[4] E. Bergmann, L. Engel, and Stefan Sándor, *Zeit. physik. Chem.* (B) **10**, 403; 1930.

[5] Lindemann, Wolter, and Groger, *Ber.*, **63**, 702; 1930. Lindemann, *Ber.*, **63**, 1246; 1930. Compare Sidgwick, *Jour. Chem. Soc.*, 1108; 1929.

[6] Levene and Mikeska, *Jour. Biol. Chem.*, **45**, 592; 1920: **52**, 485; 1922: **55**, 795; 1923. Noyes and co-workers, *Jour. Am. Chem. Soc.*, **44**, 1798; 1922: **48**, 2404; 1926.

[7] Compare K.v. Auwers, *Ber.*, **63**, 1242; 1930.

A Two-Dimensional Space Lattice?

AFTER reading the letter from Dr. R. C. Menzies in NATURE of Nov. 28, I wrote to him stating what I believe to be the cause of the orientation of the growing crystals at the liquid surface, and it is at his suggestion (letter dated Nov. 30) that I submit this note for publication.

The explanation probably lies in the convection currents set up by the growing crystals. When a crystal is floating by surface tension forces at the surface of the solution, some of the molecules of solute in the neighbourhood will be deposited on the crystal and this will decrease the density of the solution in the immediate vicinity. The crystals are thus centres of local rising currents and will therefore mutually repel each other, since the currents must spread out sideways on reaching the liquid surface. Crystals of the same size will exert the same lateral forces and must take up the close-packed hexagonal arrangement shown in the photograph. Larger crystals may be expected to exert greater forces than smaller ones, so that a swarm of large crystals will have a greater spacing than a swarm of smaller crystals when both swarms are floating in the same liquid surface; this is very apparent in a second photograph sent to me by Dr. Menzies. The effect may break up owing to (*a*) the sinking of the crystals, (*b*) the crystals growing sufficiently large to touch and unite, or (*c*) as Dr. Menzies has pointed out to me, the reaching of equilibrium between crystals and solution, when the surface currents must cease.

I have noticed the same structure in the crystallisation of a number of organic compounds, though in a much less perfect form. Substances which readily separate from hot solution in compact crystals usually give the lattice effect to a greater or lesser degree, though failing spontaneous crystallisation it is necessary to drop a little of the finely powdered substance on the surface. The phenomenon is shown somewhat feebly by 4-nitropyrogallol 1:2-dimethyl ether crystallising from alcohol, and by 4-iodopyrogallol trimethyl ether separating from light petroleum. Undoubtedly the spontaneous crystallisation and great density of the thallium derivative are responsible for the unique perfection of the case described by Dr. Menzies.

W. BAKER.

The Dyson Perrins Laboratory,
Oxford, Dec. 4.

The Tertiary Wall of Wood Fibres.

IN addition to the primary and secondary walls of the fibres of the secondary xylem of angiosperms, a third inner wall is not infrequently present. This layer is commonly known as the tertiary wall, and so far little is known of its exact nature or function. The distribution of the tertiary fibre walls in trees suggests, however, that their formation is influenced by environmental conditions, and may therefore admit of a certain amount of control.

A recent study of the occurrence of tertiary fibre walls in the wood of elm [1] led to the conclusion that these layers add to the specific gravity of wood without contributing a proportional increase to its mechanical strength. A study of the moisture relations of wood the fibres of which contain tertiary walls was undertaken to examine the commonly quoted statement that these structures influence the hygroscopicity of wood and "prevent undue shrinking and swelling".[2] Fifteen carefully matched pairs of wood specimens from several trees of *Robinia Pseudacacia* L. and of *Ulmus campestris* L. were selected, so that tertiary fibre walls were present in one member of each pair and absent from the other. Comparison of these samples revealed no difference in behaviour that could be attributed to the presence of tertiary fibre walls, either in the total shrinkage of the wood from the green to the oven-dry condition or within any shorter intermediate range of moisture content. It is true that the shrinkage of the wood of *Robinia Pseudacacia* is somewhat less than might be expected from its structure, but the reason must be sought in other features than the presence of tertiary fibre walls.

S. H. CLARKE.

Forest Products Research Laboratory,
Princes Risborough, Bucks,
Nov. 19.

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[1] "Home-grown Timbers, their Anatomical Structure and its Relation to Physical Properties: Elm." (Forest Products Research Bulletin No. 7. 1930.)

[2] E. C. Jeffrey, "The Anatomy of Woody Plants". (University of Chicago Press, 1917, p. 34.)

Turbulence in a River.

IN the river Cam, in its normal state, the conditions correspond to an eddy viscosity of the order of 1000 cm.^{2}/sec. It therefore seemed remarkable that in my work on the formation of surface waves by wind [1] the conditions for formation were the same in the river as on a pond.

It occurred to me that the uppermost layer in the river might actually be non-turbulent; and when this possibility was tested by dropping ink into the river it was verified. The drops spread out merely as in still water until they reached a depth of 10 cm. or so and were then torn apart by eddies.

It appears, therefore, that the stabilising influence of gravity prevents eddy motion from reaching the free surface. The formation of waves produced by a light wind, with lengths of 8-10 cm., is therefore controlled by ordinary viscosity and not by turbulence.

HAROLD JEFFREYS.

St. John's College, Cambridge.

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[1] *Proc. Roy. Soc.*, A, **107**, 189-206; 1925.

Research Items.

Ancient Egyptian Sealings.—During the seasons 1928–29 and 1929–30 the Harvard-Boston Expedition excavated the ancient Egyptian fortress on Uronarti (Geziret-ib-Melek). In addition, the ground south of the fort was examined, resulting in the discovery of a few graves and a large unfortified palace or dwelling-house. The fort was built in the twelfth dynasty, but abandoned as a military post before the end of the thirteenth dynasty. In the eighteenth dynasty the cult of Sesostris, the founder, was re-established and two temples built or reconstructed, the fort being occupied by the priests. An account of the results by Dr. G. A. Reisner is given in *Sudan Notes and Records*, vol. 14, pt. 1. The objects found were of no great importance, except for a large collection of sealings in mud or clay, numbering nearly five thousand. Of these, the official and the private sealings were about equal in number. Not only do these provide a large variety of designs, but they also add very considerably to our knowledge of the methods of using the seal. The sealings are of various forms. The letter seal is of firm black clay, and bears the papyrus imprint on its reverse. The funnel and double funnel sealings have a hole or holes arising from the base, and show prints of string passing two or more times around the hole. They were evidently used for sealing bags of rations and other supplies for the garrison. The parcel seal is of ordinary mud and circular in form, bearing the mark of tied string on the under side. The box seal and door seal are chiefly in slot form. The key-hole seal was forced into a hole like a key-hole. The sample seal is a single impression on a pat of mud, and has not been attached to anything. It was probably kept for comparison with the sealing of official dispatches. The sealings are usually covered with impressions of the same seal; but in a large number of cases the official seal has been over-stamped with a private seal, probably that of the officer using the official seal. It seems possible that there was a system of registration of seals, similar to that now employed in modern Egypt, to prevent fraud.

Skulls of the Pueblo and related Indian Races.—The Pueblo Indians, once inhabiting America from Texas to Arizona and from Colorado to northern Mexico, form one of the largest and most interesting of the aboriginal American groups. They are a sedentary, mainly agricultural, and peaceful people, but they have the obnoxious habit of so compressing and deforming the bones of the forehead that the craniologist stands helpless before them. However, by selecting skulls where the deformations were of minor grade, Dr. Aleš Hrdlička has been able to publish an informative report and analysis of 645 crania (*Proc. U.S. Nat. Mus.*, vol. 78, art. 2, 1931). He reaches the conclusion that the Pueblos are not a homogeneous group, but contain two distinct strains, one substantially dolichoid, the other fairly strongly brachycranic. Brain capacity and hence size of brain are relatively small, and though this may partly be attributed to the moderate stature of the people, it indicates a somewhat weakened group. As to affinities, unexpected light is shed by the skulls. The Pueblos differ substantially from their neighbours to the north-west and west, but they approach very significantly on one hand the Algonkins, and on the other hand the Gulf types of farther east. The low-vaulted Apache and related Indians now settled in the Pueblo region stand apart from the high-vaulted brachyoid Pueblos.

Distribution of Herring and Plankton.—It is of obvious value if a correlation can be shown between the abundance of herring in any area and that of their food. In *Fishery Investigations*, Ser. 2, vol. 12, No. 38; 1931 (London: H.M. Stationery Office), Mr. R. E. Savage reports on the relation between the feeding of the herring off the east coast of England and the plankton of the surrounding waters. Much information on the biology of the herring is contained in this report, which covers the Lowestoft spring fishery, the Shields summer fishery, the Yorkshire coast fishery, and the Lowestoft autumn fishery. The appetites of the herring show a diminution from May onwards through the summer, and by the autumn fishery they have practically ceased feeding. The most important feeding ground is in the Shields area, and here we have evidence of a correlation between the amount of available food and the size of the catches for the years 1922–23 and 1926. An interesting calculation is made that in order to provide all the herring landed at the English east coast seaports during 1926 with one 'average' meal, it would require three hundred tons of plankton. Useful observations are also given on the vertical distribution of various species of plankton animals. Comparison of plankton catches and stomach contents of the fish showed that the herring fed on the most abundant species in the plankton at the time, and the author is of the opinion that larger animals such as schizopods and post-larval sand-eels are definitely selected and captured, while there is a discriminate mass selection of the smaller species.

Evolution of Dominance.—Dr. R. A. Fisher has brought together in a convenient form, in *Biological Reviews*, vol. 6, No. 4, October 1931, the several groups of facts of observation upon which his theory of the evolutionary modification of dominance is based. The theory itself is the outcome of the view that the effects of Mendelian factors are largely susceptible of modification through interaction with other factors in the germinal complex. The heterozygote, in particular, since it contains both of two alternative genes, may be expected to be particularly susceptible of modification. It is shown that, from this point of view, the deleterious modifications occurring commonly in Nature and the fancy novelties favoured by man in domesticated animals and plants may both be expected to be recessive, whilst variant forms of polymorphic species should generally be dominant. The anomalous case of the domestic fowl is examined, in which a number of characters behave as dominant in crosses with the presumed ancestor, *Gallus gallus*, and the conclusion is reached that the situation here can be explained by the early history of domestication of these species. This theory asks for a reconsideration of the effect of selective action upon characteristics of very minor importance in the organism, upon, in fact, the type of difference between species which has made some students of evolution regard natural selection as a quite inadequate instrument in species production. Dr. Fisher's theory, in numerous directions, suggests further genetical experiments, often involving extensive breeding experiments with native wild populations of the organism.

Humidity Control and Entomological Problems.—In the *Bulletin of Entomological Research*, vol. 22, September 1931, Dr. P. A. Buxton contributes a short practical article on the above subject. Most of the published work bearing upon the influence of humidity on phases of insect life is in terms of relative humidity at different temperatures. We require fuller investigation as to the scale which is most appropriate for such lines of inquiry. The adoption of a constant saturation deficiency as the index may perhaps prove to be a better criterion, but the whole subject is one which has been largely neglected. Dr. Buxton discusses the several scales by means of which water vapour in the atmosphere may be measured—for example, absolute humidity, relative humidity, and saturation deficiency —and then proceeds to describe various methods for the direct measurement of humidity. These include wet and dry bulb thermometer, the use of hygroscopic substances, dew-point determination, and the working of chemical hygrometers. In dealing with methods of controlling humidity, the use of supersaturated salt solutions, sulphuric acid, and aqueous solutions of potassium hydroxide are dealt with critically, their advantages or disadvantages, as the case may be, being referred to briefly. Appropriate apparatus wherein controlled experiments can be carried out also comes in for some mention. The use of desiccators is favoured by Dr. Buxton, who, it may be added, further takes into account the needs when a current of humidified air is desirable. The paper is one likely to be useful to those biological workers who are not familiar with experiments requiring control of humidity (see also NATURE, Nov. 14, p. 837).

Liming and Fertility.—Although liming or chalking is one of the oldest operations in British agriculture, it is now realised that much land in England is less productive than it might be owing to the neglect of this practice during the past fifty years. Increase in costs and the introduction of artificial manures have probably largely contributed to this falling off in the use of lime, but owing to the heavy dressings originally applied, considerable time has elapsed before the soil has shown signs of losing its fertility. In view of the many failures of crops which can be attributed to a lack of lime, the Ministry of Agriculture has issued an illustrated bulletin (No. 35), entitled "The Use of Lime in Agriculture" (London: H.M. Stationery Office; 6d.), which should prove of real practical help to the farmer. The subject is introduced by a survey of the chief functions of lime. An account of the causes and rate of loss of lime from the soil follows, and definite symptoms of both grass and arable land deficient in lime are described. Remedial measures are considered in detail, the comparative values of the various forms of lime and chalk on the market, such as free and slaked lime, carbonate of lime, waste lime products, and lime rich in magnesia being fully discussed. Definite information as to the best quantity to apply is less simple to provide since conditions are so diverse, but advice on general lines is given, and if in any doubt the farmer is recommended to communicate with his county agricultural organiser.

Cross-Pollination in Cotton.—A study of the frequency of natural crossing between adjacent varieties of cotton, for which de Vries coined the useful term 'vicinism', has been made by Dr. M. A. Fikry (*Tech. Bull.* No. 18, Roy. Agric. Soc. Egypt). He planted strips of Red Leaf Acala cotton, which is homozygous for a dominant red leaf factor, in a field of Maarad cotton having green leaves. The plants are visited by insects, especially the honey bee and another bee of the genus *Nomia*, but wind is negligible as a factor in crossing. By making two pickings of Maarad seeds from successive ridges at increasing distances from the Acala and determining the percentage of red seedlings in each case, the conclusion was reached that 4 per cent of the seed from each plant in a cotton-field is crossed, that is, there is 96 per cent of self-fertilisation. A gradient of pollination, beginning with the source of pollen, gradually falls to zero at about forty metres, which is the maximum range to which pollen was transmitted. The amount of vicinism will no doubt vary, depending especially on the frequency of insects and the distance between the plants, but the figures obtained are a measure of the precautions necessary to maintain purity in a cotton crop.

Seeds and Seedlings of Sâl.—Some investigations are being carried out by Mr. H. G. Champion and Mr. B. D. Pant on the seed and seedlings of the Sâl (*Shorea robusta*), one of the timbers of chief commercial importance in more than one province of India (*Ind. For. Rec.* (Silv. Series), vol. 16, pt. 5; 1931). One of the conclusions reached with reference to the seed is that no relation has yet been demonstrated between the average size of the seed from a given tree and the vitality and vigour of the resultant seed crop. This is contrary to an opinion expressed in 1928. The authors consider, however, that "since the bigger the seed the better it is, one would expect the average for trees with relatively big seed to give higher average values for plant per cent and seedling height". There is a remarkably wide range in size of the seed from 0·308 in. to 0·561 in. The root system of seedlings is described in relation to soil factors, etc., and seedling types in line sowings are differentiated and their relative development studied. The interesting fact is recorded that "seedlings with several equal shoots develop nearly as well as those with a single or dominant shoot, and the presence of small shoots increases the growth of a dominant shoot". Burning back seedlings three seasons old makes no significant difference to the shoot height reached the following season. Experiences with the growth of cover or shelter crops between the lines of young sâl seedlings, notably with the crop *Tephrosia candida*, with which remarkable results have been attained in some parts of India, are described.

Tertiary Foraminifera.—A memoir by Dr. W. A. Macfadyen on "Miocene Foraminifera from the Clysmic Area of Egypt and Sinai" (*Egypt. Geol. Survey*, Cairo, 1931; pp. 149, pls. 4, map) deals mainly with the Foraminifera from the marls of the Clysmic (or Greater Gulf of Suez) area of Egypt and Sinai, but is preceded by an account of the stratigraphy and correlation of the deposits. Descriptions are given of nine carefully measured sections taken at different parts of the region, and the beds are regarded as of Burdigalian, Schlier, and Helvetian ages, with perhaps some representative of the Tortonian. The succession is compared with the Miocene series of Vienna, Transylvania, Malta, and Cyprus. The greater development of the foraminiferal marls in the central part of the area is taken to indicate that the faulted Clysmic trough was already in existence in Schlier times. The Clysmic area formed an arm of the Mediterranean in Miocene times and was not connected with the Indian Ocean until the Pliocene period; consequently the majority of the 185 species and varieties of Foraminifera recorded by Dr. Macfadyen are known to occur in the Tertiary or recent faunas of the Mediterranean region. Dr. J. A. Cushman and J. D. Barksdale (*Contrib. Depart. Geol. Stanford Univ.*, 1, 2, 1930; pp. 55-73, pls. 11, 12) describe the Foraminifera of the Martinez Eocene of California, and conclude that that formation is of the age of the Claiborne beds of the Gulf Coastal plain of the United States and Mexico.

Illumination in Factories.—The question of the best direction and intensity of the illumination of the work in factories in order to improve the efficiency of human labour and effect economy in the cost of production has led to the formation in Germany of a

Board to carry out experiments on the subject. A report on the work done in connexion with weaving, by Drs. N. Goldstern and F. Putnoky, has been translated into English and appears in the November issue of the *Journal of the Franklin Institute*. The woollen cloth being woven was illuminated directly by lamps in enamel reflectors, indirectly by lamps sending their light to the ceiling, and by a side light introduced to give shadows of the fibres, and the intensity of the illumination of each type could be changed. Each increase of illumination produced an increased output which was greater for dark than for light material. With the costs of electric light and labour in Germany, the most economical illumination is 60-70 foot candles, which secures a net gain of 6 per cent for dark and 4 per cent for light materials. With the American costs of light and labour the net gain would probably be greater.

Formation of a Spark.—The second October number of the *Physical Review* contains an account by F. G. Dunnington of an investigation of the initial stages in the formation of a spark. The method used was that of the so-called electro-optical shutter, in which the electric impulse of the spark is applied at a variable time of less than a microsecond later to the electrodes of a Kerr cell full of nitrobenzene. This becomes almost instantaneously doubly refracting, and allows the stage of growth of the spark to be seen or photographed through a polarising system. The way in which the spark-gap collapses varies. The bright conducting filaments, which follow the initial dark discharge, may appear either at the cathode or both at the cathode and in the gas. Effects such as the latter indicate that space-charges are present, and with this criterion it is found that they become more important as the number of molecules between the sparking electrodes is increased. Other interesting observations were made, such as the occasional development of a single bright filament into a bundle, and an attempt is now being made to follow the growth of the spark spectroscopically.

Flame Temperatures.—Measurements of the flame temperatures of binary mixtures of gases in admixture with air are described by Jones, Lewis, and Seaman in the November *Journal of the American Chemical Society*. The addition of oxygen to methane raises the maximum flame temperature with air by about five per cent with 20 oxygen to 80 methane. Addition of hydrogen to methane raises the flame temperature only slightly up to about eighty per cent of hydrogen, after which it increases rather rapidly. The maximum flame temperatures of mixtures of methane and acetylene indicate that the addition of small amounts of acetylene to pure methane causes a considerable increase in flame temperature. The temperatures from pure methane to 20 methane + 80 acetylene lie practically on a straight line when plotted against composition. It was not possible to determine the flame temperature of pure acetylene mixed with air, but a slight extrapolation gave the maximum of 2325° C. The highest temperature was in all cases reached with mixtures slightly on the rich side, that is, having an insufficient amount of oxygen present to consume all the combustible substances. This is in agreement with results with single hydrocarbon gases and air. Calculations of the flame temperatures gave satisfactory results.

Astronomical Topics.

Sigma Scorpii.—*Popular Astronomy* for November contains a note by Mr. B. H. Dawson on an occultation of this star that he observed at La Plata on July 25. The disappearance was in two sharp steps, at intervals of less than half a second. More than half the light was cut off at the first step. Señor Dartayet made identical notes, using another telescope 50 metres distant. The note recalls similar observations made during occultations of the same star on March 12, 1860 (Cape), and April 10, 1917 (Washington). Mr. Dawson points out that a separation of the pair by about a tenth of a second of arc is indicated. This is too large for the spectroscopic system, which has a period of 33 days. M. Henroteau had already suggested the presence of another component, with a period of about twelve years; the phenomena noted during occultations support this suggestion.

The Variable Star AK Herculis.—Reprint No. 11 of the publications of Warsaw Observatory contains a careful study of this interesting variable by J. Wasiutynski. The variability was discovered in 1917 by J. H. Metcalf, the period being at first given as $0{\cdot}210760^{\mathrm{d}}$; but it was found later that the star is of the β Lyræ type, and that the complete period is twice as long. The extreme range of light is half a magnitude, from 8·2 to 8·7; the two maxima are nearly equal, but at the secondary minimum the magnitude is 8·6. There is continual variation of light, so it is concluded that it does not arise wholly from eclipses; the stars are assumed to be elliptical in outline; the value 0·12 is, somewhat doubtfully, assigned to the ellipticity. The relative orbit also appears to be elliptical, but the article concludes that it is difficult to explain all the features of the light curve without assuming that a portion of the light-variation is physical.

Report of the Paris Observatory for 1930.—This report records a large amount of useful work in many departments of astronomy. Perhaps the most epoch-making is M. Lyot's observation of the corona without an eclipse, from the station on the Pic du Midi, with the aid of a polarimeter; the streamers could be traced to a height of 6′ above the limb. The two brightest lines in the coronal spectrum, at 5303 and 6374, were also seen and photographed. A new catalogue of 10,656 stars in the zone from +16° to +24° was published; the observations had been made between 1899 and 1912.

The sheets of the "Carte du Ciel" are being published at the rate of five per month; it is hoped that they will be completed within a year. Proper motions are being deduced by comparison with the plates taken by the brothers Henry in the last century. The last volume of the astrographic catalogue has gone to press. A catalogue is also being prepared of all the stars on the plates down to magnitude 10, giving right ascensions and declinations.

Measures were made of the positions of faint stars near Pluto suitable for use as comparison stars. Studies of the orbit of Pluto were made by MM. Mineur and Barbier. M. Baldet observed it visually with the Meudon equatorial, concluding that its diameter did not exceed 0·2″; he observed the nucleus of the comet 1930 *d* (Schwassmann-Wachmann) with the same instrument when it was within five million miles of the earth, and deduced that its diameter was of the order of 400 metres.

Daily observations of the sun are made with the spectroheliograph; the results are sent to the national meteorological office and transmitted by wireless throughout France. There is also a record of much optical and chemical research in the astrophysical laboratory.

Constitution of the Alloys of Silver and Mercury.

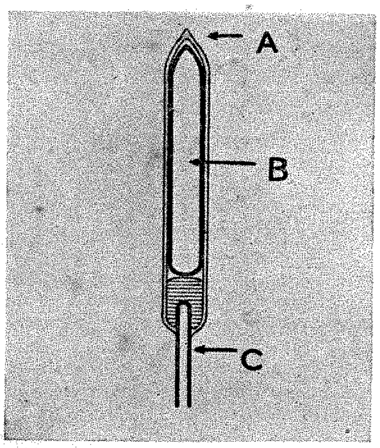

Fig. 1.

THE physical characteristics of silver and mercury place formidable experimental difficulties in the way of any attempt to apply to this system of alloys the ordinary methods of physical metallurgy. At the melting point of silver the vapour pressure of mercury is about 250 atmospheres, and in overcoming the difficulties involved great credit is due to Dr. A. J. Murphy, who, in a paper read before the Institute of Metals on Sept. 15, has investigated this thermal equilibrium diagram.

In order to obtain the necessary heating and cooling curves, the metals, in a high state of purity, and, so far as the silver was concerned, in a very fine state of division, were placed in the fused silica vessel *A* (Fig. 1), which at this stage was open. Into the tube *C* the thermo-couple wires of chromel and alumel were introduced. It was not possible to seal off the tube *A* at a distance less than 3 in. from the amalgam if undue heating were to be avoided, and to reduce the dead space that this entailed the closed silica tube *B* was introduced. The outer silica tube was finally filled with hydrogen and sealed.

With most of the alloys it was necessary to apply a high pressure to the outer walls of *A* to prevent explosion. For this purpose it was enclosed in a seamless steel bomb, fitted at both ends with massive caps which screwed down on to copper-asbestos washers. The upper cap was provided with an inlet through which gas was passed at a pressure of 120 atmospheres. An internal electric furnace circuit was then closed and heating proceeded. No variation of the gas pressure was made during the observations owing to its liability to give rise to troublesome thermal effects.

The diagram deduced is shown in Fig. 2. The α phase consists of a solid solution of the two metals. On heating to 276° C., the β phase dissociates into α and liquid, whilst the γ phase similarly dissociates into β and liquid at 127° C. Although the exact nature of the α and β phases has not been determined, formulæ of the type Ag_4Hg_3 or Ag_5Hg_4 would satisfy the observations relating to the composition of the β phase, and Ag_3Hg_4 or Ag_4Hg_5 for the γ phase.

Although in general the vapour phase is neglected in dealing with most metallic systems, this can no longer be done in that under investigation without further consideration, since both the nature and the composition of the phases might be affected by the considerable pressure under which they were formed. It is of general interest, therefore, that the author shows that the actual phases present are independent of the pressure, and that, from an application of the Clapeyron equation, the temperatures at which transformations occur are not appreciably affected.

Figs. 1 and 2 are from Dr. Murphy's paper, by courtesy of the Institute of Metals. F. C. T.

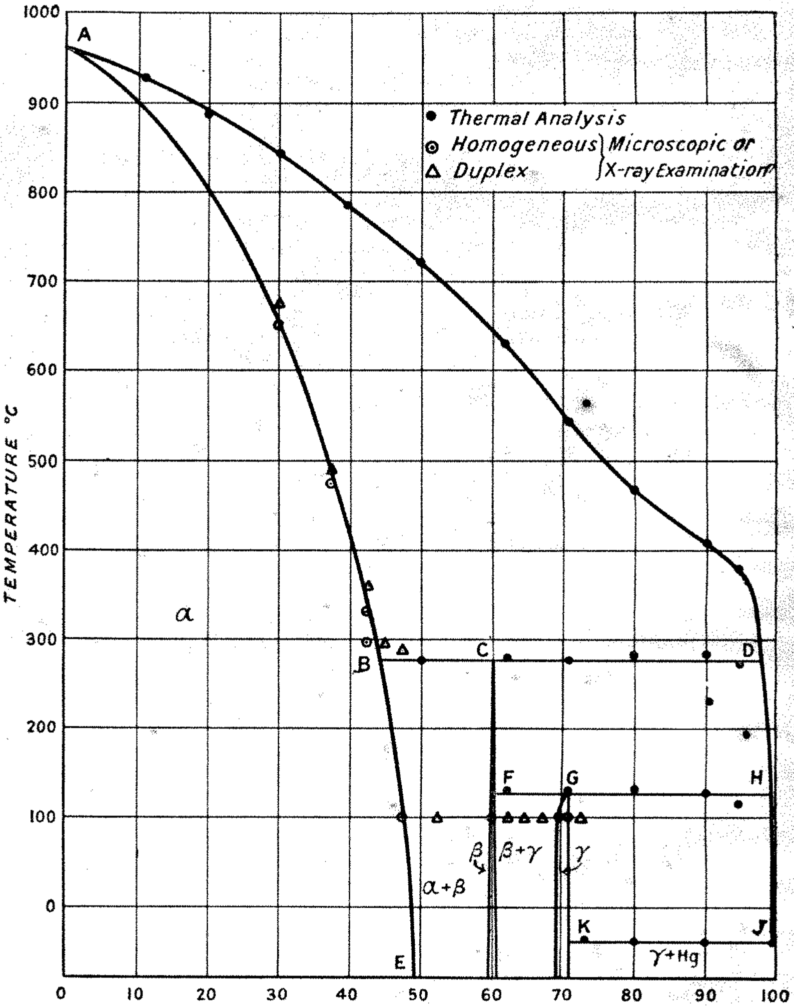

Fig. 2.—Equilibrium diagram of silver and mercury.

International Standards of Lighting.

A BRIEF summary of the chief conclusions arrived at during the session of the International Commission on Illumination (held in Cambridge on Sept. 13–19) was included in an article on the International Illumination Congress which appeared in Nature of Oct. 10, p. 642. A detailed account of the resolutions has now been issued. The series is a formidable one. There are more than seventy separate resolutions or recommendations. Of fundamental importance is the announcement that in future the Comité International des Poids et Mesures will include photometric standards within its scope. A select committee is accordingly to be formed by the International Commission on Illumination to handle this matter and co-operate with the Comité International. Other resolutions fall under the following heads: definitions; automobile headlights; factory and school lighting; street lighting; coloured signal glasses; traffic control signs; diffusing materials; test plates; photometric precision; daylight illumination; glare; colorimetry; aviation lighting; lighting education; vocabulary; heterochromatic photometry; light flux distribution, and applied lighting practice.

Under "Definition" the use of the symbol *n* for refractive index is approved, and likewise the use of c.g.s. units in official publications of the International Commission on Illumination. Authors are requested to express values (in brackets) in c.g.s units as well as in their national units. In connexion with factory and school lighting no change in the minima included in the International Commission of Illumination Code (Geneva) is made. Recommendations relate mainly to educational effort. In order to facilitate international comparisons of street lighting installations it is suggested that (*a*) a complete description of the luminaire, with its consumption of gas or electricity, (*b*) the spacing of luminaires, their height and transverse position, and (*c*) the average illumination and minimum illumination, should be given. The nominal range of a beam of an automobile headlight is specified as the distance at which an illumination of 1 lux is produced in a vertical plane. Cars driven at speeds exceeding 30 km. an hour should be furnished with (i) a driving beam (for use on the open road) and (ii) a passing beam (for use when meeting other vehicles). The intensity and lateral spread of driving beams are defined. 'Transmittance' is approved in place of 'transmission' of coloured signal glasses and lenses. The use of red at left or top, amber in centre, and green at right or bottom for traffic control signs is approved, and it is recommended that the lens diameter shall not be less than 8 in., and the lamp wattage not less than 60. Information is to be collected on the influence of traffic signs in diminishing accidents and facilitating traffic.

There were numerous conclusions in regard to diffusing materials, test plates, and photometric precision, of special interest being the statement that visual measurements are most accurate with illuminations on the photometer screen between 5 and 20 lux. Under these conditions and with no colour difference a mean error of 0·25 per cent is practicable. In commercial work an error of 3 per cent is considered usual. In connexion with daylight illumination the use of 'contour lines of constant daylight factor' is recommended. At all parts of interiors where the daylight factor at table height is less than 0·2 per cent, the daylight is regarded as definitely inadequate for work involving visual discrimination over reasonable periods of time and comparable with ordinary writing. It is proposed to set up a technical committee to study 'artificial daylight' and if possible prepare agreed forms of specifications for lighting units intended to imitate daylight. Further investigations on the sensation of discomfort associated with the presence of bright sources in the field and on the time variations of glare effects are proposed. There were a series of six resolutions bearing on standard procedure in colorimetry.

In connexion with aviation lighting there were no fewer than fourteen definitions or recommendations. The nature and position of obstruction lights, boundary lights, and airport and airway beacons were indicated. The figure of 0·2 candle at 1 km. was adopted as the requisite minimum for visibility under laboratory conditions, and experiments on the corresponding value appropriate to flying conditions are contemplated. Other recommendations dealt with the details of navigation lights, standard voltages and sockets, etc., and supplementary researches on lighting equipment, colour, etc.

There were also numerous resolutions bearing upon lighting education; for example, that the subject of illumination should receive greater consideration in post-primary schools and in all architectural colleges, that in each country there should be at least one full course of illuminating engineering available, and that all public utilities should include on their staffs technically trained representatives able to give advice on lighting matters to the public.

Research in Wood Preservation.

THE problems of wood preservation are of world-wide interest, perhaps never more so than at the present time of economic stress, when the world is threatened with a shortage of its timber supplies. The discussion on this subject, held under the chairmanship of Sir Alexander Rodger, in the Department of Forestry, Section K (Botany), at the meeting of the British Association on Sept. 24, was therefore opportune, and served a valuable purpose in directing attention to research in progress in Great Britain upon a subject of wide economic importance. The proceedings took the form of a series of short papers [1] by members of the staff of the Forest Products Research Laboratory, Princes Risborough. Mr. R. S. Pearson, director of the Laboratory, gave a brief review of the whole field of investigation, in which he stressed the view that co-operation in research between the different groups of workers is essential to the successful progress of this work. Development of new methods in wood preservation is no longer limited to devising ways and means of introducing powerful antiseptics into timber and demonstrating their efficiency by durability and service tests. Viewed at a much wider angle, the work involves biological studies of the organisms causing decay, and investigations into the effect of these organisms upon the chemical constitution of wood. The scope of the work, therefore, calls for the co-operation of mycologist, entomologist, chemist, engineer, and workers in other branches of the study of timber, particularly in relation to its structural and physical properties.

Mr. K. St. G. Cartwright dealt with some of the methods used for the testing in the laboratory of the relative value of different preservatives against wood-destroying fungi. The comparative value of tests on artificial media and on wood blocks was discussed, but it was pointed out that, up to the present time, no standard method of testing wood preservatives has been adopted throughout the world, so that the results obtained by different workers in this field are not strictly comparable. In June 1930 a conference was held on this subject in Berlin, when investigators from different countries reviewed the position and inquired into ways and means of establishing recognised standard international tests for use in determining the value of wood preservatives (Nature, **126**, 921; Dec. 13, 1930). The difficulties of standardising tests are considerable, and these were summarised by Mr. Cartwright. Although laboratory tests may give useful information for comparing the relative value of preservatives and also furnish an idea of the concentrations required for commercial use, it is necessary to supplement these by large-scale field tests. Such tests are in progress on different sites of varying soil and climatic conditions and supplement the investigations carried on in the laboratory.

The problems of wood preservation in relation to damage by insects to structural and manufactured timber in Great Britain were described by Dr. R. C. Fisher. The two groups of insects primarily concerned are the Powder-post beetles (Lyctidæ) and the Furniture beetles (Anobiidæ), to which the Death-watch beetle *Xestobium rufovillosum* belongs. The *Lyctus* beetles cause serious damage to the sapwood of partly and recently seasoned hardwoods, and the most satisfactory methods of preserving wood against damage caused by them consists in periodic inspection of stores of susceptible timbers, elimination of sapwood, and the maintenance of clean and tidy premises in timber yards and factories. The use of preservatives or insecticides has a limited value for the treatment of timber in buildings. The Death-watch beetle presents a much more difficult problem, for, although a number of palliative measures are available against this insect, knowledge of the details of its life-history are lacking. It is believed that the acquisition of a fuller knowledge of the biology and physiology of the Death-watch beetle is the most helpful contribution which can be made towards the solution of this problem, and will not only form a sound basis for the application of improved control measures, but will also shed further light on the mode of nutrition of wood-boring insects, a subject upon which existing knowledge is particularly meagre.

Mr. W. G. Campbell then discussed the problems of wood preservation from the point of view of the wood chemist. Current work on the chemistry of decay of wood by fungi and insects was summarised and the suggestion made that, if decay could be considered in terms of its ultimate chemical effect on wood substance, the future objective of preservative treatment might be the inhibition of certain definite chemical reactions instead of the poisoning of all organisms which might attack timber. Briefly, the lines along which such work is being developed can be considered under two headings: (1) the characterisation of the chemical reactions which take place during decay, and (2) the study of ways and means of treating wood so that the key reactions are inhibited. Existing knowledge of the chemical reactions caused by fungi on timber far exceeds that available on the effect of wood-boring insects, partly due to the lack of information upon the details of their life-history and development.

Whilst investigations into these problems are of paramount importance in the development of new methods of preservation, it is imperative that the best use should be made of preservatives at present available. The value of such substances depends to a large extent upon the degree of penetration achieved in their application. This aspect of the study of wood preservation was described by Mr. J. Bryan, who stressed the necessity of deep impregnation of antiseptics for the preservation of exposed timber and discussed different ways of obtaining this. A brief account was given of the various methods of impregnation by pressure difference and of methods depending on the diffusion of water-soluble preservatives. Special attention was directed to the value of incising as an aid to the satisfactory treatment of refractory timbers, a process now being used commercially in connexion with the impregnation of Douglas fir railway sleepers.

Sir Alexander Rodger referred briefly to the work on wood preservation in progress at the Forest Research Institute, Dehra Dun, and again emphasised the value of co-operative work when each subject concerned has its own contribution to add to the progress of the investigation as a whole. A short general discussion followed, to which members of industries interested in wood preservation contributed.

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[1] To be published in forthcoming numbers of *Forestry*, the journal of the Society of Foresters of Great Britain.

University and Educational Intelligence.

Edinburgh.—Dr. C. B. Williams, lecturer in agricultural and forest entomology, has requested permission to resign as from March 31, on his appointment as head of the Department of Entomology at Rothamsted Experimental Station.

The degree of D.Sc. has been conferred on R. M. Craig for a thesis on "Geology of the Outer Hebrides—North Harris and Uig, Morsgail and Aline in Lewis".

A Theresa Seessel research fellowship, for the promotion of original research in biological studies, of the value of 1500 dollars is being offered by Yale University. Preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications should be made to the Dean of the Graduate School, New Haven, Connecticut, U.S.A., before March next.

The twentieth annual Conference of Educational Associations has been arranged for Jan. 4–11, at University College, London, under the presidency of Sir William Rothenstein. All members of affiliated associations may attend any of the meetings, except those which are definitely set aside for members only. Non-members also may purchase tickets for all open meetings from the secretary, at five shillings each. The presidential address will be given on Jan. 4. On the same day, Dr. Emmanuel Miller will deliver a lecture on "The Difficult Child: Sociological *versus* Individual Interpretation". Other lectures include Mr. J. Howard Whitehouse on public schools and public life, and Mrs. C. B. S. Hodson on the desirability of including biology in the school syllabus. On Jan. 6, a popular lecture on comets and shooting stars will be given by Sir Richard Gregory. A discussion has also been arranged on the film in education. The chairman of committee of the Conference is Mr. W. W. Vaughan, the honorary treasurer, Miss H. Busk, and the secretary, Miss M. A. Challen, 29 Gordon Square, W.C.1.

Birthdays and Research Centres.

Dec. 27, 1887.—Prof. E. N. da C. Andrade, Quain professor of physics in the University of London.

I am at present engaged on three main lines of research: the accurate determination of the velocity of sound in gases by new methods, which involves a more exact knowledge of the behaviour of a column of vibrating gas in a tube; the laws governing the flow of crystalline solids, both in the poly-crystalline and in the single crystal state, in connexion with which the electrical properties of metal single crystals are under investigation; and the theoretical and experimental aspects of the viscosity of liquids. In respect of flow, the liquid state seems to be in many respects more analogous to the solid than to the gaseous state. In this connexion it is to be noted that there are very few reliable data on the viscosity of elementary substances in the liquid state. Such measurements are badly needed, and I am about to undertake an experimental investigation to remedy this deficiency.

Dec. 28, 1853.—Dr. Alexander Scott, F.R.S., director of scientific research in the British Museum and formerly superintendent of the Davy Faraday Research Laboratory of the Royal Institution.

In the past my work has been mainly on problems relating to atomic weights, on which I have still much unpublished.

Since the War my occupation has been to discover methods for preserving and restoring museum objects of every kind. This presents a never-ending series of scientific problems of the most fascinating nature. Through one's hands are continually passing marvellous specimens in gold, in carnelian and bronze, concerning which one must ask: What has caused this specimen to deteriorate in this way? or, How has the craftsmanship disappeared which thousands of years ago was able to fashion such an article?

The endeavour to find answers to such questions leaves but little time for more purely theoretical investigations.

Dec. 28, 1882.—Sir Arthur Eddington, F.R.S., Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

My main work this year has been in the borderland between relativity theory and quantum theory. For some years, the position was that not much further progress in relativity theory could be expected until the quantum theory advanced to meet it; but now the two theories are in contact, and Dirac's linear wave equation seems to provide a bridge between them. This gives a strong hint as to the direction in which relativity theory should be extended in order to cope with atomic phenomena. Following the hint, I have been working on the relativity side of the bridge, using as additional clues the values of the absolute constants of Nature. Attention was at first confined to the fine-structure constant 137; but lately further insight has been obtained from the cosmical constant and the mass-ratio of the proton and electron. The work is, I hope, progressing towards the direct formulation of a 'geometry' from which these constants will emerge naturally.

Dec. 29, 1873.—Prof. H. Stanley Allen, F.R.S., professor of natural philosophy and director of the Physics Research Laboratory in the United College of the University of St. Andrews.

Since my induction in 1923 to the St. Andrews chair —described on its foundation as a chair of natural and experimental philosophy—my work has been concerned mainly with quantum theory and with spectroscopy. My interest in the historical and philosophical aspects of natural philosophy has increased of late years, and a small volume dealing with recent developments in atomic physics is now passing through the press.

The new laboratory opened by Sir William Bragg in 1925 has provided opportunity for experimental research by zealous helpers on the subject of band spectra, the secondary spectrum of hydrogen in particular. The request from the Editor of Nature for a statement as to the chief investigations now in progress reached me two days after the disastrous fire in the chemical and physical laboratories. Apparatus for physical investigation and for advanced students has been to a large extent destroyed, and for the moment experimental research is at a standstill.

My hopes for the future may be expressed in a sentence familiar throughout Scotland—*nec tamen consumebatur*.

Dec. 29, 1878.—Dr. W. D. Lang, F.R.S., Keeper of the Department of Geology in the British Museum (Natural History).

While the neontologist sees the organic world as a single cross-section, the palæontologist views it as a series of superposed cross-sections, and seeks morphological series collected from consecutive strata, series which, when he has applied certain safeguards, he may have reason to suppose approximate to true lineages. He is thus able, with suitable material, to test the evidence afforded by individual growth-stages and their bearing on recapitulation. Further, in so far as his series represent true filiations, their terms show by what changing characters evolution can be traced. They also call in question the selection-value of characters. Lineages, again, show trends, in following which characters of parallel lineages are seen to run similar courses, and those of one lineage often to run their course regardless of the stage reached by other characters of the same lineage—facts which, again, bear upon the theory of evolution by means of natural selection.

Palæontological investigation, therefore, should, I think, be carried out along the lines of bed-by-bed collecting; of tracing lineages; of noting growth-stages; and of observing trends and the evolutionary history of individual characters; and, whether investigating Palæozoic corals, Cretaceous Polyzoa, or the faunal succession of the Dorset Lias, I have followed, and continue to be guided by, these methods of research.

Dec. 30, 1850.—Dr. William Garnett, formerly educational adviser to the London County Council.

While at Newcastle I was almost wholly occupied with the development of the College of Science into a complete university college. I also gave considerable attention to electrical engineering, and as honorary electrical engineer to the Royal Jubilee Exhibition of 1887, I arranged the first public display of the Parsons turboelectric generators, lighting therewith by means of high-power incandescent lamps a floor area of three acres. At the same Exhibition I exhibited for the first time a colliery engine plane with full-sized tubs electrically driven on a main and tail rope.

After entering the service of the L.C.C. in 1893, my time was so completely occupied in educational administration that it was impossible for me to carry out original work. My main object was to secure that the polytechnics should not be congeries of independent science and art classes, but organised educational institutions with competent principals, and teachers paid by fixed salaries and not on the examination results of their own classes.

Societies and Academies.

London.

Society of Public Analysts, Dec. 2.—H. W. Buston: A micro-method for the determination of uronic anhydride groups in pectic substances. The method involves distillation with dilute hydrochloric acid and measurement of the resulting carbon dioxide. The process is complete in 60-70 min., and the results are as accurate as those given by the macro process.—**N. E. Cocchinaras:** The composition of linseed oil. From the results of bromination experiments it is concluded that the linolenic acid of linseed oil is present in only one isomeric form, namely, that yielding the crystalline hexabromide. Less than two per cent of oleic acid was found, and the solid fatty acids were proved by fractional distillation to consist only of palmitic and stearic acid.—**T. Hedley Barry:** Oil from Malayan *Aleurites Montana* and the properties of Hong Kong oil. Oil from the seeds of *Aleurites Montana* from the Malay States had an abnormal refractive index, which was lower than any recorded for the oil of *A. Fordii*. It also gave abnormal results in the polymerisation test.—**S. G. Clarke and W. N. Bradshaw:** The calcium fluoride method for the determination of fluoride, with special reference to the analysis of nickel-plating solutions. In the presence of an excess of calcium chloride to reduce the solubility of the precipitate, calcium can be quantitatively precipitated as calcium fluoride without simultaneous precipitation of calcium carbonate. Iron does not interfere if it is first reduced to the ferrous condition by means of hydrazine, and the adsorption of calcium sulphate is largely prevented by the presence of ammonium chloride, which increases the solubility of the calcium sulphate.

Dublin.

Royal Irish Academy, Nov. 30.—C. H. Rowe: A characteristic property of systems of paths. Unless a system of curves in a space of N dimensions ($N>2$) consists of the paths of a linear connexion, the subspace generated by the curves that i[illegible]e from a point in the directions of a linear vector-sp[illegible] in general have a singularity at this point, th[illegible] nd partial derivatives of the functions involved i[illegible] parametric representation being discontinuous there.

Paris.

Academy of Sciences, Nov. 16.—Jules Drach: The determination of the linear elements for which there exists a triangular network of geodesics. Generalisations.—**J. Costantin, P. Lebard, and J. Magrou:** The influence of a period in the mountains on the productivity of the potato. Tubers of potato from healthy plants previously cultivated at a height of 1650 metres have given better developed and higher yields than similar tubers of the same origin but from plants cultivated at a low level in the preceding year.—**A. Lumière and A. Seyewetz:** The preparation of fine grain negative images by development. Normally, the size of grain of the negative developed in the usual way is a function of the initial size of the particles of silver bromide forming the sensitive emulsion. Paraphenylenediamine, in presence of caustic alkalis or carbonates, behaves like other developers from this point of view, but under certain conditions (feeble alkalinity) may give images with much finer grain than those of the initial emulsion. A formula of a suitable developer is given, together with reproductions of the same plate (× 500) with two developers showing difference in grain size.—**E. Mathias:** Ascending flashes of lightning.—**Al. Pantazi:** Certain projective properties of families of surfaces.—**P. J. Myrberg:** Systems of functions which admit of a theorem of algebraical addition.—**M. Ghermanesco:** The successive means of an n-metaharmonic function.—**L. Goldstein:** The quantic mechanics of various simple photo-chemical processes.—**G. Déchène:** Peculiarities of lead chloride semi-conducting cells.—**Garrigue:** The electrical conductivity of acetone with a continuous current.—**J. Jaffray:** Some properties of thermocouples in a vacuum. Two types of thermocouples designed for the measurements of weak alternating currents were studied. The relation between the intensity of the heating current (I) and the deviation of the galvanometer receiving the thermocurrent produced (D) was found to be $D=KI^n$, where n was approximately 2.—**R. Freymann:** The infra-red absorption spectra of mixtures of organic liquids; the hypothesis of an electrolytic dissociation for these mixtures.—**C. Haenny:** The magnetic double refraction of paramagnetic salts in aqueous solutions. Utilising the large Bellevue electromagnet, the results of Elias on the magnetic double refraction of solutions of erbium nitrate were confirmed. Solutions of cerous nitrate give very high magnetic double refraction of negative sign.—**R. Toussaint:** The measurement of fluorescence with a photoelectric cell.—**M. Bourguel:** The influence of substitutions on the frequency of the ethylene line.—**A. Perret and R. Perrot:** The hydrolysis of nitrosyl chloride and of nitrogen peroxide by caustic potash. These reactions are shown to depend on the concentration of the solution of caustic potash. Nitrosyl chloride gives not only nitrite and chloride but also nitric oxide, the latter in proportions varying from 9 per cent to 42 per cent of the total nitrogen. Nitrogen peroxide also gives some nitric oxide when absorbed in potash solution.—**Raymond Quelet:** Paramethoxymethyl-benzoic aldehyde.—**L. Palfray, S. Sabetay, and Mlle. Denise Sontag:** The dehydration of phenylglycol by potash.—**A. Demay:** The Hercynian tectonic of the southern Cevennes and of the Rouergue district.—**A. Dauvillier:** The synthesis of the polar aurora.—**J. Imbrecq:** Globular lightning with multiple explosions.—**M. Bridel and Mlle. C. Bourdouil:** The evolution of the glucides in the course of the formation of the seed of two varieties of pea.—**A. Guilliermond:** The frequent existence of specialised vacuoles in the anthocyanine cells.—**Ch. Rousseau:** The presence of zooxanthellæ in Æolidia.—**Emile F. Terroine, A. Giaja, and L. Bayle:** The formation of creatine and purin bodies of urine at the expense proteid materials.—**J. Errera, H. Vogels, and L. Haus** Animal and plant proteids. Electrometric analys —**Octave Bailly and Roger Netter:** The isolation carotene from the suprarenal glands. From 30 k grams of suprarenal capsules (ox) 0·3 grams of p carotene was isolated, or 100 mgm. per kilogram fresh glands. Its identity with plant carotene wa established.—**Ugo Lumbroso:** Inoculation of t monkey with strains of bacteria isolated from Tunisian cases of trachoma.

Geneva.

Society of Physics and Natural History, Oct. 22.—A. Brun: (1) The apparent dispersion of the optical axes in peridote and the measurement of $2V$. The author has measured the angle of the axes and the dispersion, eliminating the causes of error arising from the index of the liquid medium and the radiation employed. The examination of the dispersion curves peculiar to the peridote and to the bromonaphthaline show that the radiation 4870 A. to 4880 A. gives the most exact value of the angle $2V$. The author finds $2V_\rho>2V_v$ and for the line H_β (4861A.), $2V=87° 40'$.—(2) The separation of the *ng* and *np* ultra-violet spectra efracted by a doubly refracting prism. The author eparates the *ng* and *np* spectra of a prism by passing hem through a calcite prism, the edge of which is ormal to that of the prism studied (zircon, beryl, eridote). He has proved that colourless zircon is as ansparent for the ultra-violet as quartz.—A. Jayet d G. Amoudruz: The discovery of Magdalenian eposits near Frangy (Haute Savoie). At Douattes, ar Frangy, the remains recently discovered occur two levels. The lower, of Magdalenian age, has rnished flints and bones of mammals. In the upper vel, probably of neolithic age, pottery appears. This posit appears to connect the Magdalenian deposits f Ain with those of Veyrier.

Diary of Societies.

TUESDAY, December 29.

Royal Institution of Great Britain, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (1): The Nature of Light.

WEDNESDAY, December 30.

British Astronomical Association (at Sion College), at 5.

THURSDAY, December 31.

oyal Institution of Great Britain, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (2): Light and the Eye.

FRIDAY, January 1.

unior Institution of Engineers, at 7.30.

SATURDAY, January 2.

oyal Institution of Great Britain, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (3): Light and Colour (1).

Public Lectures.

MONDAY, January 4.

oyal Geographical Society, at 3.30.—The President: South and East (Christmas Lecture for Young People).

WEDNESDAY, January 6.

University College, at 3.—Sir Richard Gregory, Bt.: Comets and Shooting Stars.

Belfast Museum and Art Gallery, at 8.—Mrs. H. Richardson: Costume and History.

Annual Meeting.

January 4 and 5.

Mathematical Association (at London Day Training College).

Monday, Jan. 4, at 3.30.—Sir Arthur Eddington: The Decline of Determinism (Presidential Address).

At 5.—Prof. S. Brodetsky: Modern Dynamics in Astronomy, Relativity, and Quantum Theory.

uesday, Jan. 5, at 10 A.M.—Discussion on The Report of the Association of University Teachers on Entrance Tests and Initial Degrees.

At 11.15 A.M.—Dr. S. Verblunsky: The Foundations of Mathematics.

At 12.15.—Prof. A. Lodge: Interpolation by Central Differences.

At 2.30.—G. Frecheville: The Application of Mathematical Methods to Research Work in Agricultural Economics.

At 3.30.—Discussion on Calculus and Co-ordinate Geometry at the School Certificate Stage, with special reference to the Additional Mathematics Syllabus of the Joint Matriculation Board of the Northern Universities.

Conferences.

December 29 to January 1.

cience Masters' Association.

esday, Dec. 29 (at King's College for Women), at 8.15.—Dr. C. Norwood: Presidential Address.

Wednesday, Dec. 30 (at Imperial College of Science and Technology), at 10.15 A.M.—Prof. J. Thorpe: The Schools and Research (Lecture).

At 11.45 A.M.—Discussion on The Correlation of Mathematics and Science.

At 5.30.—E. G. Savage: Demonstration of Experiments on Colour.

At 6.15.—F. A. Meier: Lecture-Demonstration.

(At King's College for Women), at 8.15.—Dr. G. C. Simpson: Modern Weather Forecasting (Lecture).

Thursday, Dec. 31 (at Imperial College of Science and Technology), at 10 A.M.—Discussion on The Size of Classes for Practical Work in Science.

At 11.30 A.M.—Lecture-Demonstration by the Television Society.

At 5.30.—F. A. Meier: Lecture-Demonstration.

At 6.15.—E. G. Savage: Demonstration of Experiments on Colour.

(At King's College for Women), at 8.15.—Prof. E. W. MacBride: The Inheritance of Acquired Characters (Lecture).

January 4 to 11.

Conference of Educational Associations (at University College).

Monday, Jan. 4, at 3.—Sir William Rothenstein: Presidential Address.

At 5.—Dr. E. Miller: The Difficult Child: Sociological *v.* Individual Interpretations (Lecture) (British Psychological Society—Education Section).

Tuesday, Jan. 5, at 2.30.—Discussion on The Film as an Instrument of Humane Education (University of London Animal Welfare Society).

At 3.—J. H. Whitehouse: Public Schools and the Public Life (Lecture) (Society for Experiment and Research in Education).

Wednesday, Jan. 6, at 3.—Sir Richard Gregory, Bt.: Comets and Shooting Stars (Lecture) (School Nature Study Union).

At 5.30.—Prof. D. Laurie: Biology in Schools (Lecture) (Association of Assistant Mistresses).

Thursday, Jan. 7, at 2.30.—Mrs. C. B. S. Hodson: Desirability of including Simple Biology and Heredity Teaching in the School Curricula (Lecture) (Eugenics Society).

Friday, Jan. 8, at 2.—Discussion on Physical Education in Schools (Medical Officers of Schools Association).

January 6 to 11.

Geographical Association (at London School of Economics).

Wednesday, Jan. 6, at 9.30 A.M.—Opening of Publishers' Exhibition and Address by Miss E. H. McLean.

At 11 A.M.—Discussion between the Historical Association and the Geographical Association: What is Historical Geography?

At 2.—Sir Leslie Mackenzie: A Health Administrator's Attitude to Geography (Presidential Address).

At 5.30.—S. A. S. Hozayen: The Expansion of the Arabs and their Contribution to Geography (Lecture).

Thursday, Jan. 7, at 11 A.M.—Mrs. H. Ormsby: The Part played by the Limestones in the Human Geography of France (Lecture).

At 12.—J. Fairgrieve: Demonstration Lesson with Films.

At 2.—Demonstration of Amateur Films.

At 3.—J. Fairgrieve: The Use of Films in Teaching.

At 5.—Prof. P. F. Kendall: How Britain became an Island (Lantern Lecture).

Friday, Jan. 8, at 10.30 A.M.—Brigadier H. S. L. Winterbotham: New Developments of the 1″ Map (Lantern Lecture).

At 11.30 A.M.—Prof. Gerhard Schott: The Humboldt Current in Relation to Land and Sea Conditions on the Peruvian Coast (Lantern Lecture).

At 2.45.—Discussion on The Difficulties of using the Lantern in Primary Schools.

Discussion on The Scope and Content of the Geography of the 'rest of the world' in the First School Certificate Examination.

Exhibition.

JANUARY 5 TO 7.

EXHIBITION OF SCIENTIFIC INSTRUMENTS AND APPARATUS (at Imperial College of Science and Technology), 3 to 6 and 7 to 10.

Tuesday, Jan. 5, at 8.—C. C. Paterson: Photocells: The Valves which operate by Light (Lecture).

Wednesday, Jan. 6, at 8.—T. Smith: Photographic Shutters and their Properties (Lecture).

Thursday, Jan. 7, at 8.—Sir Oliver Lodge: Reminiscences (Lecture).

Official Publications Received.

BRITISH.

Leeds University: Department of Pathology and Bacteriology. Annual Report by Prof. Matthew J. Stewart and Prof. J. W. McLeod; with Abstract Report on Experimental Pathology and Cancer Research, by Prof. R D. Passey. Pp. 15. (Leeds.)

Annual Report for the Year 1930 of the South African Institute for Medical Research, Johannesburg Pp. 81+3 plates. (Johannesburg.)

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1410 (Ae. 531—T. 3095). Experiments on the Flow Past a Rotating Cylinder. By A. Thom. Pp 13+13 plates. 1s. net. No. 1404 (Ae. 525—Spin 62): Free-Flight Spinning Experiments with Several Models. By A. V. Stephens. Pp. 12+10 plates. 1s. net No. 1405 (Ae. 526—T 3108): The R A E. Automatic Observer Mark IA. By D. A. Jones. Pp 6+6 plates. 1s. net. No. 1407 (Ae. 528—T. 3045a): Note on Change of Wind with Height. By L. W. Bryant. Pp. 8+2 plates 6*d*. net. No 140 (Ae. 530—T. 3135): The Drag of Small Streamline Bodies. By E. Ower and C T. Hutton. Pp. 7+3 plates. 6*d*. net. (London: H.M. Stationery Office.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Forestry Society. Vol. 45, Part 2, October. Pp. xvi+121-248+27-34. (Edinburgh: Douglas and Foulis.) 7*s*. 6*d*.

The South-Eastern Naturalist and Antiquary: being the Thirty-sixth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirty-sixth Annual Congress, held at Winchester 1931. Edited by A. F Ravenshear. Pp. lxii+117 (London.) 5*s*. net

Ministry of Agriculture and Fisheries. Report on the Work of the Research and Education Division for the Year 1929–30 Pp. 76. (London: H M. Stationery Office.) 1*s*. 3*d*. net.

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Thirty-fifth Session adopted at the Annual Meeting of Governors held on the 20th October 1931. Pp. 76. (Glasgow.)

Second Annual Report of the National Smoke Abatement Society. Pp. 24 (Manchester.)

Royal Agricultural Society of England. Agricultural Research in 1930. Pp. vii+201. (London: John Murray.) 1*s*.

The Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), No. 13: On Alginic Acid; its Mode of Occurrence and its Constitution. By Dr. Thomas Gillon and Annie McGuinness. Pp. 129-133. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6*d*.

Proceedings of the University of Durham Philosophical Society. Vol 8, Part 4, July. Pp. iv+281-358+viii. (Durham.) 5*s*.

The Quarterly Journal of the Geological Society of London. Vol. 87, Part 4, No. 348, November 16th. Pp. 551-686+xv. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

Nutrition Abstracts and Reviews. Issued under the direction of the Imperial Agricultural Bureaux Council, the Medical Research Council, and the Reid Library. Vol. 1, Nos. 1 and 2, October. Pp. 351+xi. (Aberdeen: Imperial Bureau of Animal Nutrition.) 13*s*. net.

Transactions of the Royal Society of Edinburgh, Session 1930–1931. Vol. 51, Part 2, No. 20: Note on Cayley's Elimination-problem involving Superfluous Data. By Sir Thomas Muir. Pp. 162-168. 9*d*. Vol. 51, Part 2, No. 21; Studies in the Scottish Marine Fauna—The Crustacea of the Sandy and Muddy Areas of the Tidal Zone. By R. Elmhirst. Pp. 169-176. 9*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Transactions of the Institute of Marine Engineers, Incorporated, Session 1931. Vol. 43, No. 10, November. Pp. 449-504+xlii. (London.)

Proceedings of the Eighteenth Indian Science Congress, Nagpur, 1931 (Third Circuit). Pp. xli+543. (Calcutta: Asiatic Society of Bengal.)

Journal of the Indian Institute of Science. Vol. 14A, Part 7: The Origin and Nature of the Peaty Soils of Travancore. By T. R. Narayana Pillai and V. Subrahmanyan. Pp 99-117. 1 rupee. Vol. 14A, Part 8: The Relation between Seeds and Micro-organisms. By T. R. Sathe and V. Subrahmanyan. Pp 119-139. 1.4 rupees. (Bangalore.)

What is "Probable Error"? By Dr. J. F. Tocher. Pp. 63. (London: Institute of Chemistry.)

Journal of the Chemical Society. November. Pp. iv+2829-3088+viii. (London.)

Nigeria. Annual Report of the Geological Survey for the Year 1930. Pp. 48. (Lagos: C.M.S. Bookshop; London: The Crown Agents for the Colonies.) 4*s*.

University of Cambridge: Solar Physics Observatory. Nineteenth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1930 August 1–1931 July 31. Pp. 5. (Cambridge.)

Report of the Ninth Conference of the International Federation of Eugenic Organisations, Farnham, Dorset, September 11th to 15th, 1930. Pp. 100. (London.)

Physics in Industry Lecture No. 16: Physics in Relation to the Development of the Internal Combustion Engine, given before the Institute of Physics on May 19, 1931. By Alan E. L. Chorlton Pp. 32 (London.)

Journal of the Royal Society of Western Australia. Vol. 16, 1929- Pp. xx+85+xxi-xxxv. (Perth.) 15*s*

The North of Scotland College of Agriculture. Report on the Wo the North of Scotland College for the Year 1930–31. Pp. 30 (Aberde

India: Meteorological Department. Scientific Notes, Vol 3, No. The Bengal Cyclone of September 1919. By V. Doraiswamy Iyer. 119-129+8 plates. (Calcutta: Government of India Central Publica Branch.) 1.4 rupees, 2*s*.

Livingstone College. Annual Report and Statement of Accounts the Year 1930–31 Pp. 24. (London: Leyton, E.10.)

Transactions and Proceedings of the New Zealand Institute. Vol. Part 2, September. Pp. iii+67-178+plates 9-25. (Dunedin.)

FOREIGN.

Memoirs of the College of Science, Kyoto Imperial University. Se A, Vol. 14, No. 5, September. Pp 195-250. (Tokyo and Kyoto: Maru Co., Ltd.) 1.30 yen

Japanese Journal of Astronomy and Geophysics. Transactions Abstracts, Vol 9, No. 1. Pp. 75+5. (Tokyo: National Research Cou of Japan.)

Proceedings of the United States National Museum. Vol. 79, Art The Stegocephalid and Ampeliscid Amphipod Crustaceans of Newfou land, Nova Scotia and New Brunswick in the United States Natio Museum. By Clarence R. Shoemaker. (No. 2888.) Pp. 18. Vol. 79, A 34: Flies of the Genus Pseudotephritis Johnson (Diptera: Ortalidae). John R Malloch. (No. 2900.) Pp. 6. (Washington, D.C.: Governm Printing Office.)

Field Museum of Natural History. Anthropology Memoirs, Vol. No. 3: Report on Excavations at Jemdet Nasr, Iraq By Ernest Macka (Field Museum-Oxford University Joint Expedition.) Pp 217-303+plat 63-80 (Chicago.)

Memoirs of the San Diego Society of Natural History. Vol. 1: Catalo of the Marine Pliocene and Pleistocene Mollusca of California and adjac Regions, with Notes on their Morphology, Classification and Nom clature, and a Special Treatment of the *Pectinidae* and the *Turridae* (cluding a few Miocene and Recent Species); together with a Summary the Stratigraphic Relations of the Formations Involved. By U. S. Gra IV., and Hoyt Rodney Gale. Pp. 1036 (32 plates). (San Diego, Cal 8 dollars.

Smithsonian Miscellaneous Collections Vol 85, No. 6: Morphology the Insect Abdomen. Part 1: General Structure of the Abdomen and Appendages. By R. E. Snodgrass. (Publication 3124.) Pp. 128. Vol. No. 8: Modern Square Grounds of the Creek Indians. By John Swanton (Publication 3126) Pp. 46+5 plates. (Washington, D. Smithsonian Institution.)

Sudan Notes and Records. Vol 14, Part 2. Pp iv+105-197+15 plat (Khartoum: Sudan Notes and Records; London: Sudan Governm Office.) 30 P.T; 6*s*

Journal of the Faculty of Science, Imperial University of Tokyo. Sect 4: Zoology. Vol. 2, Part 4. Pp 225-447. 3.80 yen. Vol. 3, Part 1. 90. 1.60 yen. (Tokyo: Maruzen Co., Ltd.)

Report of the Aeronautical Research Institute, Tôkyô Imperial Uni sity. No. 73: Über die Herstellung und die mechanischen Eigenscha der Al-Cu-Si Legierungen. Von Masaharu Gotô, Sin-ichi Fukuta, Sa Horiguchi und Tenji Nagai. Pp 141-217. 0.56 yen. No. 74. Action Antioxygens in the Oxidation of Unsaturated Fatty Oils 3: The lation between the Induction Period in Oxidation and the Catalytic Eff of Driers. By Bunnosuke Ramaguchi. Pp. 219-235. 0.16 yen. No. Action of Antioxygens in the Oxidation of Unsaturated Fatty O 4: Oxidation of Triolein. By Bunnosuke Yamaguchi. Pp. 237-250. yen. (Tôkyô: Koseikai Publishing House.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. The Miocene and Recent Mollusca of Panama Bay. By H. A. Pilsbr Pp. 427-440. A Small Collection of Fishes from Singapore. By Henry Fowler. Pp. 443-448 (Philadelphia.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japa First Series (Mathematics, Physics, Chemistry), Vol. 20, No. 4. Pp. 4 648. (Tokyo and Sendai: Maruzen Co., Ltd.)

Publications de l'Observatoire Astronomique de l'Université de Belgrad Tome 4: Annuaire pour l'an 1932. Rédigé par V. V. Michkovitch. Pp. (Beograd.)

U.S. Department of Agriculture Circular No. 189: Control of the Sa Moth by Spraying in Alternate Years. By C. W. Collins and Clifford Hood. Pp. 12. (Washington, D.C.: Government Printing Office.) cents.

Japanese Journal of Geology and Geography. Transactions and stracts, Vol. 9, Nos. 1 and 2, September. Pp. ii+142+8+11 plat (Tokyo: National Research Council of Japan.)

U.S. Department of Commerce: Bureau of Standards. Miscellane Publication No. 181: Annual Report of the Director of the Bureau Standards to the Secretary of Commerce for the Fiscal Year ended June 1931. Pp. ii+50. 15 cents. Research Paper No. 354. The Passage of through the Walls of Pyrometer Protection Tubes at High Temperatur By Wm. F. Roeser. Pp. 485-494. 5 cents. (Washington, D.C.: Gove ment Printing Office.)

Bulletin of the American Museum of Natural History. Vol. 63, Arti 1: The Upper Zonal Bird-Life of Mts. Roraima and Duida. By Frank Chapman. Pp. 135. (New York City.)

Smithsonian Institution: United States National Museum. Bulletin 1 Contributions to the Biology of the Philippine Archipelago and adjac Regions. Four New Species of Polychaetous Annelids collected by United States Fisheries Steamer *Albatross* during the Philippine Expe tion of 1907–1910. By Aaron L. Treadwell. Pp 313-321. (Washingt D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 80, Art. Observations on the Growth Rate of the Foot in the Mound Birds of Genus Megapodius. By Herbert Friedmann. (No 2901.) Pp. 4. (Wa ington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences, Fourth Series. 20, No. 2: The Flora of the Revillagigedo Islands. By Ivan M. Johnst Pp. 9-104. (San Francisco.) 1.25 dollars.

Collection des travaux chimiques de Tchécoslovaquie. Rédigé publiée par E. Votoček et J. Heyrovský. Année 3, No. 11, Nove Pp. 517-562. (Prague: Regia Societas Scientiarum Bohemica.)